



# Genetic Variability Studies in Yellow Seeded Linseed

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## **Authors' contributions**

*This work was carried out in collaboration among all authors. Author Jaishri carried out the experiment and wrote the manuscript with the support of author JKP and analyze the data and contributed to the interpretation of results. Authors Dr. SSR and Dr. NM supervised and planned the experiment. All authors provided critical feedback and helped shape the research, analysis and manuscript. All authors read and approved the final manuscript.*

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## **ABSTRACT**

The experimental materials consisted of 40 yellow seeded genotypes of linseed taken from "AICRP on linseed, Department of Genetics and Plant Breeding, IGKV, Raipur", Chhattisgarh, India along with one check variety Surabhi. Seed yield is an important trait and the cumulative result of a number of component traits controlled by polygenes and influenced greatly by the environmental factors. Hence, yield alone would not be effective for selection of superior genotypes. In order to make the selection effective one has to give emphasis on the yield attributing traits. According to analysis of variance, "significant differences exist for all the parameters investigated from yellow seeded linseed genotypes." It demonstrates that the yellow seeded genotypes of linseed have sufficient variability in seed yield and contributing characteristics. 1000 Seed weight (7.7g) and seed yield (15g) were the highest in the YLS-31 and YLS-23 genotypes, respectively. The highest GCV was found in number of secondary branches per plant (39.5%) followed by seed yield (32.1%), harvest index (21.6%), and number of primary branches per plant (24.3%). The highest PCV was

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found in the number of primary branches per plant (47%). Number of secondary branches per plant (43.2%), 1000 seed weight (37.9%), number of capsules per plant (33.9%) and harvest index (22.8%) were the next most important factor.

**Keywords:** Additive gene; harvest index; heritable; replications.

## 1. INTRODUCTION

Linseed (*Linum usitatissimum* L.), commonly known as alsin, flax, or flaxseed, is a seed that comes from the *Linum usitatissimum* L. plant. It belongs to the genus name *Linum* and is self-pollinating. *Linum* is a Latin term that means "very beneficial" and comes from the word *lin*, which meaning "thread." It belongs to the Linaceae family. It flourishes in deep damp sand, silt, and clay soils. The species is endemic to the eastern Mediterranean, Western Asia, the Middle East, and India. It's a multipurpose oilseed crop that has been farmed for fiber (flax) and oil since ancient times (yellow seed linseed). Linseed has two origins, based on plant diversity, namely South West Asia, mainly in India [1] and the Mediterranean region of Europe and the United States.

The flowers are bisexual, have erect, long pedicels, a superior ovary, or hypogynous state, and are made up of five sepals, five petals in various colors such as blue, violet and white. five stamens and five carpels that combine to form a complex pistil, each of which is divided by a false septum. The fruit comes in the form of globular capsules with eight to ten seeds. The oval, lenticular seed has a smooth, glossy surface, is 46 mm in length, and is colored from brown to golden seeds with a protein level of 20-25% and an oil content of 35-45%. In general the harvest index varies from 0.19 to 0.31. The test weight or 1000 seeds weight is nearly 4.5 per 1000 seeds. It is a significant oilseed crop grown on 2.09 lakh hectares in India, with yields of 1.40 lakh tones and 669 kg/ha, respectively. 10.92 thousand hectares of linseed with a productivity of 316 kg/ha were planted in Chhattisgarh in 2021–2022 (Source: Director's Report AICRP Linseed and Safflower 2022-23). It is grown on 41.42 lakh hectares worldwide, producing 33.39 lakh tons, and has a productivity of 952 kg/ha. (Source-FAOSTAT 2020–21). After China, Kazakhstan, the Russian Federation, Canada, and the United States of America, India came in sixth place in terms of output [2]. India ranks sixth globally in terms of the two acreage and production contributed by linseed, at 13% and 5.5%, respectively.

For the genetic enhancement of linseed crop either through direct improvement of traits in which plant breeder is interested or indirect enhancement through component traits can be successfully achieved using ample genetic information on linseed crop. In order to touch the eventual goal of getting high quality seed yield, study of presence of genetic variability for seed yield and its improvement, is a crucial prerequisite. Seed weight and seed yield in yellow seeded linseed will provide an additional assistance in deciding the selection criteria for selecting dual purpose linseed genotypes and would provide enough opportunities to enhance its cultivation in the state of Chhattisgarh.

## 2. MATERIALS AND METHODS

The field experiments were conducted in Randomized complete block design with three replications during rabi season 2020-21 in forty yellow seeded linseed genotypes including one check (Surabhi). The genotypes were collected from All India Coordinated Research Project (AICRP) on Linseed, functioning at the Research Cum Instructional Farm, Department of Genetics & Plant Breeding Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. All the recommended package of practices was carried out to raise the good crops. Five competitive plants have been randomly selected from each plot for taking observations for the variability studies.

In this experiment, observations on traits related to seed yield and its components traits based on linseed descriptor, Kanpur [3] "National guidelines for the conduct of tests for Distinctness, Uniformity and Stability in linseed, India" published as per Catalogue on linseed germplasm, Project Coordinating Unit (Linseed), Kanpur, [3] have to record. Following traits were evaluated plant height (cm), days to 50 percent flowering, number of capsules per plant, days to maturity, number of primary branches/plant, number of secondary branches/plant, 1000 seed weight (g), oil content (%), harvest index (%), seed yield/ plant (g).

**Genetic-statistical analysis:** All the statistical analysis has to be done with the aid of windostat version 9.2 from indostat service, Hyderabad.”

**List 1. Genotypes of yellow seeded linseed**

S.N.	Genotypes	S.N.	Genotypes
1.	YLS-1	21.	YLS-21
2.	YLS-2	22.	YLS-22
3.	YLS-3	23.	YLS-23
4.	YLS-4	24.	YLS-24
5.	YLS-5	25.	YLS-25
6.	YLS-6	26.	YLS-26
7.	YLS-7	27.	YLS-27
8.	YLS-8	28.	YLS-28
9.	YLS-9	29.	YLS-29
10.	Surabhi©	30.	YLS-30
11.	YLS-11	31.	YLS-31
12.	YLS-12	32.	YLS-32
13.	YLS-13	33.	YLS-33
14.	YLS-14	34.	YLS-34
15.	YLS-15	35.	YLS-35
16.	YLS-16	36.	YLS-36
17.	YLS-17	37.	YLS-37
18.	YLS-18	38.	YLS-38
19.	YLS-19	39.	YLS-39
20.	YLS-20	40.	YLS-40

Analysis of Variance was carried out as per the method suggested by Panse and Sukhatme [4]. Heritability in terms of broad sense (bs) was evaluated by using the formula given by Allard [5]. The genotypic coefficient of variation and phenotypic coefficient of variation was computed as per Burton [6], heritability (broad sense), and genetic advance as a percent of the mean as per Allard [5]. The genotypic and phenotypic coefficient of correlation was calculated using the method given by Johnson et al. [7].

**3. RESULTS AND DISCUSSION**

Based on the data of linseed the mean sum of squares due to genotypes was found to be highly significant under all the conditions for all the characters. This evidently specifies that variability does exist in all the genotypes for all the component traits. Results showed significant and relatively large percentage of the total variation attributable to “G x E interaction” suggests that genotypes responded differently to different environments of linseed.

Earlier finding of Reddy et al. [8], Tyagi et al. [9], Kumar et al. [10], Paul et al. [11] and Dhirhi and

Mehta [12] reported that analysis of variance clearly indicated that there was highly significant variation amongst the genotypes for all the traits studied.

Analysis of variance for seed yield and its contributing traits” in the set of yellow seeded genotypes of linseed are as follows in the tables.

Oil content ranges from 31.1% (YLS-36) to 41.9% (YLS-20) with a mean value 35.6%. YLS-20 has recorded high oil content (41.9%) when compared to the best performing check variety Surabhi © (31.5%).

The seed yield of the yellow seeded genotypes of linseed varied from (3.97g) to (13.9g). YLS-40 was best genotype in terms of seed yield per plant as compared to all other genotypes which showed (13.9g) seed yield. Harvest index ranges from 13.4% (YLS-3) to 40.6% (YLS-4) with a mean value of 30.2 %. YLS-4 was recorded highest harvest index.

Earliest days to 50% flowering was recorded in YLS-4 (48.6 days), whereas best performing check variety was recorded 64.3 days i.e. Surabhi.

Variation due to phenotypic coefficient is high as compared to genotypic coefficient. It evidently specifies that the appearing variation is not due to genotype but also due to the influence of environment. Comparative study of “coefficient of variation” on various traits revealed relatively high influence of genotypic variation in determining the total “phenotypic variation” for most of the traits.

The maximum variation in genotypic coefficient was found for number of secondary branches per plant (39.5%) subsequently seed yield (32.14%), and number of capsules per plant (31.0%). GCV is moderate for 1000-seed weight (16.8%) and plant height (14.0%). While, high variation in phenotypic coefficient was found for number of primary branches per plant (47.03%) followed by number of secondary branches per plant and seed yield (37.9%) shows the existence of considerable amount of variability for those characters among the genotypes. Similarly, the reports made by earlier workers in linseed viz., Awasthi and Rao [13], Reddy et al. [8] Tariq et al. [14], Kumar et al. [10] and Patel et al. [15] who reported “higher phenotypic and genotypic coefficient of variations for these traits.

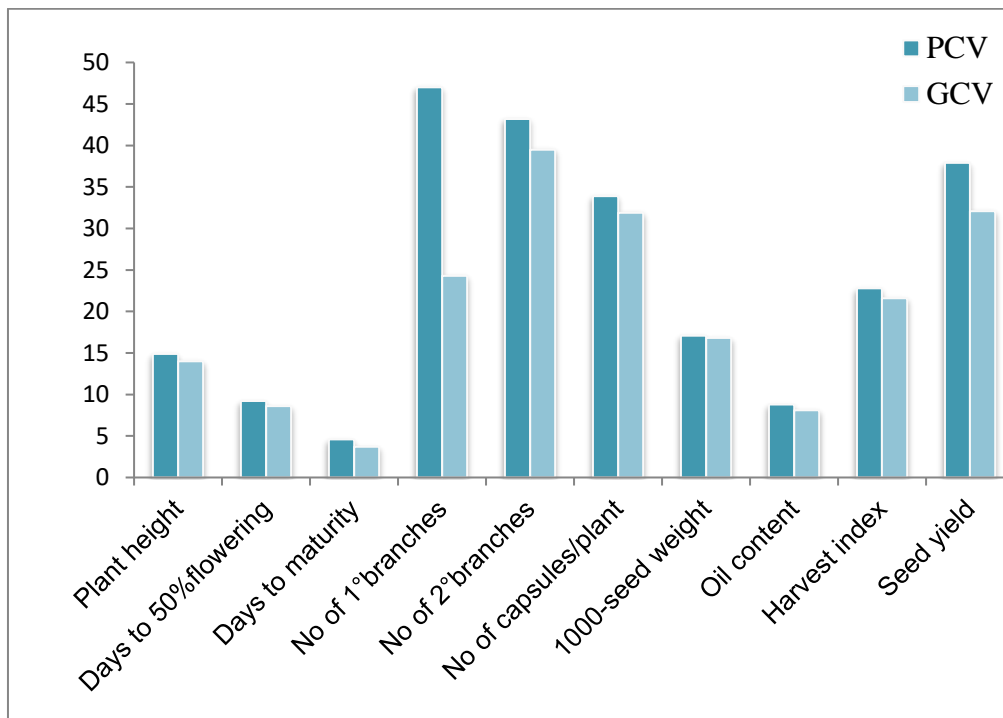
**Table 1. Analysis of variance for seed yield and its contributing traits in yellow seeded linseed during 2020-2021 at Raipur (C.G)**

S.N.	Source of variation	DF	PH(cm)	DTF	DM	PB	SB	C	SW(g)	OC(%)	HI(%)	SY(g)
1	Replication	2	24.9*	11.0	1.81	68.5**	167.5	195.6	0.02	5.2	0.3	40.5**
2	Treatment	39	177.4**	89.8**	70.3**	12.9**	170.0**	802.4**	3.25**	26.9**	133.6**	30.8**
3	Error	78	7.6	3.8	11.0	6.1	10.4	33.0	0.03	1.3	4.9	3.6
4	Total	119										

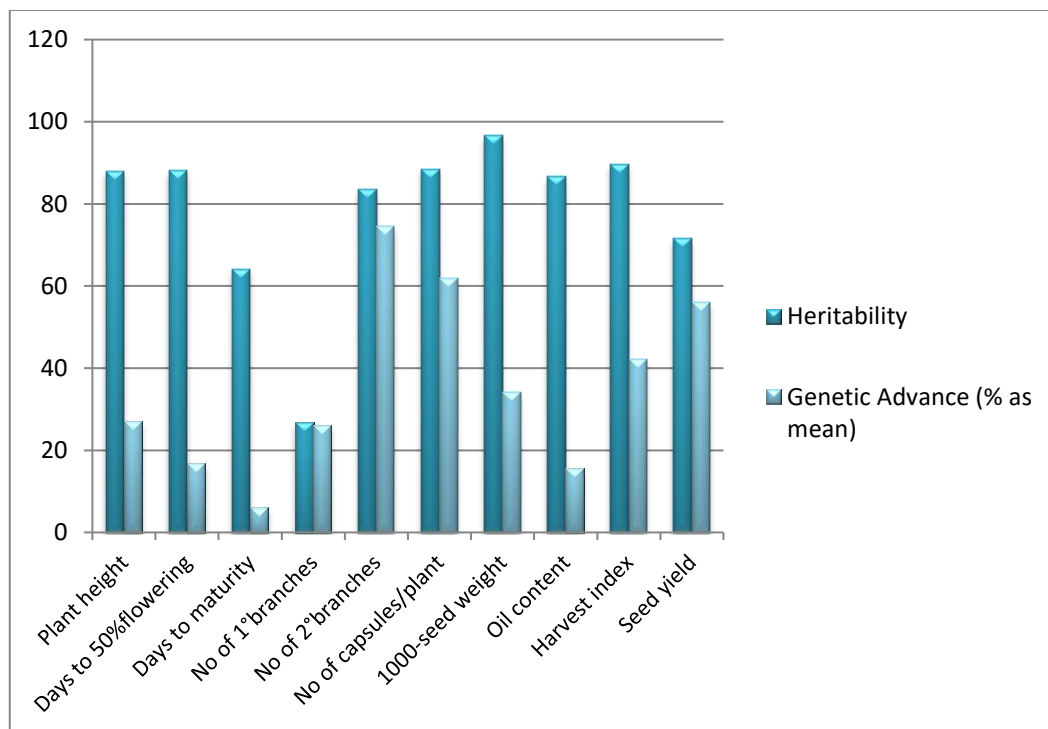
Significant at 5 % level (\*), Significant at 1 % level (\*\*)

PH- Plant height (cm)  
 DTF- Days to 50% flowering  
 DM- Days to maturity  
 PB- Primary branches per plant  
 SB- Secondary branches per plant

C- Number of capsules per plant  
 SW- 1000 Seed weight (g)  
 SY- Seed yield (g)  
 OC- Oil content (%)  
 HI- Harvest index (%)



**Fig. 1(a).** Graphical representation of comparison of PCV (Phenotypic coefficient of variation) and GCV (Genotypic coefficient of variation) of seed yield and its contributing traits in yellow seeded linseed during 2020-21 at Raipur (C.G.)



**Fig. 1(b).** Graphical representation of Heritability and genetic advance as mean percent for seed yield and its contributing characters in yellow seeded linseed 2020-21 at Raipur

**Table2. Genetic parameter of variation for seed yield and its contributing traits of yellow seeded linseed during 2020-2021 at Raipur(C.G)**

S.N.	Characters	Mean	Range		Critical differences (5%)	Coefficient of Variation (%)		$h^2_{(bs)}$	GA	GA % (mean)
			Max.	Min.		PCV	GCV			
1	Plant height (cm)	53.4	70.4	41.6	4.5	14.9	14.0	88.0	14.5	27.1
2	Days to 50% flowering	61.8	70.7	48.6	3.2	9.2	8.6	88.1	10.3	16.7
3	Days to maturity	119.4	126.8	111.2	4.4	4.6	3.7	64.2	7.3	6.1
4	No. of 1°branches/plant	6.1	11.8	2.2	4.0	47.0	24.3	26.8	1.6	26.0
5	No. of 2°branches/plant	18.4	29.0	4.0	7.2	43.2	39.5	83.6	13.7	74.5
6	No. of capsules/plant	50.4	92.6	16.0	8.3	33.9	31.9	88.5	31.0	61.9
7	1000 -seed weight(g)	6.1	7.71	4.0	0.3	17.1	16.8	96.7	2.0	34.1
8	Oil content(%)	35.6	41.9	31.1	1.8	8.8	8.1	86.6	5.6	15.7
9	Harvest index (%)	30.2	40.6	13.4	3.6	22.8	21.6	89.6	12.7	42.2
10	Seed yield	9.3	15.0	3.8	2.7	37.9	32.1	71.6	5.2	56.0

The high heritability was observed in almost all the traits except number of primary branches per plant. Highest heritability was found for 1000-seed weight (96.7%) subsequently harvest index (89.6%) and number of capsules per plant (88.5%) whereas highest genetic advance was observed in number of secondary branches per plant (74.5%) followed by number of capsules per plant (61.9%) and seed yield (56.0%).

High heritability accompanied with high genetic advance was reported for traits viz; plant height subsequently number of secondary branches per plant, number of capsules per plant, 1000-seed weight, harvest index and seed yield. High heritability accompanied with high genetic advance enhanced the selection intensity in yellow seeded genotypes of linseed over the base population. "Significant amount of genetic variability" was recorded for quantitative characters which is an essential breeding material for selection in linseed for Chhattisgarh.

These results are in agreement with the findings of Vardhman and Rao [16], Pali and Mehta [17], Singh et al. [18], Dash et al. [19] Tiwari et al. [20] and Upadhyay and Mehta [21] reported high heritability for seed yield per hectare and number of capsules per plant. Similarly, this result is in agreement with Paul and Kumari [22] and Pali and Mehta [17] revealed that "broad sense heritability for all the characters viz., days to 50% flowering, number of primary branches per plant, number of secondary branches per plant, 1000 seed weight and harvest index were found high" [23].

1000-seed weight of YLS-31 have highest mean value (7.71g) when compared with the best performing check variety Surabhi © (4.83 g).

YLS-20 has recorded high oil content (41.9%) when compared to the best performing check variety Surabhi © (31.5%).

YLS-4 (40.6%) was recorded highest harvest index when compared to the check variety Surabhi © (28.9%).

Highest seed yield was recorded for YLS-23 (15.0g) with a mean value of 9.3g. The minimum value was found in YLS-2(3.8g) Whereas check variety Surabhi © was recorded 5.7

#### 4. CONCLUSION

Analysis of variance depicted that significant amount of variation existed among all the yellow

seeded linseed genotypes under study. The considerable amount of variability in any breeding material is essential not only for providing a foundation for selection but also for little useful information regarding selection of diverse parents that could be utilized in hybridization programmes. Under studied considerable range of variation was recorded for all the traits showed enough scope for enhancement in desirable direction. In general phenotypic coefficient of variation was high when compared to genotypic coefficient of variation for all component trait which imply that environmental conditions have concealing effect on the expression of genetic variability. High heritability accompanied with high genetic advance indicates that these characters are governed by additive gene action. Hence, selection based on these characters would be rewarding.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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