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ESTIMATION OF GENETIC VARIABILITY, CORRELATION COEFFICIENT ANALYSIS AND PATH COEFFICIENT ANALYSIS FOR YIELD AND ITS CONTRIBUTING TRAITS IN GENOTYPES OF LINSEED (*LINUM USITATISSIMUM* L.)

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ABSTRACT

In this study, sixty linseed genotypes, including three checks (RLC-133, RLC-143, and RLC-148), were assessed to analyze genetic variability, correlation coefficient, and path coefficient analysis for yield and its contributing traits in linseed genotypes during *rabi* 2021-22 and *rabi* 2022-23 at the Department of Genetics and Plant Breeding, IGKV, Raipur, C.G., India. An analysis of variance for all traits revealed that the presence of significant variability among the sixty linseed genotypes. The phenotypic coefficient of variation (PCV) exceeded the genotypic coefficient of variation (GCV) across all traits. The highest value of GCV and PCV was recorded for seed yield per plant (39.1 and 40.5), number of capsules per plant (31.7 and 34.6), number of seeds per plant (31.7 and 35.1) and number of primary branches per plant (22.6 and 32.3) on pooled basis of *rabi* 2021-22 and *rabi* 2022-23. High heritability coupled with high genetic advance as percent of mean was estimated in seed yield per plant (93.5 and 77.9), number of capsules per plant (84.3 and 60), number of seeds per plant (81.3 and 58.9) and 1000 seed weight (g) (86 and 31.4) on pooled basis of *rabi* 2021-22 and *rabi* 2022-23, indicating that heritability might result from additive genetic effects, suggesting that simple selection based on these traits could be effective. Positive and significant correlation between the required characters promote improvement in both the traits. Seed yield per plant exhibited positive significant genotypic and phenotypic correlation with number of primary branches per plant (0.21 and 0.20), number of capsules per plant (0.6 and 0.6), number of seeds per plant (0.63 and 0.64) and 1000 seed weight (0.18 and 0.18) on pooled basis. Path coefficient analysis considering seed yield per plant as dependent character revealed that number of seeds per plant (0.5) showed the highest positive direct effect followed by days to 50% flowering (0.15), seed length (0.14), 1000 seed weight (0.13), number of capsules per plant (0.12), number of seeds per capsule (0.1) and plant height (0.01) on pooled basis. Direct selection for these traits may rewarded the improvement in yield because it showed their real relationship between seed yield and other characters. Significant and positive correlation along with positive direct effect with seed yield per plant was exhibited by traits such as number of capsules per plant (0.6, 0.6 and 0.12), number of seeds per plant (0.63, 0.64 and 0.5) and 1000 seed weight (0.18, 0.18 and 0.13). It signifies strong association between them and these traits should be prioritized while breeding for growth in seed yield per plant (g).

Keywords **:** Variability, Linseed, genotypes, heritability, correlation, path coefficient.

Introduction

Linseed or flax (*Linum usitatissimum* L.) is a diploid (2n=30), self-pollinated annual plant, having genome size of 368-373 Mb (Ragupathy *et al*., 2011). It is valued for its oilseed and fiber (Lay and Dybing, 1989), and belongs to the Linaceae family, which includes 14 genera and over 200 species. Linseed has two origin centers i.e., South West Asia, mainly in India (Vavilov, 1935; Richharia, 1962) and the Mediterranean region of Europe (Darlington, 1963). Later it was introduced into New World (The Americas) after extensive dissemination throughout Asia and Europe (Soto-Cerda *et al.* 2013). The

Mediterranean region near the Indian subcontinent harbours the greatest biodiversity of *Linum* species (Genesar and Morris, 2003; Fu, 2005; Kaur *et al.*, 2017), with Ethiopia serving as a secondary center (Wakjira, 2004). *L. usitatissimum* is notable within the Linaceae family for its economic importance. Seed yield directly affects crop profitability, while traits increasing oil content enhance value (Tadesse *et al.*, 2009). The cultivated species originate from a single event of domestication from *L. bienne* (Allaby *et al.*, 2005). Early domestication focused on annual growth cycle, reduced capsule shattering, and improved self-fertilization efficiency (Fu, 2011).

Despite the many benefits of linseed, its cultivation is restricted to only 195 thousand hectares area in India with the production and productivity level of 130 thousand tonnes and 666 kg per. ha (Ministry of Agriculture, Government of India, 2021-22). In Chhattisgarh, Linseed is cultivated over 11.5-thousand-hectare area, with a production of 3.89 thousand tonnes and productivity of 338 kg per. ha (Source- Director's report of annual group meeting of safflower and linseed 2022). A declining trend in the area, production and productivity in linseed was observed in India.

The effectiveness of various characters that influence seed yield is the outcome of a complex relationship among several plant traits. All yield and quality related traits of plant interact with each other associated either directly or indirectly. It is vital for a plant breeder perspective to know the correlation of various plant traits their direct and indirect input towards seed yield to devise a more comprehensive and precise breeding procedure. Present study was carried out to analyze the relationship of yield with its causative factors and investigate the direct and indirect effects of morphologically independent characters on yield.

Materials and Methods

In the current study, the research material utilized was obtained from the AICRP on Linseed, Department of Genetics and Plant Breeding, Indira Gandhi Krishi Vishwavidyalaya, Raipur, C.G. (India). The material consisted of sixty diverse genotypes, including both exotic and indigenous varieties. The experiment was conducted at the Research cum Instructional Farm, College of Agriculture, IGKV, Raipur, Chhattisgarh, situated at an altitude of 289.6 meters above mean sea level (210 16" N and 810 36" E). The study was carried out using a Randomized Complete Block Design with three replications utilizing plots containing a single four-meter-long row. The spacing was maintained at 30 cm between rows and 10 cm between individual plants. To ensure sufficient germination, pre-sowing irrigation was applied. Prior to sowing, the experimental plots were carefully prepared, and Farm Yard Manure (FYM) was incorporated. Linseed cultivation adhered to the suggested application rates for fertilizers and manure. Irrigation was administered as required, and the trial was routinely weeded. Linseed cultivation adhered to the suggested application rates for fertilizers and manure. Irrigation was administered as required, and the trial was routinely weeded. Other necessary cultural practices were performed accordingly. Every accession was consistently monitored during the entire growing season at various growth stages, and any off type's traits were removed.

The observations were recorded on five randomly selected plants from each line for eleven quantitative characters viz. days to 50% flowering, days to maturity, plant height (cm), number of primary branches per plant, number of capsules per plant, number of seeds per capsule, number of seeds per plant, seed length (mm), seed width (mm), 1000 seed weight (g) and seed yield per plant (g).

All the statistical analysis has been done with help of statistical package Windostat 9.30 ver., except for correlation analysis which is done by R 3.6.1. The analysis of the statistical data was carried out under following points that are analysis of variance, range, standard deviation, genotypic & phenotypic coefficient of variation, heritability and correlation coefficient analysis among the quantitative character recorded.

Results and Discussion

Analysis of variance

Before subjecting the data to the analysis of various genetic parameters, an analysis of variance (ANOVA) was conducted for all eleven traits to assess differences among the genotypes. The ANOVA performed according to the Randomized Complete Block Design revealed that the mean sum of squares attributable to genotypes was highly significant for all traits examined, including days to flowering, days to maturity, plant height (cm), number of primary branches per plant, number of capsules per plant, number of seeds per capsule, number of seeds per plant, seed length (mm), seed width (mm), 1000 seed weight (g) and seed yield per plant (g) are presented in Table 1.

Genetic variability

The findings of genetic variability indicated that, overall, the phenotypic coefficient of variation for all traits examined was greater than the corresponding

genotypic coefficient of variation, suggesting a significant environmental impact on the expression of these traits (Table 2).

Phenotypic and genotypic coefficient of variability

The estimates of phenotypic coefficient of variation was greater than genotypic coefficient of variation which means environment exerted masking influence on the expression of genetic variability. This suggests that the traits are influenced not only by genetic factors but also by the surrounding environment, thereby contributing to their overall variability. On pooled basis of *rabi* 2021-22 and *rabi* 2022-23, The high genotypic coefficient of variance (GCV) was recorded for seed yield per plant followed by the number of capsules per plant, number of seeds per plant and number of primary branches per plant whereas, the phenotypic coefficient of variation (PCV) showed the highest values for seed yield per plant, number of seeds per plant, number of capsules per plant and number of primary branches per plant.

Table 1: Analysis of variance (ANOVA) for seed yield and its component traits of linseed for year 2021-22, 2022-23 & on pooled basis

S. No.	Characters	Mean sum of squares (d.f.)								
		2021-2022			2022-2023			Pooled		
		Replication (2)	Treatment (59)	Error (118)	Replication (2)	Treatment (59)	Error (118)	Replication (2)	Treatment (59)	Error (118)
1	Days to 50% flowering	0.96	39.89**	8.97	4.55	35.40**	8.49	4.84	73.77**	7.28
2	Days to Maturity	57.09	72.28**	35.84	5.76	69.93**	34.38	54.01	143.64**	20.61
3	Plant height (cm)	3.72	82.48**	6.53	2.31	93.76**	8.69	5.85	157.71**	9.79
4	Number of primary branches per plant	0.14	2.74**	0.09	0.10	3.15**	0.06	0.21	3.56**	0.53
5	Number of capsules per plant	12.74	1088.87**	10.27	6.56	1153.05**	2.90	14.03	1972.01**	59.25
6	Number of seeds per capsule	0.22	1.51**	0.24	0.20	1.20**	0.29	0.16	2.16**	0.32
7	Number of seeds per plant	2036.76	64395.93**	1207.82	1981.96	86122.63**	661.15	3796.65	13027.92**	4795.31
8	Seed length (mm)	0.01	0.34**	0.08	0.01	0.33**	0.10	0.01	0.61**	0.09
9	Seed width (mm)	0.02	0.10**	0.01	0.02	0.10**	0.01	0.03	0.18**	0.01
10	1000 seed weight (g)	0.30	2.81**	0.17	0.08	3.21**	0.20	0.08	5.97**	0.16
11	Seed yield per plant (g)	0.04	1.75**	0.02	0.02	2.00**	0.01	0.06	3.60**	0.04

and ** are Significant at 5% and 1% respectively

Table 2 : Estimation of genetic parameter for seed yield and its contributing traits in linseed on pooled basis

S. No.	Characters	Mean	Range		GCV %	PCV %	h^2(bs) %	GA as % of mean
			Min	Max				
1	Days to 50% flowering	58.85	50.67	65.83	5.7	7.3	60.3	9.1
2	Days to Maturity	107.26	93.50	117.00	4.2	6.0	49.9	6.1
3	Plant height (cm)	48.82	34.90	60.52	10.2	12.0	71.6	17.7
4	Number of primary branches per plant	3.15	1.60	4.90	22.6	32.3	48.8	32.5
5	Number of capsules per plant	56.26	24.23	93.43	31.7	34.6	84.3	60.0
6	Number of seeds per capsule	8.10	6.20	8.94	6.8	9.8	48.8	9.8
7	Number of seeds per plant	456.51	211.40	764.03	31.7	35.1	81.3	58.9
8	Seed length (mm)	4.51	3.88	5.37	6.6	9.3	50.0	9.6
9	Seed width (mm)	2.27	1.89	2.58	7.4	8.4	76.2	13.2
10	1000 seed weight (g)	5.98	4.59	8.60	16.5	17.7	86.0	31.4
11	Seed yield per plant (g)	1.97	0.65	3.62	39.1	40.5	93.5	77.9

Heritability and genetic advance as percent of mean

On pooled basis of *rabi* 2021-22 and *rabi* 2022-23, high heritability was recorded for seed yield per plant followed by 1000 seed weight, number of capsules per plant, number of seeds per plant, seed

width and plant height. This suggests that selecting directly for these traits would likely yield significant improvements in their phenotypic expression.

The highest genetic advance as percentage of mean was recorded for seed yield per plant followed by the number of capsules per plant, number of seeds per plant, number of primary branches per plant and 1000 seed weight (g). This indicates that these characters are governed by additive genes and selection can be rewarding for improvement of such characters.

On pooled basis of *rabi* 2021-22 and *rabi* 2022-23, high heritability coupled with high genetic advance as percent of mean was observed for seed yield per plant, number of capsules per plant, number of seeds per plant and 1000 seed weight (g), suggesting that selection of these traits accumulate more additive genes leading to further improvement in their performance.

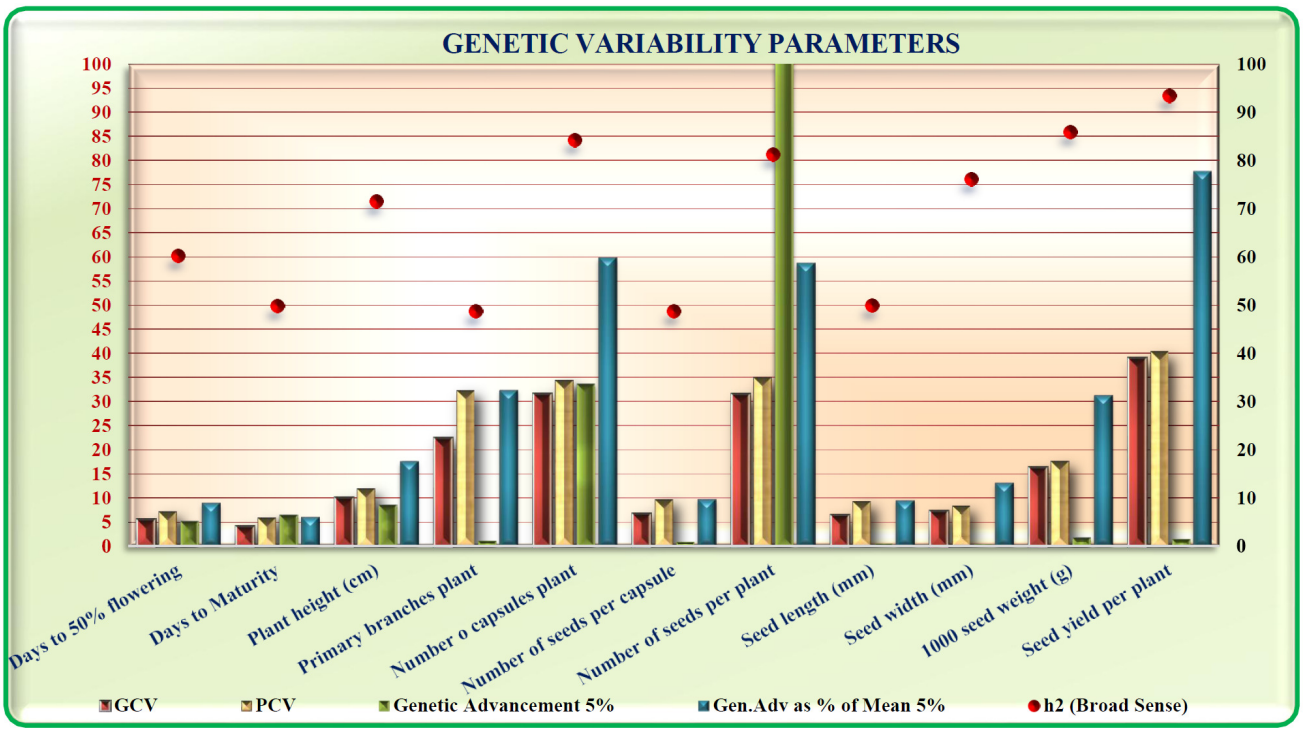

Fig. 1: Graphical representation of genetic variability parameters for seed yield and its component on pooled basis in linseed

Correlation coefficient analysis

Association studies revealed seed yield per plant reported positive significant genotypic and phenotypic correlation with most of characters like number of capsules per plant, number of seeds per capsule, number of seeds per plant, during *rabi* 2021-22. Seed yield per plant showed positive significant genotypic and phenotypic correlation with number of primary branches per plant, number of capsules per plant, number of seeds per plant, seed length and thousand seed weight during *rabi* 2022-23 and number of primary branches per plant, number of capsules per plant, number of seeds per plant and thousand seed weight on pooled basis. Thus selection of genotypes based on these character will be useful in future breeding programmes in linseed.

Path coefficients analysis

Path coefficient analysis considering seed yield per plant as dependent character revealed that number of capsules per plant followed by number of seeds per capsule, seed length, days to 50% flowering and thousand seed weight had positive direct effect during *rabi* 2021-22. Seed yield per plant showed highest positive direct effect on number of capsules per plant, thousand seed weight, seed length, number of seeds per capsule, number of seeds per plant, plant height and days to 50% flowering during *rabi* 2022-23 and on pooled basis. The direct selection for number of capsules per plant, number of seeds per capsule, seed length, days to 50% flowering and thousand seed weight could be used as selection criterion for their improvement. Direct negative effect for plant height may be useful for short stature plant in linseed.

Significant and positive correlation along with positive direct effect with seed yield per plant was exhibited by traits such as number of capsules per plant, number of seeds per capsule, seed length and thousand seed weight during *rabi* 2021-22. Significant and positive correlation along with positive direct effect with seed yield per plant was exhibited by traits such as number of capsules per plant, number of seeds per plant, seed length and thousand seed weight during *rabi* 2022- 23 and on pooled basis of *rabi* 2021-22 and *rabi* 2022-23 except for seed length. It signifies strong association between them and these traits should be prioritized while breeding for growth in seed yield per plant (g).

Table 3: Genotypic and phenotypic correlations for seed yield and its contributing traits in linseed on pooled basis

S. No.	Characters		Days to 50% flowe-ring	Days to maturity	Plant height	Number of primary branches per plant	Number of capsules per plant	Number of seeds per capsule	Number of seeds per plant	Seed length	Seed width	1000 seed weight	Seed yield per plant
1	Days to 50% flowering	r_g	**1.000**	0.571**	0.030	0.233*	-0.021	0.104	0.003	-0.046	-0.056	0.049	0.008
		r_p	**1.000**	0.578**	0.033	0.267**	-0.012	0.120	0.017	-0.044	-0.050	0.049	0.011
2	Days to maturity	r_g		**1.000**	-0.003	0.188*	-0.187*	0.179*	-0.146*	-0.178*	-0.154*	-0.202*	-0.305**
		r_p		**1.000**	-0.004	0.213*	-0.188*	0.187*	-0.143	-0.180*	-0.159*	-0.199*	-0.310**
3	Plant height	r_g			**1.000**	-0.199*	-0.080	0.127	-0.058	0.147*	0.099	0.056	0.024
		r_p			**1.000**	-0.231*	-0.092	0.119	-0.073	0.146	0.093	0.057	0.021
4	Number of primary branches per plant	r_g				**1.000**	0.353**	0.224*	0.425**	-0.160*	-0.114	0.001	0.206*
		r_p				**1.000**	0.311**	0.161*	0.371**	-0.184*	-0.158*	0.005	0.197*
5	Number of capsule per plant	r_g					**1.000**	-0.042	0.957**	-0.129	-0.105	-0.082	0.602**
		r_p					**1.000**	-0.091	0.958**	-0.138	-0.127	-0.081	0.602**
6	Number of seeds per capsule	r_g						**1.000**	0.222*	-0.072	-0.120	-0.099	0.146
		r_p						**1.000**	0.174*	-0.082	-0.147*	-0.099	0.135
7	Number of seeds per plant	r_g							**1.000**	-0.147*	-0.131	-0.090	0.631**
		r_p							**1.000**	-0.162*	-0.162*	-0.092	0.639**
8	Seed length	r_g								**1.000**	0.565**	0.433**	0.139
		r_p								**1.000**	0.566**	0.434**	0.137
9	Seed width	r_g									**1.000**	0.448**	0.065
		r_p									**1.000**	0.453**	0.059
10	1000 Seed weight	r_g										**1.000**	0.178*
		r_p										**1.000**	0.180*
11	Seed yield per plan	r_g											**1.000**
		r_p											**1.000**

*, ** = Significant at 5% and 1% levels, respectively

Table 4: Path coefficient analysis showing direct (diagonal and bold) and indirect effects of seed yield and its contributing traits in linseed on pooled basis

S. No.	Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of primary branches per plant	Number of capsules per plant	Number of seeds per capsule	Number of seeds per plant	Seed length (mm)	Seed width (mm)	1000 seed weight (g)	Seed yield per plant (g)
1	**Days to 50% flowering**	**0.153**	0.087	0.005	0.036	-0.003	0.016	0.001	-0.007	-0.009	0.007	0.008
2	**Days to maturity**	-0.147	**-0.258**	0.001	-0.049	0.048	-0.046	0.038	0.046	0.040	0.052	-0.305**
3	**Plant height (cm)**	0.0003	0.000	**0.012**	-0.002	-0.001	0.002	-0.001	0.002	0.001	0.001	0.024
4	**Number of primary branches per plant**	-0.008	-0.007	0.007	**-0.035**	-0.012	-0.008	-0.015	0.006	0.004	0.000	0.206*
5	**Number of capsules per**	-0.003	-0.023	-0.010	0.043	**0.121**	-0.005	0.116	-0.016	-0.013	-0.010	0.602**

	plant											
6	**Number of seeds per capsule**	0.010	0.017	0.012	0.022	-0.004	**0.097**	0.022	-0.007	-0.012	-0.010	0.146
7	**Number of eeds per plan**	0.002	-0.073	-0.029	0.213	0.480	0.111	**0.501**	-0.074	-0.066	-0.045	0.631**
8	**Seed length (mm)**	-0.007	-0.026	0.021	-0.023	-0.019	-0.010	-0.021	**0.145**	0.082	0.063	0.139
9	**Seed width (mm)**	0.001	0.003	-0.002	0.002	0.002	0.002	0.003	-0.012	**-0.020**	-0.009	0.065
10	**Thousand seed weight (g)**	0.006	-0.026	0.007	0.0001	-0.011	-0.013	-0.012	0.056	0.058	**0.129**	0.178*

Residual effect 0.275

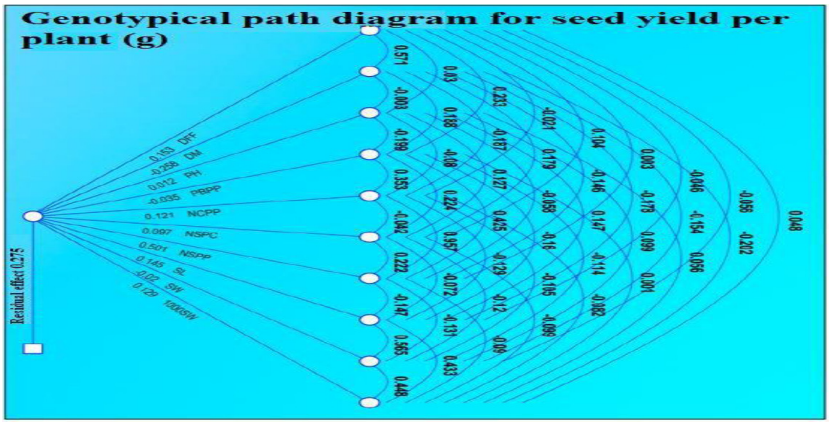

Fig. 2: Genotypical path diagram for seed yield per plant on pooled basis

References

Allaby, R.G., Peterson, G.W., Andrew, D.M. and Fu, Y.B. (2005). Evidence of the domestication history of flax (*Linum usitatissimum* L.) from genetic diversity of the Sad2 locus. *Theor. Appl. Genet.*, **112** : 58-65.

Darlington, C. D. 1963. Psychology, Genetics and the process of History. *British J. Psychol*. **54**: 293-298.

Director's report of annual group meeting of safflower and linseed 2022.

Fu, Y.B. (2005). Geographic patterns of RAPD variation in cultivated flax. *Crop Sci*., **45** : 1084-1091.

Fu, Y.B. (2011). Genetic evidence for early flax domestication with capsular dehiscence. *Genet. Resour. Crop Evol*., **58** : 1119- 1128.

Genser, A.D. and N.D. Morris. 2003. History of cultivation and uses of flaxseed. In flax- The genus Linum [A.D. Muir and N.D. Westcott, editors]. London, pp 1-21.

Kaur, V., Yadav, R. and Wankhede, D.P. 2017. Linseed (*Linum usitatissimum* L.) genetic resources for climate change intervention and its future breeding. *J. Appl. Nat. Sci*., **9**. 1112-1118. **39**(5):702-709.

Lay, C.L. and D.D. Dybing. 1989. Linseed. In: G. Robbelen *et al.* (eds.). Oil crops of the world, their breeding and utilization. McGraw- W Publishing Company. New York: 416-430.

Ministry of Agriculture, Government of India, 2021-22.

Ragupathy, R., Rajkumar, R. and Cloutier, S. 2011. Physical mapping and BAC-end sequence analysis provide initial insights into the flax (*Linum usitatissimum* L.) genome. *BMC Genomics*. 12: 217.

Richharia, R. H. (1962). *Linseed*. The Indian Central Oilseeds Committee, Hyderabad, India: 155.

Soto-Cerda, B.J., Diederichsen, A., Ragupathy, R. and Cloutier, S. 2013. Genetic characterization of a core collection of flax (*Linum usitatissimum* L.). Suitable for association mapping studies and evidence of divergent selection between fiber and linseed type. *BMC Plant Biology*, **13**(78).

Tadesse, T., Singh, H. and Weyessa, B. (2009). Genetic Divergence in linseed germplasm. *J. Innov. Dev. Strategy*, **3**(2): 13-20.

Vavilov, N.I. (1935). Studies on the origin of cultivated plants. *Bot. Pl. Breed*., 16 : 39-145.

Wakjira, A., Maryke, T. and Arno, H. 2004. Variability in oil content and fatty acid composition of Ethiopian and introduced cultivars of Linseed. *Journal of Science Food and Agriculture*, **84**: 1-8.