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Variability studies in yellow seeded linseed (*Linum usitatissimum* L.) genotypes of chhattisgarh plains

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Abstract
Sixty three (63) yellow seeded linseed genotypes taken from AICRP on linseed, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) along with three checks (Surabhi, R-552, RLC-92) were evaluated for variability among yield and yield contributing traits in yellow seeded linseed at Raipur (C.G.). The highest genotypic coefficient of variation was recorded for number of capsules per plant (38.7) followed by number of seeds per plant (3), seed yield per plant (31.8), seed length (15.7) whereas, highest phenotypic coefficient of variation was observed for number of seeds per plant (55) followed by number of capsules per plant (39.7), seed yield per plant (35.7), seed length (18.2) indicating the existence of considerable amount of variability for those traits among the genotypes. Days to 50% flowering and number of capsules/plant showed high heritability of 94% followed by plant height (81%). The significant genetic variability in any breeding material is a prerequisite as it does not only provide a basis for selection but also provide some valuable information regarding selection of diverse parents for use in hybridization programme.

Keywords: Yellow seeded linseed, variability

Introduction
The name *Linum* originated from "lin" or "thread" and the species name *usitatissimum* is a Latin word meaning "most useful". It is also called flaxseed or linseed when it is used as oilseed and referred to as fiber flax or just flax (in Europe) when it is used for fiber. Linseed or flax is one of the oldest crops cultivated by man. Linseed is an annual herb with 6,000-7,000 years planting history. Flaxseed is rich in fat, protein and dietary fibre. An analysis of brown flax averaged 41% fat, 20% protein, 28% total dietary fibre, 7.7% moisture and 3.4% ash, which is the mineral-rich residue left after samples are burned. The protein content of the seed decreases as the oil content increases. The oil content of seed generally varies from 33 to 45 per cent. If we consider the nutritional properties of linseed, the foremost thing to be mentioned is the presence of a high amount of omega fatty acids. There are two groups of omega fats: omega-3 and omega-6 fatty acids. Linolenic acid, eicosapentaenoic acid (EPA) and docosahexanoic acid (DHA) are three types of omega-3 fatty acids and are nutritionally important. Flaxseed is a rich source of dietary fiber (accounting 28%), both soluble as well as insoluble fibers. Flaxseed is the richest source of plant lignans. Besides having such a rich nutritional profile, the edible use of linseed in the country remains stagnant and the health benefits of the crop could not reach to people's diet.
Yellow seeded linseed has a higher amount of oil% as compared to brown seeded linseed (Diederichsen, 2006) [3] and yellow seeded linseed oil is found to be contributing to more clearer oil as compared to brown seeded linseed oil. The dry matter content in yellow seeded linseed is also found to be higher than that of brown seeded linseed. Brown seeded linseed is found to have high amount of mucilage in its seed coat due to higher thickness as compared to yellow seeded linseed. The National Cancer Institute has identified yellow seeded flax to possess a potential source of cancer fighting properties. Therefore studies related to yellow seeded linseed for variability will provide a new prospect to linseed improvement area of the state.

Materials and methods
The experimental materials comprised of sixty three (63) lines of yellow seeded linseed genotypes in the germplasm accession of AICRP on linseed, Indira Gandhi Krishi Vishwavidyalaya, Raipur. The genotypes were obtained by phenotypic selection from the linseed germplasm pool in *rabi* 2014-15. Theselection was made on the basis of seed colour, seed size and shape.

Classes were made on the basis of the phenotypic traits. The experiment was laid out in a randomized block design with three replications during Rabi 2015-16. The entries were sown in one row each of 3 m length with spacing of 30 cm between rows and 10 cm approximately between the plants the recommended packages of practices were followed for raising a healthy crop and all necessary plant protection measures were taken to control the pest and diseases. The observations were recorded for different qualitative and quantitative characters in linseed (based on Catalogue on linseed germplasm, Project Coordinating Unit (Linseed), C.S.A.U.A. & T. campus.

Results and discussion

The purpose of the present investigation was to generate information on morphological and molecular diagnostic traits, which can throw light on the chances of further improvement of these genotypes either through selection or through hybridization programme Analyses of variance for 11 yield and yield attributing traits in linseed have been given in Table The table indicated that the mean sum of squares due to genotypes was found to be significant for all the traits except for number of seeds per capsule. This indicates the presence of variability among yellow seeded linseed genotypes for yield and its contributing traits.

Table 1: Analysis of variance for yield and its contributing traits in yellows seeded linseed, 2015-16 at Raipur (C.G.).

S. No.	Source of variation	Df	Mean sum of squares									
			Plant height	Technical plant height	Days to 50% flowering	Days to maturity	No. of capsules/plant	No. of seeds /capsule	No. of seeds /plant	Seed length	100 seed weight	Seed yield/plant
1	RMSS	2	1.09	0.034	9.7	114.98**	50*	2.79	1937	0.0055	0.016	1.43*
2	Genotypes MSS	65	81.7**	0.44*	136.9**	80.54*	629**	1.54	5317*	0.0178**	0.02*	2.10**
3	EMSS	130	5.66	0.11	2.44	17.53	11	1.45	2017	0.0018	0.003	0.16

*- significant at 5% level of significance **- significant at 1% level of significance

Genetic variability

Results of genetic variability revealed that in general, phenotypic coefficient of variation for all the traits under study was higher to their corresponding genotypic coefficient of variation indicating substantial influence of environment in the expression of characters. (Table-2)

The highest genotypic coefficient of variation (GCV) was recorded for number of capsules per plant (38.7) followed by number of seeds per plant (3), seed yield per plant (31.8), seed length (15.7). The other traits exhibited moderate genotypic coefficient of variation. Phenotypic coefficient of variation (PCV) was found to be the highest in number of seeds per plant (55) followed by number of capsules per plant (39.7), seed yield per plant (35.7), seed length (18.2).

The traits viz. number of capsules per plant, number of seeds per plant and seed yield per plant exhibiting high genotypic and phenotypic coefficient of variation indicate the existence of considerable amount of variability for these traits among the genotypes. Hence, there is ample scope of improvement for these traits. Earlier finding of Mishra and Yadav (1999) [6] were in agreement with present study. These results fall in line with those of Mirza *et al.* (1996) [7], Mishra and Yadav (1999) [6] and Pali and Mehta (2013a) [8] reported highest magnitude of genotypic variation was observed for number of seeds per plant.

Heritability

Heritability measures the degree of resemblance between phenotypic and breeding value. Heritability is valid strictly for the population from which they are derived. The estimate for the same characters may vary considerably for different populations. Difference in the estimate of heritability is mainly due to environmental variance. The environmental variance is dependent on the condition of cultivar and management. More variable condition reduces the heritability whereas more uniform conditions increase it. The concept of heritability in broad sense is useful in knowing the relative influence of genotype and environment in determining the phenotypic difference. The estimate of heritability have been broadly classified into, low (<50%), medium (50-70%) and high (>70%) classes. Heritability in broad sense was calculated for each of the yield contributing trait under Study. The highest heritability was recorded for days to 50% flowering (94%) and number of capsules/plant (94%) followed by plant height (81%), seed yield per plant (79%) and seed length (74%). The lowest value for heritability was observed for number of seeds per capsule (18%). (Table-2).

These results fall in line with those of Mirza *et al*. (1996) [7], Mishra and Yadav (1999) [6] and Pali and Mehta (2013a) [8] reported high heritability for number of capsules plant per plant, number of seeds per plant, number of secondary branches per plant, 100 seed weight and seed yield per plant, while moderate heritability was observed for number of primary branches plant reported high heritability and high genetic advance for number of branches per plant, number of branches per plant, number of capsules per plant and seed yield per plant.

Genetic Advance (GA)

The highest amount of genetic advance was observed for number of seeds per plant (1168.81), followed by number of capsules per plant (340.80), days to 50% flowering (159.40), plant height (105.65), days to maturity (71.48) and seed yield per plant (20.62). The minimum value of genetic advance was seen for number of capsules per plant (0.33).

Table 2: Genetic parameters of variation for yield and yield contributing characters in yellow seeded linseed

S. No.	Characters	Mean	Range		Critical difference	Coefficient of variation		H^2 (bs)%
			Max.	Min.		PCV	GCV	0.81
1	Plant height(cm)	57.4	64	49	3.80	9.73	8.79	0.94
2	Days to 50% flowering	73.7	82	50	2.50	9.32	9.08	0.54
3	Days to maturity	124.7	105	130	6.7	4.97	3.67	0.47
4	Technical plant height(cm)	4.61	5.2	4	0.55	10.33	7.13	0.94
5	Number of capsules per plant	37.16	75	6.7	5.32	39.7	38.7	0.018
6	Number of seeds per capsule	8.59	10	7	1.93	14.18	1.94	0.35

7	Number of seeds per plant	323.72	729.3	54.7	227.3	55	32	0.74
8	Seed length	0.46	0.6	0.3	0.06	18.2	15.7	0.67
9	100 seed weight(g)	0.70	0.89	0.42	0.97	15.1	12.4	0.79
10	Seed yield/plant(g)	2.13	9.13	0.42	0.64	35.7	31.8	0.81

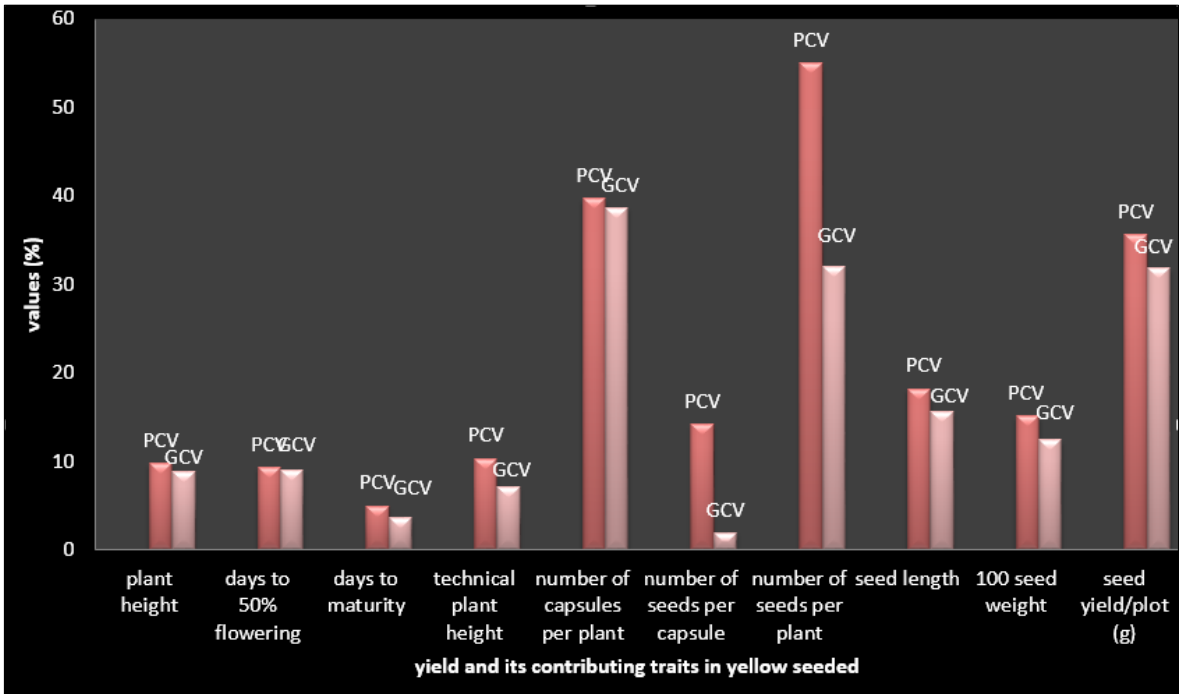

Fig 1: Graphical representation of coefficient of variation for yield and its attributing traits in linseed.

Conclusion

It was clear from the analysis of variance that variability existed among the yellow seeded linseed genotypes taken under study. Significant amount of genetic variability was observed for most the quantitative traits. The significant genetic variability in any breeding material is a prerequisite as it does not only provide a basis for selection but also provide some valuable information regarding selection of diverse parents for use in hybridization programme.

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