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A comparative analysis of genetic variability in linseed (*Linum usitatissimum* L.) under normal and late sown conditions

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Abstract
Analysis of genetic variability for yield and yield related traits was carried out using 14 characters in 34 diverse linseed genotypes. Under two environmental conditions i.e. normal and late sown conditions. High variability was observed for majority of the traits in both the conditions. High PCV and GCV was observed for fibre yield and seed yield per plant and straw yield under normal sown conditions; under late sown conditions straw yield, seed yield per plant and aerial biomass showed highest PCV and GCV. The mean values of primary branches per plant, secondary branches per plant, capsules per plant, aerial biomass were higher but mean values of 1000 seed weight and harvest index was reduced in late sown condition indicating sink number is affected by delayed sowing. High heritability coupled with high genetic advance was observed for fibre yield, seed yield per plant, straw yield and aerial biomass under normal and late sown conditions. These traits can be used as selection indices to improve yield in late sown condition as well as timely sown condition.

Keywords: linseed, phenotypic (PCV) coefficient of variation, genotypic coefficient of variation (GCV), heritability and genetic advance

Introduction
Linseed (*Linum usitatissimum* L.) commonly known as Alsi, is a multipurpose *rabi* oilseed crop, cultivated for oil (36 to 48%) and fibre (good quality having high strength and durability), belongs to the family Linaceae having 14 genera. Being an important oilseed crop, its average productivity in India as well as in Himachal Pradesh is very low, because of various factors (narrow genetic base, raising of crop by the resource poor farmers in marginal and sub-marginal areas, non-availability of high yielding varieties having resistance to biotic and abiotic stresses, etc). Keeping in view of increasing demand of linseed, there is consistent need to increase genetic seed yield potential. One way to increase seed yield potential and related traits is recombination of favorable genes. To achieve this goal, knowledge about extent of genetic variability of different traits and their correlation is very important, as the success of breeding program mostly hinge on the presence of genetic variability in the breeding material. As we know that, genetic variability provides better chances of selecting desired types and improvement in crop plants occurs through selection only if sufficient variability is present in the population.
Genetic traits such as genotypic coefficient of variability, heritability and genetic advance provide precise estimate of genetic variation of quantitative traits (Khan *et al*., 2000) [6]. The estimate of heritability is one of the most importance selection parameter, indicating the possibility and extent to which improvement can be brought about through selection. The genetic advance is more useful in predicting the actual value of selection (Johnson *et al*., 1955) [5]. Thus, studies on various parameters of genetic variability such as phenotypic and genotypic coefficient of variation, heritability and genetic advance are of paramount importance.

Material and Methods
The experimental unit comprised of 34 promising linseed (*Linum usitatissimum* L.) genotypes including three checks (Nagarkot, Him Alsi -2, Binwa) were evaluated under two environmental conditions i.e. normal sown and late sown during *rabi* crop season of 2012-13 in Randomized Block Design with three replications at Experimental Farm of the Department of Crop Improvement, CSK HPKV, Palampur. The Plot size was 1x1 m^2 and each genotype was grown in one meter length. The row-to-row distance was 25 cm and plant-to-plant was 5 cm. Recommended cultural practices and plant protection measures were followed to raise the crop. Data were recorded on number of primary branches per plant, number of

secondary branches per plant, plant height, number of capsules per plant, number of seeds per capsule, technical height, fibre yield, straw yield, retted straw yield, aerial biomass, harvest index, 1000-seed weight, oil content and seed yield per plant (g). These observations were recorded on five randomly selected plant of each genotype from every replication. The data were subjected to statistical analysis for the estimation of genetic coefficient of variation; heritability in broad sense; expected genetic advance as per the formula suggested by Burton and De Vane (1953) [4] and Johnson *et al*. (1955) [5].

Results and Discussion

The analysis of variance revealed significant differences among the genotypes for all the traits studied under both environments, indicating wide range of genetic variability and scope for selection of these traits. Similar results were also observed by Khorgade and Pillai (1994) [7] for capsules per plant. The results of genetic variability under normal sown and late sown conditions were presented in Table 1and 2. The maximum range of variation was observed for plant height followed by number of capsules per plant and harvest index under normal sown condition; plant height followed by number of capsules per plant and technical height under late sown condition indicated the scope for selection for these traits.

The estimates of PCV were higher than their corresponding GCV for all characters studied which indicated that the apparent variation is not only due to genotypes but, also due to the influence of environment. Therefore, caution has to be exercised in making selection for these characters on the basis of phenotype alone as environmental variation is unpredictable in nature. Highest phenotypic and genotypic coefficient of variation was observed for fibre yield followed by seed yield per plant and straw yield under normal sown conditions; under late sown conditions highest phenotypic coefficient of variation was observed for straw yield followed by seed yield per plant, retted straw yield and aerial biomass and genotypic coefficient of variation was observed for straw yield followed by 1000-seed weight, aerial biomass and seed yield per plant. Similar findings were also reported by Chandrashekhar *et al*. (1998) [2] and Mishra *et al*. (1999) [1, 10]. Low PCV and GCV values were recorded for oil content and seeds per capsule under normal sown conditions. Under late sown condition oil content, seeds per capsule and plant height performed low PCV and GCV values. Heritability in broad sense was high (>60%) for most of the traits under both normal and late sown conditions. However, for an effective selection programme, knowledge of the estimates of heritability alone is not sufficient and genetic advance if studied along with heritability is more useful.

Table 1: Genetic parameters of variability for different traits of linseed under normal sown condition

S. No.	Character	Mean±S.E.(m)	Range (Mini-Maxi.)	PCV (%)	GCV (%)	h²bs (%)	Genetic advance % of mean
1.	Primary branches/plant	6.92±0.31	5.33-9.10	12.77	10.15	63.00	16.59
2.	Secondary branches/plant	5.15±0.28	4.00-7.23	16.68	13.83	68.80	23.63
3.	Plant height (cm)	58.59±3.32	43.60-71.00	14.16	10.21	50.20	15.16
4.	Technical height(cm)	32.21±1.13	22.47-40.20	14.28	12.91	81.70	24.04
5.	Straw yield (g)	3.02±0.18	1.65-4.07	21.71	18.96	76.30	34.11
6.	Retted straw yield (g)	1.65±0.14	1.22-2.07	19.92	13.45	45.60	18.71
7.	Fibre yield (g)	0.45±0.03	0.30-0.56	29.68	27.97	88.80	54.30
8.	Aerial biomass (g)	4.38±0.25	2.42-5.86	19.71	17.12	75.40	30.62
9.	Seeds/capsule	7.81±0.13	7.03-8.73	6.62	5.98	81.40	11.11
10.	Capsules/plant	35.88±2.32	29.20-54.40	15.77	11.11	49.60	16.12
11.	Seed yield/plant (g)	1.36±0.12	0.77-1.86	25.14	20.39	65.80	34.07
12.	Harvest index (%)	31.12±2.06	20.13-41.75	17.35	13.02	56.30	20.14
13.	1000-seed weight (g)	6.52±0.13	4.78-7.61	12.94	12.47	92.80	24.75
14.	Oil content	38.45±0.40	35.80-42.03	5.02	4.69	87.40	9.04

High estimates of heritability coupled with high genetic advance was observed for fibre yield, seed yield per plant, straw yield and aerial biomass under normal sown condition; straw yield, 1000-seed weight, aerial biomass, retted straw yield, seed yield per plant, fibre yield, secondary branches per plant, capsules per plant and harvest index

Table 2: Genetic parameters of variability for different traits of linseed under late sown condition

S. No.	Character	Mean±S.E.(m)	Range (Mini.-Maxi.)	PCV (%)	GCV (%)	h²bs (%)	Genetic advance % of mean
1.	Primary branches/plant	10.99±0.55	6.40-14.40	18.21	15.99	77.1	28.94
2.	Secondary branches/plant	11.47±0.62	6.70-16.70	22.80	20.77	83.0	38.98
3.	Plant height (cm)	57.03±3.15	40.10-75.67	15.66	12.40	62.7	20.22
4.	Technical height(cm)	30.01±1.56	19.20-45.33	18.85	16.57	77.3	30.00
5.	Straw yield (g)	5.48±0.31	2.30-8.71	39.19	37.95	93.7	75.69
6.	Retted straw yield (g)	2.76±0.26	1.48-4.67	36.65	32.70	79.6	60.10
7.	Fibre yield (g)	0.32±0.02	0.15-0.52	28.70	27.05	88.8	52.51
8.	Aerial biomass (g)	6.99±0.41	3.39-10.58	36.59	35.13	92.2	69.48
9.	Seeds/capsule	7.81±0.15	7.00-8.70	6.40	5.47	73.1	9.63
10.	Capsules/plant	47.54±3.79	31.73-62.50	25.47	21.41	70.7	37.08
11.	Seed yield/plant (g)	1.52±0.15	0.84-2.65	36.78	32.38	77.5	58.71
12.	Harvest index (%)	22.26±1.77	16.70-32.82	24.44	20.18	68.2	34.32
13.	1000-seed weight (g)	4.18±0.09	1.76-6.70	35.44	35.23	98.8	72.14
14.	Oil content	37.55±0.41	33.19-40.81	5.04	4.67	85.8	8.91

PCV: Phenotypic Coefficient of variation; GCV: Genotypic Coefficient of variation; h²bs (%): heritability in broad sense.

Under late sown condition indicating the additive genetic control in the inheritance of these traits suggesting that early generation phenotypic selection would be effective for these traits. Similar findings were also reported by Mirza *et al.* (1996) [11], Pardhan *et al*. (1999) [10] and Payasi *et al*. (2000) [9]. High heritability coupled with moderate genetic advance was observed for primary branches per plant, secondary branches per plant, technical height and 1000-seed weight under normal sown condition; plant height, technical height and primary branches per plant under late sown condition, revealed that these traits seems to be more heritable and can be improved by selection, which was observed by earlier workers Singh and Dikshit (1988) [8], Nie *et al*., (1992) [12] and Singh (2001) [3].

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