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Variability studies for yield and its component traits in Lentil (*Lens culinaris Medikus* spp. *Culinaris*) under Bundelkhand region

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Abstract
An experiment was conducted at P.G. Research Block of College of Agriculture, Banda University of Agriculture and Technology, Banda during *rabi* 2019-2020 to evaluate lentil germplasm lines for variability, heritability, genetic advance and genetic advance as per cent of mean for yield and yield related traits. The experimenting materials were consist of 84 genotypes/varieties including check. The material was sown in Augmented Design II. Row length was 5m long, row to row distance was 30 cm and plant to plant spacing was 10 cm. Statistical analysis was done using statistical package XLSTAT, R 4.0 and online software developed by IASRI. Analysis of variance (ANOVA) indicated that significant differences were found among lentil genotypes for all 11 characters except plant height, number of seed per pod and harvest index. Genotype KLB- 115 was desirable for early flowering, LEE-18-172 for early maturity and KLB-1453 for dwarf plant type. The genotype IPLS-09-03 was found desirable for seed yield per plant. High PCV and GCV values were recorded for biological yield per plant and number of pod per plant. High genetic advance as percent of mean was noted for biological yield per plant, number of pod per plant, secondary branches per plant and primary branches per plant. High heritability along with high genetic advance as per cent of mean was observed for primary branches per plant, secondary branch per plant, number of pod per plant and biological yield per plant indicated that additive gene action is predominantly responsible for expression of these traits. Hence, direct selection for these traits may be effective for improvement of yield in lentil.

Keywords: Variability, Lentil, *Lens culinaris Medikus* spp., Bundelkhand

Introduction
Lentil (*Lens culinaris* Medikus spp. *Culinaris*) is an erect bushy annual self-pollinated *rabi* legume crop and is commonly known as Masur. The name "lentil" is derived from its typical lens shaped seeds (Joshi *et al*., 2017) [18] and evidences from Early Stone Age suggested that this is earliest domesticated crop (Get *et al*., 2019) [9]. Its diploid chromosome number is 2n = 2x = 14 and haploid genome size is 4063 Mbps (Arumuganathan and Earle, 1991) [2].
There is two sub-species of cultigen *Lens culinaris* Medikus macrosperma having seed diameter 6-9 mm and microsperma having seed diameter 2-6 mm (Barulina, 1930) [4] which was later on renamed as race *macrosperma* and race *microsperma* (Cubero, 1981) [7]. Microsperma (small seeded) type of lentil varieties are mainly cultivated in Punjab, Haryana, Uttar Pradesh and Bihar and covers 65% of the total area of lentil in India whereas macrosperma (large seeded) type varieties covers about 35% of the total area and mainly grown in Madhya Pradesh and adjoining districts of Uttar Pradesh (Tickoo *et al*., 2005) [13].
Lentil is mostly consumed as Dhal either whole or in split form in a human diet. Its flour is also used to prepare different kind of value added products such as soup, purees, bread and cakes (Williams and Singh, 1988) [26].
Lentil is a rich source of protein comprising about 26% protein and therefore is considered as poor man's meat, an alternative source of animal protein for under privileged people of the world (Akter *et al*., 2020) [1]. It also encompasses high amount of vitamins, minerals, prebiotic carbohydrates and is also contain Fe, Zn and betacarotene (Ninou *et al*., 2019) [19] and having low glycemic index (Johnson *et al*., 2020) [15]. Being rich source of protein and nutrient density, it supplement cereal based diet. Lentil plant residues contain about 10.2% moisture, 1.8% fat, 4.4% protein, 50% carbohydrate, 21.4% fiber and 12.2% ash and therefore very good source for cattle feed (Shrestha *et al*., 2018) [23].

In India, the production and productivity of lentil was about 1.56 lac tonnes and in U.P., it covered 0.476 lac ha area with 0.488 lac tonnes production and productivity of 1026 kg per ha during 2018-2019 (ASD, 2018-19).

Laskar and Khan (2017) [17] reported that the average production of lentil in India is below than the average production of the world. The agricultural land is shrinking day by day due to high population growth rate and therefore, there is an urgent need to break the important yield constraints especially low yielding cultivated lentil varieties and the narrow genetic base.

In order to formulate effective breeding strategy for development of high yielding cultivar, there is need to know the nature and magnitude of genetic variability present in a breeding population. The knowledge on genetic variability, heritability, and genetic advance are most important tools which can be used for selection criteria for improvement of seed yield. Hence present investigation has been under taken with the objective to estimate GCV, PCV, heritability and genetic advance for yield and yield related traits in lentil.

Materials and Methods

Location

The present study was carried out at P.G. Research Block of College of Agriculture, Banda University of Agriculture and Technology, Banda during *rabi* 2019-2020. The center is located at 24º53' and 25º55' North and 80º07'and 81º34' East at altitude of 113 m amsl. The climatic conditions of this district is similar to the climatic conditions of semi-arid region of the country. The total average annual rainfall of the district is about 800-910 mm and distribution pattern of rainfall is erratic in nature. The highest relative humidity which is around 85% occurs in the month of August and lowest in April.

Plant material

The experimenting material used in present investigation were comprised of 84 genotypes including 80 test germplasm lines (consisting indigenous as well as exotic accessions obtained from Chandra Shekhar Azad University of Agriculture Science and Technology, Kanpur, Uttar Pradesh and ICAR-Indian Institute of Pulses Research, Kanpur, Uttar Pradesh) and four checks namely DPL-62, KML-320, L4076 and IPL316.

Field design

The material was evaluated in augmented block design (Federrer, 1956) [8]. The design comprised of eight blocks containing 14 genotypes in each with 10 test entries and four check varieties. The check varieties were distributed randomly in each block along with test genotypes. The row length was 5m long, row to row distance was 30 cm and plant to plant spacing was 10 cm. Recommended agronomical package and practices were followed to raise good crop.

Statistical analysis

The data were recorded for eleven quantitative traits namely days to 50% flowering, days to maturity, plant height (cm), number of primary branches per plant, number of secondary branches per plant, number of pods per plant, number of seeds per pod, 100-seed weight (g), biological yield per plant (g), seed yield per plant (g) and harvest index (%) on ten randomly tagged plants of eighty genotypes and four checks. The mean values were subjected to the statistical analysis using the statistical package XLSTAT, R 4.0 and online software developed by IASRI. Genotypic and phenotypic coefficient of variation was calculated as per formula given by Burton and de Vane (1953) [5]. Heritability in broad sense was estimated using the method given by Hanson *et al.* (1956) [10]. Genetic advance and genetic advance as per cent of mean was computed as per the formula suggested by Johnson *et al.* (1955) [11].

Results and Discussion

The perusal of analysis of variances (ANOVA) indicated significant differences among lentil entries and tested genotypes for all 11 characters except plant height, number of seed per pod and harvest index (Table-2). This shows that wide range of variability is present for yield and yield related traits among the genotypes which will ensures better chances of producing desired recombinants while making crosses for lentil improvement. The results are in agreement with the findings of Singh *et al*. (2018) and Jeberson *et al*. (2015) [14].

The minimum and maximum mean value of 84 germplasm accessions (including four checks) of lentil for eleven characters are given in table 3. The minimum number of days to 50% flowering was detected for KLB-115 (71.03 days) while genotype ILL-9967 (97.53 days) took maximum duration to flower. The shortest maturity period was recorded for LEE-18-172 (107.72) while longest for IPLS-09-03 (123.72). The range for plant height was observed from 17.71 cm to 57.93 cm for KLB-1453 and genotype LH-84-8, respectively. Highest number of primary branches per plant was displayed by genotype KL-1658 (5.47) whereas entry EC-208362 (1.32) has minimum number of primary branches per plant. Highest number of secondary branches per plant was exhibited by KLB-112 (29.23) whereas EC-208362 (2.88) possessed minimum secondary branches per plant. The genotype 2002-76-L produced maximum (113.34) number of pod per plant while (18.07) number of pod per plant was exhibited by genotype KLB-58. The highest seeds per pod was noted in genotype KL127 (2.10) while least number of seeds per pod was found in entry L-3555 (1.02). 100-seed weight was varied from highest value KL123 (3.47) and lowest value of 100- seed weight was found in EC-520204 (1.02). The highest and lowest biological yield per plant was observed for LH-84-8 (18.54) and KLS-1459 (2.09), respectively. The genotype ILL-9913 (50.77) had highest harvest index, while lowest harvest-index was recorded in IPL 416 (13.04). The highest seed yield per plant was recorded in IPLS-09-03 (4.34 gm), while lowest seed yield per plant was found in KLB-58 (0.74 gm).

The magnitude of phenotypic coefficient of variance (PCV), genotypic coefficient of variance (GCV), range, mean, heritability in broad sense, expected genetic advance and genetic advance as percent of mean for traits under study are given in Table 4. Wide range of variation was recorded for PCV which ranged from 2.28% (days to maturity) to 45.38% (biological yield per plant) whereas the range of GCV was from 1.96% (days to maturity) to 35.97% (biological yield per plant). High estimates (> 20%) of PCV and GCV were observed for biological yield per plant (45.38%) and number of pod per plant (29.71%) while 100-seed weigh**t** (9.1%), days to 50% flowering (6.62%), seed yield per plant (5.43%), plant height (4.51%), days to maturity (2.28%) and number of seeds per pod (0.81%) showed low magnitude of GCV and PCV. These results are corroborated with the findings of Sakthivel *et al*. (2019) [21], Hassan *et al*. (2018) [12] and Chowdhary *et al*. (2019) [6].

The degree of transmission of characters from parents to offspring and amount of variability for characters present in population both are important for effective selection. Heritability gives clear cut idea about transferability of characters from parents to its offspring. More genetic gain under selection can be realized for the traits which are highly heritable and stable. Heritability along with genetic advance is more reliable guide for making selection as heritability alone does not provide sufficient indication regarding the magnitude of genetic gain which could be possible through selection.

Robinson (1966) [20] has categorized the estimates of heritability as low (5-10%), medium (10-30%) and high (30% and above). In present investigation, high broad sense heritability was found for all the traits under study which was varied from 73.99% (days to maturity) to 39.08% (harvest index). High heritability estimates for quantitative characters may help breeders to base their selection on the basis of expression of these characters.

The expected genetic advance was estimated at 5% selection intensity and it was varied from 0.17% for number of seed per pod to 6.82% for harvest index. High genetic advance as percent of mean was observed for biological yield per plant (58.74%), number of pod per plant (36.69%), secondary branches per plant (28.19%) and primary branches per plant (25.6%) while it was moderate for harvest index (17.01%), 100-seed weight (12.97%). Low estimates of genetic advance as percent of mean was found for seed yield per plant (7.46%), days to 50% flowering (7.34%), plant height (4.42%), days to maturity (3.47%) and number of seed per pod (0.76%). The present findings are in agreement with earlier reports of Jaberson *et al*. (2015) and Singh *et al*. (2018).

High heritability along with high genetic advance as per cent of mean was found for primary branches per plant, secondary branch per plant, number of pod per plant, biological yield per plant and high heritability coupled with moderate genetic advance as per cent of mean were recorded for 100 seed weight and harvest index. The existence of high heritability coupled with high genetic advance as per cent of mean clearly indicated that the additive gene action is predominant in the manifestation of these traits and as a result more chance of improving these attributes through simple selection. The above findings are corroborated with the result of Kumar (2020) [16], Singh *et al*. (2018), Vanave *et al*. (2019) [25] and Tyagi and Khan (2010) [24].

High heritability with low genetic advance was estimated for days to 50% flowering, days to maturity, plant height, number of seeds per pod and seed yield per plant indicated that these traits are predominantly governed by non-additive gene action and thus direct selection for these traits are not effective. The results are in agreement with Yadav *et al*. (2016) [27], Tyagi and Khan (2010) [24] and Singh *et al*. (2018).

Table 1: List of Lentil Genotypes including Check Used in Present Study along with their source

S. N.	Genotype	Source	S. N.	Genotype	Source	S. N.	Genotype	Source
1	KML-326	CSAU, Kanpur	29	TAL-7	IIPR, Kanpur	57	IPLS-09-10	IIPR, Kanpur
2	KLB-112	CSAU, Kanpur	30	LEE-18-172	IIPR, Kanpur	58	98-3LA	IIPR, Kanpur
3	KL-1658	CSAU, Kanpur	31	LEE-18-169	IIPR, Kanpur	59	EC-542161	IIPR, Kanpur
4	KLO8-5	CSAU, Kanpur	32	TAL-3	IIPR, Kanpur	60	LL-1	IIPR, Kanpur
5	KLB114	CSAU, Kanpur	33	LEE-18-173	IIPR, Kanpur	61	LH-84-8	IIPR, Kanpur
6	KLB-115	CSAU, Kanpur	34	LEE-18-165	IIPR, Kanpur	62	ILL-81-14	IIPR, Kanpur
7	LSS-18-149	CSAU, Kanpur	35	KL-59-3	IIPR, Kanpur	63	EC-208362	IIPR, Kanpur
8	KL 122	CSAU, Kanpur	36	IC560332	IIPR, Kanpur	64	L-3555	IIPR, Kanpur
9	IPL416	IIPR, Kanpur	37	L-112-7	IIPR, Kanpur	65	EC-208345	IIPR, Kanpur
10	KL127	CSAU, Kanpur	38	IPLS-09-34	IIPR, Kanpur	66	PANT-L-04	IIPR, Kanpur
11	KL129	CSAU, Kanpur	39	98-15L-A	IIPR, Kanpur	67	L-112-6	IIPR, Kanpur
12	KLB-116	CSAU, Kanpur	40	96-15L-A	IIPR, Kanpur	68	EC-520204	IIPR, Kanpur
13	KL123	CSAU, Kanpur	41	IG-4284	IIPR, Kanpur	69	ILL-9957	IIPR, Kanpur
14	KLB-1452	CSAU, Kanpur	42	FLIP-98-318	IIPR, Kanpur	70	PANT L-234	IIPR, Kanpur
15	KLB-1454	CSAU, Kanpur	43	2002-76-L	IIPR, Kanpur	71	ILL-9967	IIPR, Kanpur
16	KLB-5	CSAU, Kanpur	44	SEHORE-74-3	IIPR, Kanpur	72	EC-522160	IIPR, Kanpur
17	KLB-1460	CSAU, Kanpur	45	L-112-16	IIPR, Kanpur	73	EC-542186	IIPR, Kanpur
18	KLB-1462	CSAU, Kanpur	46	IP25-09-22	IIPR, Kanpur	74	EC-582180	IIPR, Kanpur
19	KLB-1464	CSAU, Kanpur	47	IG4200	IIPR, Kanpur	75	ILL-7723	IIPR, Kanpur
20	KLB-1453	CSAU, Kanpur	48	IPLS-09-1	IIPR, Kanpur	76	ILL-9913	IIPR, Kanpur
21	KLS-1455	CSAU, Kanpur	49	IG4208	IIPR, Kanpur	77	ILL-9948	IIPR, Kanpur
22	KLS-1459	CSAU, Kanpur	50	TAL-6	IIPR, Kanpur	78	L-45996	IIPR, Kanpur
23	IPL-313	IIPR, Kanpur	51	IG-4000	IIPR, Kanpur	79	PANT L-639	IIPR, Kanpur
24	TAL-4	IIPR, Kanpur	52	IPLS-09-03	IIPR, Kanpur	80	L-112-19	IIPR, Kanpur
25	KL-3230	CSAU, Kanpur	53	IPLS-09-33	IIPR, Kanpur	81	DPL-62	IIPR, Kanpur
26	KLS-1461	CSAU, Kanpur	54	IPLS-09-06	IIPR, Kanpur	82	KML-320	IIPR, Kanpur
27	KL-09-3	CSAU, Kanpur	55	IG4244	IIPR, Kanpur	83	L4076	IIPR, Kanpur
28	KL-09-5	CSAU, Kanpur	56	L-4147	IIPR, Kanpur	84	IPL316	IIPR, Kanpur

Table 2: Analysis of variance of augmented design for eleven characters in lentil genotypes

Characters	Sources of variation					
	Blocks	Treatment	Genotype	Checks	Genotype vs Check	Error
	d.f. (7)	d.f. (83)	d.f. (79)	d.f. (3)	d.f. (1)	d.f. (21)
Days to 50% flowering (days)	9.817	26.584*	25.044*	74.948*	3.108	10.805
Days to maturity (days)	15.888*	7.912*	7.165*	28.281*	5.858	1.734
Plant height (cm)	30.877	44.582*	31.986	275.061*	348.214*	20.827
No. of primary branches per plant	0.304	0.432*	0.371*	1.370*	2.433*	0.125
No. of secondary branches per plant	5.751	11.144*	10.780*	10.448*	41.928*	3.120
Number of pod per plant	115.714	351.34*	306.013*	414.368*	3743.086*	122.898
Number seed per pod	0.028	0.037*	0.032	0.062*	0.422*	0.018
100-seed weight (g)	0.024	0.202*	0.169*	0.841*	0.859*	0.053
Biological yield per plant (g)	2.885*	8.190*	7.914*	6.89	33.903*	2.626
Seed yield per plant (g)	0.163	0.770*	0.644*	1.337*	8.984*	0.219
Harvest index (%)	69.776	78.919	64.869	298.437*	530.305*	43.752

*, ** Significant at 5% and 1% probability level, respectively

Table 3: Adjusted mean of genotypes and checks, range, standard deviation, standard error and least significant differences for eleven quantitative characters in lentil

S.N.	Genotypes	Days to 50% flowering	Days to maturity (Days)	Plant height (cm)	No. of primary branches per plant	No. of secondary branches per plant	No. of pod per plant	No. of seed per pod	100 seed weight (g)	Biological yield per plant (g)	Harvest index (%)	Seed yield per plant (g)
1.	KML-326	88.03	114.97	37.53	2.87	10.83	30.09	1.70	1.70	5.52	16.88	0.97
2.	KLB-112	83.03	112.97	21.93	3.87	29.23	75.69	1.50	2.47	14.52	22.00	3.86
3.	KL-1658	85.03	112.97	31.53	5.47	20.23	31.29	1.70	2.21	6.72	20.19	1.47
4.	KLO8-5	80.03	114.97	21.93	4.27	12.43	30.49	1.50	1.81	4.72	21.71	0.99
5.	KLB114	82.03	110.97	33.33	2.47	11.43	77.09	1.70	2.12	11.72	24.16	3.29
6.	KLB-115	71.03	117.97	22.53	2.07	15.83	29.69	1.70	2.20	3.82	37.41	1.28
7.	LSS-18-149	88.03	114.97	30.93	2.87	16.43	32.49	1.50	2.61	6.72	25.34	1.80
8.	KL 122	91.03	116.97	34.53	2.47	9.23	30.69	1.70	2.03	5.72	20.99	1.24
9.	IPL416	94.03	117.97	33.33	3.27	15.83	32.89	1.70	2.61	10.72	13.04	1.82
10.	KL127	78.03	111.97	21.33	2.47	10.43	32.29	2.10	2.71	5.32	34.04	1.78
11.	KL129	85.53	113.47	26.31	3.37	17.48	26.07	1.57	2.83	10.00	14.97	1.64
12.	KLB-116	85.53	112.47	22.11	4.17	15.48	27.47	1.37	2.12	2.60	41.89	1.21
13.	KL123	72.53	110.47	21.91	3.57	13.08	26.67	1.57	3.47	8.00	25.19	2.17
14.	KLB-1452	78.53	110.47	27.31	5.37	13.08	18.67	1.57	2.04	5.00	16.98	0.88
15.	KLB-1454	90.53	109.47	25.91	3.77	16.48	32.07	1.37	1.72	4.60	22.52	1.09
16.	KLB-58	83.53	110.47	35.11	3.57	16.28	18.07	1.57	1.88	3.60	20.14	0.74
17.	KLB-1460	84.53	113.47	26.51	3.37	20.08	43.47	1.57	1.85	4.20	34.64	1.58
18	KLB-1462	86.53	118.47	25.71	4.37	15.68	21.67	1.57	1.83	4.60	17.29	0.82
19	KLB-1464	87.53	113.47	31.51	4.97	18.68	50.67	1.77	2.61	8.00	31.62	2.73
20	KLB-1453	72.53	111.47	17.71	3.57	17.08	47.47	1.17	2.51	6.80	33.49	2.46
21	KLS-1455	82.53	113.72	26.33	4.04	14.01	52.04	1.50	2.01	5.71	35.69	2.15
22.	KLS-1459	83.53	110.72	33.73	3.64	15.01	22.24	1.50	1.77	2.09	30.50	0.82
23	IPL-313	83.53	109.72	33.93	3.24	12.01	29.24	1.30	1.95	2.09	39.67	1.15
24	TAL-4	85.53	117.72	31.93	3.84	14.01	35.04	1.30	1.82	2.29	40.43	1.25
25	KL-3230	72.53	111.72	22.53	3.44	15.41	33.84	1.30	2.04	3.37	34.44	1.35
26	KLS-1461	90.53	119.72	33.93	3.04	15.01	45.44	1.30	1.84	3.09	42.81	1.65
27.	KL-09-3	79.53	109.72	36.73	1.84	13.41	44.24	1.30	2.48	4.09	46.97	2.27
28.	KL-09-5	76.53	111.72	33.73	4.24	12.61	55.84	1.70	1.81	5.09	37.44	2.07
29.	TAL-7	78.53	117.72	32.53	2.84	14.81	67.64	1.50	2.05	9.29	31.70	2.85
30.	LEE-18-172	79.53	107.72	27.73	2.84	17.61	56.64	1.30	2.23	7.09	34.81	2.51
31.	LEE-18-169	75.78	121.22	27.28	3.24	15.88	75.02	1.33	2.53	8.91	44.67	3.75
32.	TAL-3	78.78	114.22	30.28	2.84	15.88	65.22	1.73	2.75	9.31	39.79	3.53
33.	LEE-18-173	73.78	113.22	26.08	3.44	17.88	33.22	1.53	2.61	5.11	36.08	1.70
34.	LEE-18-165	82.78	114.22	35.08	3.44	16.68	64.22	1.73	2.59	8.21	42.59	3.29
35.	KL-59-3	84.78	113.22	44.48	3.24	13.48	52.22	1.53	1.93	5.03	45.82	2.05
36.	IC560332	86.78	116.22	35.48	2.84	17.68	73.02	1.53	1.83	8.31	33.43	2.67
37.	L-112-7	86.78	117.22	37.68	2.84	14.68	66.22	1.53	2.03	9.11	30.29	2.69
38.	IPLS-09-34	89.78	120.22	39.08	2.84	16.28	50.22	1.53	1.83	7.56	25.59	1.91
39.	98-15L-A	83.78	115.22	40.88	3.84	16.08	76.22	1.53	2.28	9.11	40.17	3.48
40.	96-15L-A	85.78	118.22	40.68	2.84	12.88	51.22	1.53	1.40	9.11	15.42	1.50
41.	IG-4284	77.28	115.72	36.93	2.94	17.88	66.74	1.40	2.14	5.42	50.23	2.82
42.	FLIP-98-318	80.28	114.72	42.13	3.54	17.28	59.74	1.60	1.23	5.82	23.13	1.40
43.	2002-76-L	75.28	113.72	40.33	2.94	18.08	113.34	1.60	1.76	9.62	39.10	3.89
44.	SEHORE-74-3	84.28	113.72	42.93	2.94	14.28	65.34	1.80	2.16	7.22	37.72	2.82
45.	L-112-16	86.28	114.72	38.33	2.94	16.68	69.94	1.80	2.31	7.62	40.34	3.18
46.	IP25-09-22	88.28	113.72	37.93	2.94	17.08	78.94	1.80	1.35	5.82	34.63	2.09
47.	IG4200	88.28	114.72	40.93	2.94	17.88	45.14	1.60	1.68	6.02	24.44	1.53
48	IPLS-09-1	91.28	113.72	46.53	3.74	18.08	76.14	1.40	1.93	8.82	31.24	2.86
49.	IG4208	85.28	116.72	43.13	2.74	12.48	53.14	1.40	2.76	8.10	35.27	2.96
50	TAL-6	87.28	112.72	33.13	2.94	7.28	44.14	1.40	2.05	5.25	33.24	1.81
51	IG-4000	81.53	121.72	33.33	2.37	11.03	33.39	1.17	2.05	6.81	20.41	1.37
52	IPLS-09-03	83.53	123.72	40.73	2.37	15.53	100.39	1.57	2.14	10.81	41.71	4.34

53	IPLS-09-33	83.53	119.72	38.33	2.97	17.43	84.79	1.77	1.85	8.61	38.87	3.17
54	IPLS-09-06	84.53	119.72	35.53	2.37	16.43	40.59	1.37	1.72	5.61	27.47	1.43
55	IG4244	80.53	118.72	45.73	2.57	16.03	43.39	1.97	2.40	5.61	41.39	2.07
56	L-4147	88.53	117.72	36.73	2.37	13.63	48.99	1.57	1.43	5.61	27.69	1.44
57	IPLS-09-10	87.53	118.72	34.33	2.37	14.83	40.99	1.57	2.28	5.01	41.34	1.81
58	98-3LA	85.53	118.72	43.73	2.37	13.43	44.39	1.57	2.14	5.41	38.78	1.87
59	EC-542161	82.53	119.72	36.33	2.37	15.63	50.39	1.37	2.06	7.21	30.03	2.05
60	LL-1	85.53	122.72	34.33	2.17	15.43	42.99	1.37	2.08	6.21	30.48	1.76
61	LH-84-8	88.78	112.72	57.93	3.12	12.28	93.54	1.42	1.90	18.54	21.02	3.45
62	ILL-81-14	90.78	114.72	33.93	3.32	14.08	59.54	1.82	1.63	5.94	33.95	1.95
63	EC-208362	76.78	113.72	32.83	1.32	2.88	52.54	2.02	1.78	5.54	34.74	1.87
64.	L-3555	83.78	116.72	28.53	3.32	6.48	59.74	1.02	1.15	3.94	36.45	1.43
65	EC-208345	91.78	114.72	32.63	3.12	10.48	39.54	1.62	1.96	3.34	45.90	1.55
66	PANT-L-04	83.78	117.72	34.38	3.32	14.48	59.74	1.42	1.46	4.55	39.34	1.77
67.	L-112-6	83.78	116.72	37.73	3.52	10.48	63.74	1.62	1.58	5.14	40.65	2.05
68.	EC-520204	76.78	110.72	38.53	3.72	14.88	40.14	1.22	1.02	3.44	25.81	0.89
69.	ILL-9957	83.78	117.72	34.73	3.12	19.08	44.54	1.42	1.64	9.74	16.42	1.41
70.	PANT L-234	82.78	116.72	34.73	3.12	11.08	27.34	1.62	1.43	2.50	30.08	0.78
71.	ILL-9967	97.53	116.47	25.55	3.64	14.38	45.72	1.50	1.37	4.12	32.56	1.39
72	EC-522160	84.53	114.47	36.15	3.04	18.18	66.52	1.30	2.59	16.32	24.55	3.33
73	EC-542186	82.53	114.47	31.75	3.64	19.18	77.92	1.50	1.31	5.52	39.11	2.13
74.	EC-582180	83.53	115.47	34.55	3.04	15.78	52.72	1.50	2.31	7.52	34.31	2.43
75.	ILL-7723	81.53	112.47	32.35	3.44	16.98	57.52	1.50	2.93	8.52	40.31	3.23
76.	ILL-9913	84.53	115.47	25.95	3.44	17.58	77.92	1.50	2.55	8.12	50.77	3.95
77.	ILL-9948	83.53	116.47	33.15	3.04	19.58	53.92	1.70	1.90	6.52	33.47	2.09
78.	L-45996	87.53	118.47	30.55	3.44	12.38	56.32	1.50	1.71	4.82	41.81	2.03
79.	PANT L-639	85.53	116.47	30.95	3.24	17.58	96.72	1.50	1.52	8.32	38.68	3.02
80.	L-112-19	82.53	115.47	35.35	3.04	11.98	54.52	1.50	2.09	9.52	26.80	2.27
General Mean												
Check Varieties Mean	DPL-62	83.50	113.63	26.03	2.46	12.89	31.68	1.36	1.43	4.54	21.93	0.93
	KML-320	87.38	115.13	35.05	3.20	14.03	48.85	1.53	1.96	6.29	30.92	1.89
	L4076	80.13	116.00	23.29	2.56	15.15	38.80	1.39	1.76	6.26	23.15	1.42
	IPL316	82.13	118.13	34.17	3.25	12.68	36.84	1.33	2.20	4.81	34.59	1.65
Range	Lowest	71.03	107.72	17.71	1.32	2.88	18.07	1.02	1.02	2.09	13.04	0.74
	Highest	97.53	123.72	57.93	5.47	29.23	113.34	2.10	3.47	18.54	50.77	4.34
Std. Dev.												
Std. Error												
LSD_1 at 5%		3.42	1.37	4.75	11.53	1.84	11.53	0.14	0.24	1.69	3.31	0.49
LSD_2 at 5%		9.67	3.87	13.42	32.60	5.20	32.60	0.40	0.68	4.77	9.35	1.38
LSD_3 at 5%		10.81	4.33	15.01	36.45	5.81	36.45	0.44	0.76	5.33	10.46	1.54
LSD_4 at 5%		7.92	3.17	11.00	26.72	4.26	26.72	0.33	0.55	3.91	7.67	1.13

Where,

LSD_1 = Critical difference between two check means.

LSD_2 = Critical difference between adjusted mean of two genotypes in same block.

LSD_3 = Critical difference between adjusted mean of two genotypes in different block.

LSD_4 = Critical difference between adjusted mean of genotype and check mean.

Table 4: Range, general mean, GCV, PCV, heritability h^2 genetic advance and genetic advance in per cent of mean for 11 characters of lentil germplasm

Characters	Range		General mean	GCV (%)	PCV (%)	Heritability (b. s.)	GA	GA as % of mean
	Min.	Max.						
Days to 50% flowering	71.031	97.531	83.54	4.86	6.62	53.82	5.36	7.34
Days to maturity	107.72	123.72	115.36	1.96	2.28	73.99	3.93	3.47
Plant height (cm)	17.708	57.928	32.42	3.11	4.51	47.65	6.19	4.42
Primary branches per plant	1.319	5.469	3.1	15.28	18.78	66.17	0.83	25.6
Secondary branches per plant	2.884	29.234	14.65	16.69	20.35	67.24	4.27	28.19
Number of pod per plant	18.066	113.34	48.18	22.96	29.71	59.73	21.5	36.56
Number of seed per pod	1.024	2.099	1.5	0.54	0.81	45.48	0.17	0.76
100-seed weight (g)	1.019	3.469	1.98	7.57	9.1	69.19	0.59	12.97
Biological yield per plant (g)	2.087	18.537	6.34	35.97	45.38	62.83	3.44	58.74
Seed yield per plant (g)	0.745	4.337	1.29	4.43	5.43	66.73	1.12	7.46
Harvest index (%)	13.035	50.77	31.09	13.21	21.13	39.08	6.82	17.01

Conclusion

In present investigation, wide range of variation was found for most of the traits in studied germplasm. The genotype KLB-115 is desirable for early flowering, LEE-18-172 for early maturity, KLB-1453 for dwarf plant type. The genotype KL-1658 and KLB-112 is desirable for number of primary branches per plant and number of secondary branches per plant, respectively. Genotype 2002-76-L is promising for number of pod per plant and genotype KL127 is best for number of seeds per pod. The genotype KL123 is desirable for 100 seed weight, LH-84-8 for biological yield per plant, ILL-9913 for harvest index and IPLS-09-03 is desirable for seed yield per plant. High estimates of PCV and GCV were observed for biological yield per plant and number of pod per plant. High genetic advance as percent of mean was observed for biological yield per plant, number of pod per plant, secondary branches per plant and primary branches per plant. High heritability along with high genetic advance as per cent of mean was found for primary branches per plant, secondary branch per plant, number of pod per plant and biological yield per plant indicating substantial contribution of additive gene action for expression of these traits and therefore, direct selection for these traits may be helpful in improving yield in lentil.

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