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Studies on genetic variability parameters for seed yield in lentil (*Lens culinaris* Medik.)

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Abstract
Thirty six lentil genotypes (collected from different parts of India and from abroad) including two checks were analyzed for seed yield and its components by estimating genetic variability. Analysis of variance showed highly significant differences among the genotypes for nine traits but non significant for number of primary branches per plant, number of pods per cluster and number of seeds per pod. High heritability estimates were recorded for the traits viz., 100-seed weight, followed by grain yield per plant, biological yield per plant, number of pods per plant, number of filled pods per plant, number of secondary branches per plant and plant height. In general phenotypic coefficients of variation were observed to be greater than their corresponding genotypic coefficients of variation. High estimates of heritability coupled with high genetic advance were documented for 100 seed weight, grain yield per plant, biological yield per plant, number of pods per plant, number of filled pods per plant and number of secondary branches per plant indicating that selection in such traits might be effective. Hence these traits could be used by breeders for the improvement of seed yield resulting in the unfolding of high yielding varieties of lentil.

Keywords: Genetic variability parameters, seed yield, lentil, *Lens culinaris* Medik.

Introduction
Lentil (*Lens culinaris* Medik.) is a cool season food legume crop. It is nutritionally very rich containing 25% protein, 59% carbohydrates, 2% minerals and 343 calories per 100 g (Sharma *et al*, 2013) [17]. Genetic variability creation and selection of important traits among those variations is the first responsibility of any plant breeder to achieve better yield and desirable agronomic traits. However, the influence of environment on the traits should be known to carry out effective selection. Variability and heritability of the population are the prerequisites for successful breeding program in selecting the genotypes with desirable characters. According to Falconer, heritability is defined as the measure of the correspondence between breeding values and phenotypic values. Thus, heritability incites the reliability of phenotype as a guide to its breeding value which in return determines how much of the phenotype would be passed onto the next generation. Heritability and response to selection is directly related which is referred to as genetic advance. High genetic advance with high heritability estimates offer the most effective condition for selection (Larik *et al*., 2000) [12]. Genetic advance is the degree of gain in a character obtained under a particular selection pressure. Thus, genetic advance is yet another very important selection guideline that serves breeder in a selection program. Thus, this study was carried out with the objective to assess the variability, heritability and genetic advance of grain yield with other related components of yield for selection of more desired trait that contribute in the improvement of lentil.

Methodology

The experimental material consisted of thirty six lentil genotypes including two check varieties viz., HUL-57 and Arun. These genotypes were obtained from different regional research station like IIPR, Kanpur, BHU, IARI, New Delhi, GBPUA&T, Pantnagar and from aboard ICARDA, Lebanon. The experiment was laid in RBD during winter season of 2018-2019 at Pulse Research Farm, Bhitti, Bihar Agricultural University, Sabour (Bhagalpur), India. The data were recorded from five randomly selected plants from each plot on thirteen morphological characters, except days to 50% flowering and days to maturity, which was observed on complete plot basis. The mean value of the thirteen traits as recorded was subjected to analysis of variance (ANOVA). The phenotypic and genotypic variances were calculated according to the formula suggested by Burton and De vane (1953) [3]. Heritability (h^2) in broad sense was computed using the formula given by Lush (1940) [13]. Genetic advance as per cent of mean (GAM) for each traits were computed using the formula by Johnson *et al.* (1955) [7].

Result and Discussion

Basic statistics i.e ANOVA for quantitative traits revealed that the mean sum of squares due to genotypes were found significant for all the characters under study except number of primary branches per plant, number of pods per cluster and number of seeds per pod which is considered as non-significant characters (Table 1). Present study showed sufficient variability present in lentil genotypes to allow selection for the traits studied. Low variability for number of primary branches per plant, number of pods per cluster and number of seeds per pod was also reported by Sultana *et al.* (2010) [18] and Sharma *et al*. (2013) [17]. High variability for rest of the traits in lentil genotypes was also reported by Malik *et al*., (1984) [14], Toklu *et al*., (2009) [19], Sultana *et al.* (2010) [18] and Sharma *et al*. (2013) [17], Pandey *et al*. (2015) [16].

Table 1: Analysis of variance of RBD for thirteen characters in lentil genotypes

S. No.	Characters	Mean sum of squares		
		Replication (d.f.=2)	Treatment (d.f.=35)	Error (d.f.=35)
1	Days to 50% flowering	1.361	7.093*	4.190
2	Days to maturity	22.954*	16.860**	7.278
3	Plant height	2.083	29.808**	4.817
4	No. of primary branches per plant	0.236	0.109	0.121
5	No. of secondary branches per plant	0.182	16.087**	1.063
6	No. of pods per cluster	0.007	0.127	0.139
7	No. of pods per plant	109.631	3553.106**	182.867
8	No. of seeds per pod	0.003	0.029	0.034
9	No. of filled pods per plant	66.957	3324.448**	188.780
10	100 Seed weight	0.000	0.921**	0.000
11	Grain yield per plant	0.202	19.782**	0.367
12	Biological yield per plant	0.953	67.063**	2.426
13	Harvest index	55.567	99.741**	25.703

*,** denotes significance at 5% and 1% probability level, respectively

Evaluation of thirty six lentil accessions showed significant differences for the traits under study. The estimates of mean, standard error of mean, range, genotypic and phenotypic coefficient of variation (GCV and PCV), heritability (bs) and genetic advance as percent of mean for various traits under study are shown in Table 2. In general, lentil genotypes exhibited wide spectrum of variability for most of the traits with maximum and minimum range along with its mean values. For instance, days to 50% flowering ranged from 77.67 to 86.33 with the mean of 82.42, days to maturity ranges from 119.67 to 134.33 with the mean of 124.62. Likewise, plant height ranged from 31.64 cm to 46.03 cm with the mean value of 38.85 cm, number of secondary branches per plant ranged from 5.11 to 17.67 with the mean of 8.28. Number of pods per plant and number of filled pods per plant varied from 66.13 to 208.40 with a mean of 117.94 and 61.40 to 194.87 with a mean of 106.94, respectively. 100 seed weight ranged from 1.58 to 4.01 g with a mean of 2.61 g. The maximum grain yield per plant obtained was 12.09 g with minimum value of 2.45 g. Biological yields per plant ranged from 5.36 to 22.83 g with a mean of yield of 10.92 g and lastly harvest index varied from 37.27 to 61.30% with a mean of 50.36%. The range of variation was found to be wide enough for the number of secondary branches per plant, number of pods per plant, number of filled pods per plant, grain yield per plant and biological yield per plant. These findings are in relation with Sultana *et al*. (2010) [18], Tyagi *et al*. (2011) [21] and Sharma *et al.* (2013) [17].

Result of coefficient of variation revealed that PCV was slightly higher than the corresponding GCV values for all the traits in accordance with findings of Chowdhury *et al*. (2019) [4]. Among the traits, grain yield per plant exhibited high estimates of GCV and PCV (46.15% and 47.44%, respectively) followed by biological yield per plant (42.50% and 44.83%, respectively) and number of filled pods per plant (30.23% and 32.85%, respectively) which indicates wide variability. Other characters like days to 50% flowering, days to maturity and plant height exhibited low GCV and PCV as also reported by Sharma *et al*. (2013) [17]. It is evident that the heritability (broad sense) estimated for the significant ten quantitative characters was ranged from 18.76% (days to 50% flowering) to 99.93% (100 seed weight). Higher heritability was observed for the traits like 100-seed weight (99.93%), followed by grain yield per plant (94.63%), biological yield per plant (89.88%), number of pods per plant (86.00%), number of filled pods per plant (84.70%), number of secondary branches per plant (82.48%) and plant height (63.36%). Harvest index (48.95%) and days to maturity (30.50%) showed moderate heritability. Lastly low heritability was showed by days to 50% flowering (18.76%). Genetic advance as percent of mean ranged from 1.07 (days to 50% flowering) to 92.49 (grain yield per plant). High genetic advance as percent of mean was documented for number of secondary branches per plant (50.56), total number of pods per plant (54.29), total number of filled pods per plant (57.32), 100-seed weight (43.69), grain yield per plant (92.49)

and biological yield per plant (82.99). Moderate genetic advance as percent of mean was observed for plant height (12.18) and harvest index (14.22). Rest two character viz, days to 50% flowering and days to maturity exhibited low magnitude of genetic advance as % of mean. This report is similar to the findings of Tyagi and Khan (2009) [20], Sultana *et al*. (2010) [18], Tyagi and Khan (2011) [21], Gupta *et al*. (2012) [6], Sharma *et al*. (2013) [17], Paliya *et al*. (2015), Pandey *et al*. (2015) [16], Kumar *et al*. (2017) [8, 9, 11], Chowdhury *et al*. (2019) [4].

Table 2: Estimation of genetic parameters of ten different characters in lentil genotypes

S. no	Characters	Mean ±SEM	Range	PCV (%)	GCV (%)	Heritability (%)	GA (As % Mean)
1	Days to 50% flowering	82.42±1.18	77.67-86.33	2.76	1.19	18.76	1.07
2	Days to maturity	124.62±1.56	119.67134.33	2.60	1.43	30.50	1.63
3	Plant height	38.85±1.27	31.64-46.03	9.33	7.43	63.36	12.18
4	No. of secondary branches per plant	8.28±0.60	5.11-17.67	29.76	27.03	82.48	50.56
5	No. of pods per plant	117.94±7.81	66.13-208.40	30.65	28.42	86.00	54.29
6	No. of filled pods per plant	106.94±7.93	61.40-194.87	32.85	30.23	84.70	57.32
7	100 Seed weight	2.61±0.01	1.58-4.01	21.22	21.22	99.93	43.69
8	Grain yield per plant	5.51±0.35	2.45-12.09	47.44	46.15	94.63	92.49
9	Biological yield per plant	10.92±0.90	5.36-22.83	44.83	42.50	89.88	82.99
10	Harvest index	50.36±2.93	37.27-61.30	14.09	9.86	48.98	14.22

Conclusion

Genetic variability parameters revealed that number of pods per plant, number of filled pods per plant and 100 seed weight could be the deciding factors for the improvement of lentil genotypes for grain yield. The PCV and GCV values were high for grain yield per plant, biological yield per plant, number of secondary branches per plant, number of pods per plant, number of filled pods per plant and 100-seed weight suggesting the probability of refinement of these traits through selection. High heritability coupled with high expected genetic advance as per cent of mean for 100 seed weight, grain yield per plant, biological yield per plant, number of pods per plant, number of filled pods per plant and number of secondary branches per plant, these characters show least environmental affect which could be improved more easily than the other characters for more productivity of lentil.

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Competing Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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