International Journal of Advanced Research in Biological Sciences
ISSN: 2348-8069
www.ijarbs.com
DOI: 10.22192/ijarbs Coden: IJARQG(USA) Volume 6, Issue 11 -2019

Research Article

DOI: http://dx.doi.org/10.22192/ijarbs.2019.06.11.001

Genetic Variability, Genetic Advance, Correlation and Heritability of Cold Tolerance Lentil (*Lens culinaris* Medic.) Genotypes at High Hill of Nepal

Netra Hari Ghimire[1], Hari Narayan Mandal[1]
[1]Agriculture Research Station Vijaynagar, Jumla, Nepal Agricultural Research Council, Nepal.
*Corresponding author Email: *nhghimirenarc@gmail.com*

Abstract

Lentil (*Lens culinaris* Mediac.) is the major cash generating, exportable and protein rich crop of Nepal. Assessment of variability is crucial to identify the most important traits in lentil improvement program, low yield in lentil is probably due to the lack of genetic variability in high hill area of Nepal . An experiment was conducted at Agricultural Research Station (ARS), Vijayanagar, Jumla Nepal consisting thirty six genotypes of lentil during 2016 in alfa lattice design in two replications to observe genetic variability, correlation, heritability, and genetic advance using six quantitative traits and selection and advancement of cold tolerance, early maturing, high yielding, disease resistant, genotypes for high mountain environment of Nepal. Analysis of variance showed all characters were highly significant differences (<0.01) except days to maturity observed (<0.05) indicating presence of inherent genetic variability for the studied traits among the genotypes. High broad sense heritability coupled with high expected genetic advance as percent of mean were observed in number of pods per plant (92 and 67.78%), thousands grain weight (97 and 41.96%), grain yield (63 and 35.4%) indicating these parameters are governed by additive gene action and direct selection can be applied in varietal development. All parameters obtained high phenotypic coefficient of variance than genotypic coefficient of variance indicating role of environmental for expression of the traits. Parameters number of pods per plant (0.642**), thousands grain weight (0.354**), days to maturity (0.401**), plant height (0.321**) positively correlated with grain yield indicating indirect selection of these traits can be applied for yield increament. Total five clusters were obtained in eighty five percent euclidean similarity clusturing indicating genetic closeness/distances among the genotypes.

Keywords: Correlation, Genetic Advance, Heritability, Lentil, Variability

Introduction

Grain legumes: "climate smart crop, poor's man meat "; important food component and vital role for food and nutritional security, soil nitrogen economy, crop diversification, crop intensification and sustainable agriculture. Lentil (Lens culinaris Medik. culinaris) is a diploid (2n = 2x = 14), self pollinated and annual cool season grain legume with genome size of 4,063 Mpb (Arumuganathan and Earle, 1991). It is considered to be the first agriculture crop grown more than 8500 years ago (Aghili et al., 2012). In 2016, global production of lentils was 6.3 million tonnes, led by Canada with 51% and India with 17% of the world total. Saskatchewan is the most productive growing region in Canada (95% of Canadian lentils grown). For 2016, Statistics Canada reported a national production yield of 3.2 million tonnes from 5,700,000 acres (2,300,000 ha) harvested https://en.wikipedia.org/wiki/Lentil. Canada is the largest producer of lentil and produces 2.5 million tons followed by India, Turkey and Nepal (FAOSTAT, 2017). Canada, India, Turkey, USA, Nepal, Australia, Ethiopia, Bangladesh, Kazakisthan are top ten lentil producing countries of the world sequentially https://www.atlasbig.com/en-us/countries-lentil-production.

Lentil is the top most legume of Nepal in terms of area and production. Total area covered by lentil in 2016/17 was 206969 ha producing 254308 mt with productivity 1.229 mt/ha in Nepal (MOAD, 2018). It shares 64% area and 67% production of total legumes of the country. Production of this cool season annual crop spread from the Near East to the Mediterranean area, Asia, Europe and finally the Western Hemisphere. Nepalese lentil shared by 3% in area and 3 % in production in the total area and production of the world (MOAD, 2018). Lentil is one of the exportable commodities and it is being exported to India, Bangladesh, Sri lanka, Republic of Korea, Pakistan, Malasiya and European countries via Singapore.

Lentil is an excellent supplement to cereal grain diets because of its good protein/carbohydrate content. Protein content ranges from 22 to 28%, however the nutritional value is quite low because lentil has deficient in the amino acids methionine and cystine. It is used in soups, stews, casseroles and salad dishes. Lentil can be used as a green manure crop and one particular Canadian variety, Indianhead provides a large amount of fixed nitrogen (estimated to be 20 lb/acre). It is also a key commodity crop enhancing in crop diversification, intensification and sustainable agriculture in the country. In these days the demands of lentil are sharply increasing in Nepal because of changing the people food habits i.e. lentil dal is the important component of Nepalese and well adapted in the existing farming system. Most importantly, it can grow well in limited rainfall areas of the world which might be the good option to cope with the climate change.

Lentil is newly introduced crop in Jumla, Nepal. Area covered by lentil in Jumla was 13 ha and 10 mt production with average yield 770 kg/ha in 2013 (ARS, 2014). It has scope in cool climate like Jumla and similar zone. We experienced that lentil can revive after snow coverage of January- February and produced satisfactory yield. This crop fits in upland and lowland cropping pattern of Jumla. It has short cropping period than wheat so farmer can plant rice after it's harvest. In upland condition bean can be planted after harvesting of lentil. Another aspect Jumla is organic district farmer are not allowed to apply inorganic fertilizers so it will supply nitrogen some extent by biological nitrogen fixation. Altogether 13 lentil varieties has been released for general cultivation in terai and upto mid hill but no variety for high hill till the date. There is low productivity of lentil in mountain areas than national average. Productivity can be enhanced by exploiting genetic variability of the existing elite genotypes and by utilization of variability present in exotic genotypes. The information on genetic variability, heritability and correlation are most important tools used for selection criteria for improvement of seed yield. Hence there is need to indentify the positive correlations between growth and yield related traits and eliminate negative correlations which may probably arise from developmentally induced relationships (Tambal et al., 2000). Cluster analysis can be a good source to identify the variation in the germplasm and to classify based on similarity and dissimilarity index. This analysis is also useful for the selection of parents for the breeding program and crop modeling (El-Deeb and Mohamed, 1999; Jaynes et al., 2003). Availability of genetic diversity is the major key to develop ideal plant type.

The present study was, therefore, undertaken to identify a proper plant type for selection so as to improve the seed yield keeping in view the inter relation between traits, variability, genetic advance, clusturing and heritability. Advancement of cold tolerance, early maturing, high yielding, disease resistant and drought tolerance lentil genotypes for high hill area of Nepal.

Materials and Methods

The experiment was conducted at Agricultural Research Station (ARS), Vijayanagar, Jumla, Nepal. during regular lentil growing season of high hill (November, 2016 to June, 2017). Geographically ARS is situated at a ultitude of 2290 amsl and 29^0 17’ north latitude and 28^0 10’ east longitudes of mid west Nepal. This station is located at high hill region and thus is characterized by cool temperate to alpine eco belts with low rainfall. Soil of this station as developed on recent to old river, moderately deep to very deep and moderately to poor drained. The topography is gently sloppy to rolling lying in the high mountain region. Surface soil and sub-surface soils are dominantly coarse textured (Sandy loam) and are acidic to moderately alkaline in reaction .The nitrogen content of the soil is generally very low to medium while available phosphorous is high to very high and available potassium is medium to high. The organic carbon content of farm soil is low to high. The average maximum and minimum temperature is about 25^0C in June and 2^0C in February. There was no rainfall during October 15 to December 15, 2016. But total rainfall during lentil growing period of 2016/2017 was satisfactory 244 mm with an average of 54 mm. (Meteology office, Jumla, 2017, Annex 1). All recommended dose of manure and fertilizer (20:40:20 kg $N:P_2O_5:K_2O$ and 6 ton FYM/ha) were applied as basal in lentil.

Thirty six genotypes were used that are acquired from International Centre for Agriculture research in Dry areas (ICARDA) including one local susceptible check for this study. The germplasm was evaluated in Alpha lattice (6*6) design with two replications. Three rows of each entry were planted having row-row distance of 25 cm with 3m row length with 2.25 m2 plot area and 200 seeds per plot. All the recommended cultural practices were followed to raise the healthy crop. Days to 50% flowering and days to 90% maturity were recorded on the plot basis. Ten random plants in each plot were used to record the plant height, number of pods per plant. Grain yield was taken from net harvested area of 2.25 m2 and 12% moisture percent was maintained while weighing and thousands grain weight were taken from same harvested lot. List of genotypes and their additional information given in (Table 1).

Annex 1: Weather data of research place Jumla 2016/17.

Year	Month	Average temperature (°C)		Relative Humidity (%)	Total Rainfall (mm)
		Maximum	Minimum		
2073 (Mid July2016)	July-Aug	23.88	16.17	81.74	252.60
	Aug-Sep	25.05	14.72	77.10	102.70
	Sep-Oct	25.06	11.65	69.60	24.20
	Oct-Nov	21.41	0.74	57.08	0
	Nov-Dec	20.72	-2.23	47.9	0
	Dec-Jan	15.30	-3.96	55.46	9.70
	Jan-Feb	15.64	-2.56	58.05	24.00
	Feb-March	17.12	-0.97	54.73	53.60
	March-April	21.51	4.21	59.73	53.30
2074 (Mid June 2017)	Aril-May	24.34	7.90	62.05	42.80
	May-June	25.42	10.93	65.71	60.60
	June-July	25.66	15.48	73.76	180.10
	Total				803.60
	Average	21.76	6.01	63.58	66.97

Source: Meterological Field Office, Jumla

Table 1. Lentil International Cold Tolerance Nursery – 2016 used in the study

Entry No.	Entry Name	Accession No. (ILL)	Pedigree	Origin	FAO Status *
1	PI 299170	975	-	Chile	D
2	FLIP1995-030L	7686	-	ICARDA	U
3	FLIP2007-99L	10277	ILL5582 x ILL6475	ICARDA	U
4	FLIP 2007-128L	10306	ILL 7989 x AKM 279	ICARDA	U
5	AKM 302	10657	-	Turkey	U
6	FLIP2012-5L	10980	ILL1005XILL6972	ICARDA	U
7	FLIP2012-30L	11005	ILL7502XILL590	ICARDA	U
8	FLIP2012-45L	11020	ILL6024XILL7686	ICARDA	U
9	FLIP2012-52L	11027	ILL7981XILL7706	ICARDA	U
10	FLIP2012-61L	11036	ILL4605XILL10872	ICARDA	U
11	FLIP2012-64L	11039	ILL4605X L-5125	ICARDA	U
12	FLIP2012-127L	11102	ILL1005XILL9942	ICARDA	U
13	FLIP2012-128L	11103	ILL1005XILL9942	ICARDA	U
14	FLIP2012-140L	11115	ILL590XILL6002	ICARDA	U
15	FLIP2012-145L	11120	ILL6037XILL7981	ICARDA	U
16	FLIP2012-150L	11125	ILL8009XILL7979	ICARDA	U
17	FLIP2012-151L	11126	ILL7537XILL7982	ICARDA	U
18	FLIP2012-152L	11127	ILL7537XILL7982	ICARDA	U
19	FLIP2012-155L	11130	ILL4605XILL7982	ICARDA	U
20	FLIP2012-160L	11135	ILL6434XILL8095	ICARDA	U
21	FLIP2012-161L	11136	ILL7940XILL7981	ICARDA	U
22	FLIP2012-235L	11210	ILL5562XILL4400	ICARDA	U
23	FLIP2012-236L	11211	ILL5562XILL4400	ICARDA	U
24	FLIP2012-267L	11242	ILL6199XILL6994	ICARDA	U
25	FLIP2014-018L	11428	ILL1005 x ILL9977	ICARDA	U
26	FLIP2014-033L	11443	ILL5883 x ILL6458	ICARDA	U
27	FLIP2014-038L	11448	ILL7980 x ILL6994	ICARDA	U
28	FLIP2014-043L	11453	ILL323 x ILL1918	ICARDA	U
29	FLIP2014-051L	11461	ILL6037 x ILL7012	ICARDA	U
30	FLIP2014-054L	11464	ILL6994 x ILL5725	ICARDA	U
31	FLIP2014-060L	11470	ILL4605 x ILL7723	ICARDA	U
32	FLIP2014-076L	11486	ILL6994 x ILL5725	ICARDA	U
33	FLIP2014-079L	11489	ILL6994 x ILL5725	ICARDA	U
34	FLIP2014-135L	11545	ILL7980 x ILL6994	ICARDA	U
35	Cifci	10837	-	Turkey	U
36	Local Susceptible Check				

* D = Designated, U = Undesignated

Analysis of variance done by using Genstat 18th edition, correlation was computed by using statistical software SPSS at significance level of (0.05), mean separation among the lines was done with statistical software ADEL-R and clusuring of the genotypes was done with statistical software MINITAB. Estimation and categorization of genetic advance was done according to (Johnson et al., 1955). The heritability and genetic advance of the traits were calculated by the formula given by (Falconer, 1960).

Results and Discussion

Analysis of variance showed characters days to 50% flowering, plant height, number of pods per plant, thousands grain weight, and grain yield kg/ha were highly significant differences (<0.01) and trait days to 90% maturity was (<0.05) Table 2. That indicates presence of inherent genetic variability for the studied traits among the genotypes. Breeder can utilize the variability for selection and may use in hybridization for trait improvement, gene transfer to the other genotypes. Jeberson et al., 2015 reported result which was in full support to our findings that days to 50% flowering, days to maturity, plant height, number of pods per plant, thousands grain weight, and grain yield kg/ha were significant differences in lentil. Similarly, Bicer and Sakar (2004 and 2010), Jawad et al., (2018) presented the the result in support to our findings.

Mean squares and F statistic of six different agronomic parameters are presented in Table 2. Separation of mean values of quantitative traits are given in Table 3. It was observed that genotype 34 (FLIP2014-135L) was the highest producing line with the average yield of 1236 kg/ha and highest number of pods per plant 68. The highest plant height was observed in Genotype 26 (FLIP2014-033L) i.e. 31.6cm. The Genotype 35 (Cifci) was found to be the earliest maturing line that matures in 183 days. Highest thousands grain weight observed in genotype 19 (FLIP2012-155L) was 88 gm (Table Table 3).

Table 2. Mean squares and F statistic of different agronomic traits of cold tolerance lentile genotypes tested at high hill of Nepal

SN	Traits	Rep	Treat	Error	Fcal	CV	P value
1	DFF	13.3	54.5	7.6	7.1	1.9	**
2	DM	1.7	18.4	8.5	2.2	1.5	*
3	Pht	7.6	9.0	3.6	2.5	7.4	**
4	NPPP	30.7	349.0	15.3	22.9	9.9	**
5	TGW	0.1	315.7	5.4	58.0	3.8	**
6	Yld	16544.4	60548.3	13734.3	4.4	13.2	**

Note; DFF: Days to 50% flowering, DM: Days to 90% maturity, NPPP: Number of pods per plant, Pht: Plant height (cm), TGW: Thousands grain wt (gm) and Yld: Grain yield (kg/ha)

The genotypic, phenotypic variances, broad sense heritability and genetic advance for all the traits are given in Table 4. The observed phenotypic coefficient variance (PCV) was higher than the genotypic coefficient of variance (GCV) for all six quantitative traits indicating role of environment to express the character.

Table 3. Mean separation of different agronomic traits of 36 cold tolerance lentile genotypes tested at high hill of Nepal

EN	Genotypes	DFF	DM	Pht	NPPP	TGW	Yld
1	PI 299170	142.5 ^{fghij}	187.5 ^{efghi}	25.2 ^{cdefgh}	27.5 ^{jklmn}	56 ^{kl}	840 ^{defghijk}
2	FLIP1995-030L	150 ^{bc}	187.5 ^{efghi}	24.6 ^{cdefghi}	57 ^{b}	66.5 ^{defg}	917.8 ^{bcdefgh}
3	FLIP2007-99L	144 ^{defghi}	190 ^{bcdefg}	27.3 ^{bcdef}	58.5 ^{b}	60 ^{hijk}	911.15 ^{bcdefgh}
4	FLIP 2007-128L	148 ^{bcdef}	191.5 ^{abcdef}	27.5 ^{bcde}	43.5 ^{de}	78.5 ^{bc}	1066.665 ^{abcde}
5	AKM 302	147.5 ^{bcdef}	191 ^{abcdef}	25.9 ^{cdefg}	54 ^{bc}	66 ^{defg}	991.1 ^{bcdefg}
6	FLIP2012-5L	138 ^{j}	190 ^{bcdefg}	24.4 ^{defghi}	23.5 ^{mn}	43 ^{o}	582.22 ^{l}
7	FLIP2012-30L	148 ^{bcdef}	186 ^{fghi}	24 ^{efghi}	43.5 ^{de}	77 $_{bc}$	1115.555 ^{abc}
8	FLIP2012-45L	137.5 ^{j}	196 ^{a}	24.8 ^{cdefgh}	38 ^{efgh}	62 ^{ghij}	915.555 ^{bcdefgh}
9	FLIP2012-52L	140 ^{hij}	187.5 ^{efghi}	28.1 ^{abcd}	33.5 ^{ghijk}	58 ^{jkl}	640 ^{kl}
10	FLIP2012-61L	149.5 ^{bcd}	186.5 ^{efghi}	27.3 ^{bcdef}	35 ^{fghij}	49 ^{m}	800 ^{ghijkl}
11	FLIP2012-64L	138.5 ^{ij}	191.5 ^{abcdef}	30 ^{ab}	32.5 ^{hijk}	59 ^{ijkl}	897.8 ^{cdefghi}
12	FLIP2012-127L	143 ^{efghij}	188.5 ^{defghi}	27.8 ^{abcde}	42.5 ^{def}	58.5 ^{jkl}	1075.55 ^{abcd}
13	FLIP2012-128L	138 ^{j}	185 ^{ghi}	22.9 ^{ghi}	27 ^{klmn}	59 $_{ijkl}$	586.65 ^{l}
14	FLIP2012-140L	138 ^{j}	183.5 ^{hi}	24.4 ^{defghi}	23.5 ^{mn}	48 ^{mn}	706.7 ^{hijkl}
15	FLIP2012-145L	147 ^{bcdef}	188 ^{efghi}	24.4 ^{defghi}	28.5 ^{ijklmn}	76 ^{bc}	826.665 ^{fghijk}
16	FLIP2012-150L	138 ^{j}	189.5 ^{cdefg}	20.9 ^{i}	22 ^{n}	42 ^{o}	795.555 ^{ghijkl}
17	FLIP2012-151L	139 ^{ij}	187 ^{efghi}	25.2 ^{cdefgh}	34 ^{ghijk}	55 ^{l}	884.45 ^{cdefghij}
18	FLIP2012-152L	150.5 ^{bc}	191 ^{abcdef}	26.3 ^{bcdefg}	24.5 ^{lmn}	46.5 ^{mno}	775.3 ^{ghijkl}
19	FLIP2012-155L	141 ^{ghij}	191 ^{abcdef}	22 ^{hi}	40.5 ^{efg}	88 ^{a}	1040 ^{abcdef}
20	FLIP2012-160L	146.5 ^{bcdefg}	189.5 ^{cdefg}	27.7 ^{bcde}	61 ^{ab}	78 ^{bc}	1044.445 $_{abcdef}$
21	FLIP2012-161L	152 ^{b}	195.5 ^{ab}	27.2 ^{bcdef}	59 ^{b}	66 ^{defg}	1048.89 ^{abcdef}
22	FLIP2012-235L	145.5 ^{cdefgh}	189.5 ^{cdefg}	27.7 ^{bcde}	39.5 ^{efgh}	67 ^{def}	1142.22 ^{ab}
23	FLIP2012-236L	144 ^{defghi}	188.5 ^{defghi}	28.3 ^{abc}	32.5 ^{hijk}	80.5 ^{b}	831.11 ^{efghijk}
24	FLIP2012-267L	150 ^{bc}	192 ^{abcde}	25.3 ^{cdefgh}	22.5 ^{mn}	75 ^{c}	602.225 ^{kl}
25	FLIP2014-018L	147.5 ^{bcdef}	189 ^{defgh}	23.6 ^{fghi}	27.5 ^{jklmn}	30 ^{p}	786.65 ^{ghijkl}
26	FLIP2014-033L	152 ^{b}	195 ^{abc}	31.6 ^{a}	33 ^{ghijk}	43 ^{o}	1115.555 ^{abc}
27	FLIP2014-038L	142.5 ^{fghij}	190 ^{bcdefg}	24.1 ^{efghi}	32 ^{hijkl}	70 ^{d}	891.1 ^{cdefghi}
28	FLIP2014-043L	146 ^{cdefg}	187 ^{efghi}	24.2 ^{efghi}	30 ^{ijklm}	64.5 ^{efgh}	671.15 ^{ijkl}
29	FLIP2014-051L	147.5 ^{bcdef}	186.5 ^{efghi}	25.1 ^{cdefgh}	29.5 ^{ijklmn}	59.5 ^{ijkl}	648.89 ^{jkl}
30	FLIP2014-054L	147.5 ^{bcdef}	191 ^{abcdef}	25.6 ^{cdefgh}	35.5 ^{fghi}	62 ^{ghij}	1093.335 ^{abc}
31	FLIP2014-060L	140 ^{hij}	194 ^{abcd}	25.2 ^{cdefgh}	32.5 ^{hijk}	44 ^{no}	755.555 ^{ghijkl}
31	FLIP2014-076L	149 ^{bcd}	187 ^{efghi}	24.4 ^{defghi}	49 ^{cd}	68.5 ^{de}	964.445 ^{bcdefg}
33	FLIP2014-079L	138 ^{j}	189.5 ^{cdefg}	24.9 ^{cdefgh}	61 ^{ab}	61 ^{hij}	1066.665 ^{abcde}
34	FLIP2014-135L	148.5 ^{bcde}	192 ^{abcde}	26.1 ^{cdefg}	68 ^{a}	63.5 ^{fghi}	1235.555 ^{a}
35	Cifci	149 ^{bcd}	183 ^{i}	25.6 ^{cdefgh}	55.5 ^{bc}	60 ^{hijk}	951.11 ^{bcdefg}
36	Local Susceptible	159 ^{a}	190 ^{bcdefg}	25.5 ^{cdefgh}	56.5 ^{bc}	61 ^{hij}	835.555 ^{efghijk}
	Grand mean	**145.07**	**189.375**	**25.70**	**39.26**	**61.15**	**890.37**
	SEM	2.76277	2.917036	1.891454	3.905381	2.332231	117.1936
	LSD (0.05%)	5.608722	5.921898	3.839857	7.928345	4.73468	237.9156

Note; DFF: Days to 50% flowering, DM: Days to 90% maturity, NPPP: Number of pods per plant, Pht: Plant height (cm), TGW: Thousands grain wt (gm) and Yld: Grain yield (kg/ha)

The high broad sense heritability coupled with high expected genetic advance as percent of mean was observed for the traits, grain yield (63 and 35.4), number of pods per plant (92 and 67.78) and thousands grain weight (97 and 41.96) Table 4. These characters can be considered as favorable attributes for the improvement through selection and this may be due to additive gene action could be improved upon by adapting selection without progeny testing. Low heritability combined with low genetic advance as percentage of mean was noted for days to maturity and plant height which indicates that the scope for improving such traits through selection is very much limited and this may be attributed to the non-additive. Hussan et al., 2018, reported high heritability and %GA for grain yield 96% and 55.809 he also reported high heritability and %GA for thousand grain weight 93% and 53.02 and 95% heritability and 41.4%GA for number of pods per plant which fully supports our findings. Tyagi and Khan (2010) also supported our findings. Mekonnen et al 2014 also supported our findings.

Table 4. Range, standard deviation, variance, broad sence heritability, PCV, GCV and percent mean genetic advance for quantitative traits of lentil genotypes

SN	Traits	Range	Mean	Std	Vg	Vp	H	GCV	PCV	GA	%mean GA
1	DFF	137.5-159	145.1	5.5	23.4	31.0	0.75	3.3	3.8	10.0	6.87
2	DM	185-196	189.4	3.6	5.0	13.5	0.37	1.2	1.9	4.6	2.42
3	Pht	20.9-31	25.7	2.5	2.7	6.3	0.43	6.4	9.7	3.4	13.15
4	NPPP	22-68	39.3	13.4	166.9	182.1	0.92	32.9	34.4	26.6	67.78
5	TGW	30-88	61.2	12.6	155.1	160.6	0.97	20.4	20.7	25.7	41.96
6	Yld	582.2-1235.5	890.4	192.0	23407.0	37141.3	0.63	17.2	21.6	315.2	35.40

Note; DFF: Days to 50% flowering, DM: Days to 90% maturity, NPPP: Number of pods per plant, Pht: Plant height (cm), TGW: Thousands grain wt (gm) and Yld: Grain yield (kg/ha)

Correlation:

Phenotypic correlation between six parameters of 36 genotypes of lentil is illustrated in table 6. Parameters number of pods per plant (0.642**), thousands grain weight (0.354**), days to maturity (0.401**), plant height (0.321**) positively correlated with grain yield indicating indirect selection of these traits can be applied for yield increament. Result showed days to maturity and plant height are are strongly correlated each other, similarly number of pods per plant have significant positive correlation with days to 50% flowering. We can select plants having high number of pods per plant, more thousand grain weight, longer, and late varieties for higher grain yield in lentil.

Table 5: Phenotypic correlation coefficient between six parameters of lentil

	DFF	DM	Pht	NPPP	TGW	Yld
DFF	1					
DM	0.118	1				
Pht	0.241*	0.356**	1			
NPPP	0.342**	0.141	0.216	1		
TGW	0.153	0.044	0.048	0.373**	1	
Yld	0.226	0.401**	0.321**	0.642**	0.354**	1

*. Correlation is significant at the 0.05 level , **. Correlation is significant at the 0.01 level.
Note; DFF: Days to 50% flowering, DM: Days to 90% maturity, NPPP: Number of pods per plant, Pht: Plant height (cm), TGW: Thousands grain wt (gm) and Yld: Grain yield (kg/ha)

Pandey et al., (2015) reported, the correlation coefficient revealed that seed yield per plant had positive association with days to maturity, plant height, number of primary branches per plant, number of secondary branches per plant, total number of pods per plant, number of effective pods per plant, number of seeds per plant and number of seeds per pod. This supports our findings. Mekonnen et al 2014 also supported our findings for correlation.

Clusturing

Dendrogram generated based on UPGMA clustering method and Euclidean similarity coefficient among thirty six lentil genotypes is given in table 6 and figure 1. Clusturing was done with UPGMA clustering method with 85% eucdian similarity coefficient and five clustures were generated. Clusture 1 contains 9 genotypes (25%) out of total 36 genotypes named. This clusture carries lower values for all the traits than the grand centroid. Clusture II also carries nine genotypes 25%. This clusture is slightly superior for thousand grain weight, number of pods per plant and grain yield than grand centroid. Clusture III includes ten genotypes (27%) this clusture higher values for all the traits than grand centroid. Genotypes from clusture 3 can be selected for advance trials. Clusture IV includes seven genotypes (19%) of total. This group carries lower values for all the traits we can utilize earliness from this clusture. Clusture V contains single genotype FLIP2014-135L which is highest yielder, more thousands grain weight than grand centroid and having highest number of pods per plant, this will be selected for advance trial like CVT (coordinated varietal trial) and large plot demonstration.

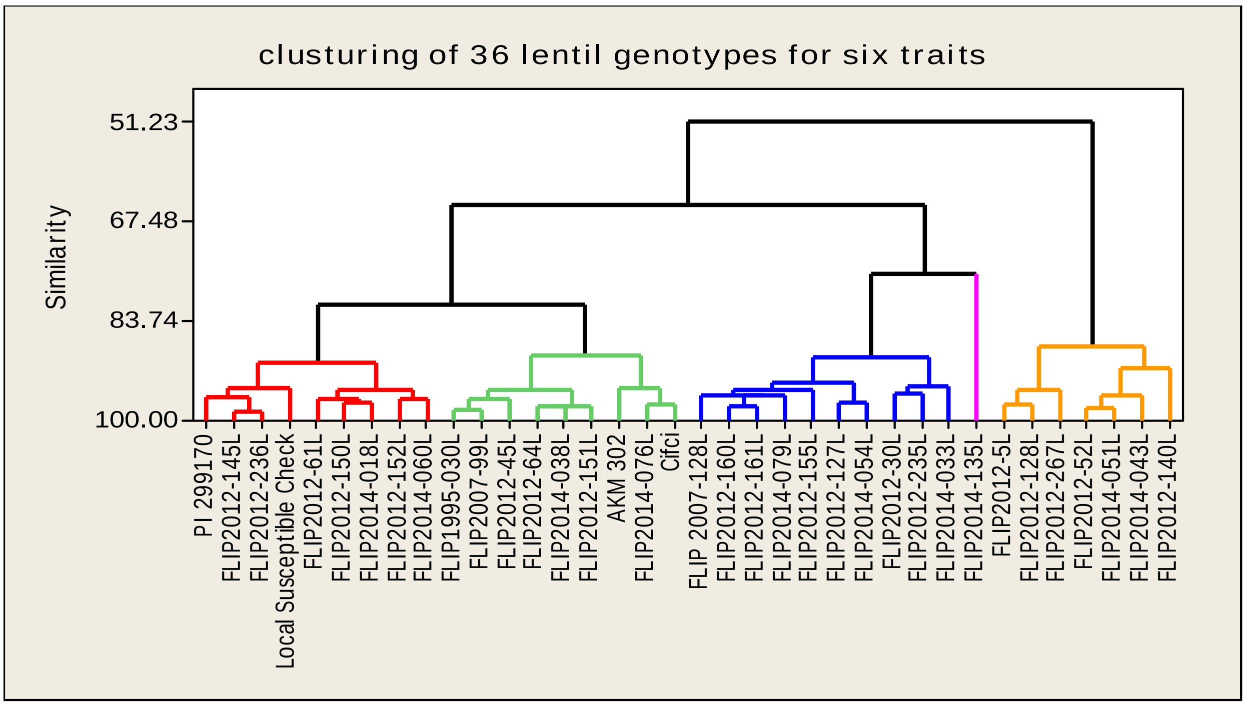

Fig 1. Unwaited pair group method with arithmetic mean (UPGMA) clusturing of cold tolerance lentil genotypes

Table 6. The average of traits for each cluster obtained from UPGMA cluster analysis

Variable	Cluster1	Cluster2	Cluster3	Cluster4	Cluster5	Grand centroid
DFF	146.444	144.111	146.15	142.5	148.5	145.069
DM	189.333	189.222	190.7	187.357	192	189.375
Pht	25.189	25.767	26.6	24.914	26.1	25.697
NPPP	31.833	45.611	45.9	27.071	68	39.264
TGW	53.889	63	67.9	58.143	63.5	61.153
Yld	805.154	924.946	1080.89	633.976	1235.56	890.366

Note; DFF: Days to 50% flowering, DM: Days to 90% maturity, NPPP: Number of pods per plant, Pht: Plant height (cm), TGW: Thousands grain wt (gm) and Yld: Grain yield (kg/ha)

Conclusion

Obtained results indicates presence of sufficient genetic variability for the studied traits and genotypes are suitable for breeding purpose. Result resembled high heritability coupled with high genetic advance for grain yield, number pods per plan and thousands grain weight shows these traits are governed by additive gene effects and selection of these traits would be more effective for genetic improvement. Mean separation and clusturing showed genotypes FLIP-2014-135L is superior among the tested genotypes will be selected for further evaluation in advance trial for high hill region of Nepal. Parameters days to maturity, plant height, number of pods per plant and thousands grain weight contribute for higher grain yield. We can select plants having more number of pods per plant, higher grain weight for higher grain yield of lentil.

Acknowledgments

The authors would like to thank Grain Legumes Research Program Khajura for providing genetic materials received from International Centre for Agriculture research in Dry areas (ICARDA) . We would like to thank technical assistant staffs of Agricultural Research Station Vijayanagar, Jumla for their support on conducting experiment on the field.

Conflict of Interest

The authors declare that there is no conflicts of interest regarding publication of this manuscript.

Authors contribution

N.H. Ghimire: Designed and performed experiment, analyzed data and wrote the paper.
H.N.Mandal: Performed experiment, data recorded.

References

Aghili, P., Ali, A. I. Hossein, S. and Yousef, A. 2012. Study of correlation and relationships between seed yield and yield components in Lentil (Lens culinaris Medik). Ann. Biol. Res. 3: 5042-5045.

ARS. 2014. (Agricultural Research Station), Jumla. 2014. Annual Report 2014. Page 64.

Arumuganathan, K. Earle, E.D. 1991. Nuclear DNA content of some important plant species. Plant Mol Biol. 9: 208-218.

Biger, B. T. and Sakar, D. 2004. Genetic Variability and Heritability for Grain Yield and Other Characters in Lentil. J. Biol. Sci., 4 (2): 216-218, 2004.

Biger, B. T. and Sakar, D. 2010. Heritability Of Yield and Its Components In Lentil (Lens Culinaris Medik.). Bulg. J. Agric. Sci., 16: 30-35

El-Deeb, A. A. and Mohamed, N. A. 1999. Factor and cluster analysis for some quantitative characters in sesame (Sesamum indicum L.). Ann. Conf. ISSR, Cairo Univ. 34.

Falconer, D. S. 1960. Introduction to Quantitative Genetics. Oliver and Boyd, Edinburgh pp. 365.

Mekonnen, F., Mekbib, F. Kumar, Shiv. Ahmed, S. and Sharma, T. R. 2014. Agromorphological Traits Variability of the Ethiopian Lentil and Exotic Genotypes. Hindawi Publishing Corporation Advances in Agriculture Volume 2014, Article ID 870864, 15 pages http://dx.doi.org/10.1155/2014/870864.

Food and Agricultural organization of the United Nations (FAOSTAT). (2017). Retrieved from http://faostat3.org/home/index/html

Hussan, S. U. Khuroo, N. S. Lone, A.A. Dar, Z.A. Dar S.A. and Dar. M.S. (2018). Study of variability and association analysis for various agromorphological traits in lentil (Lens culinaris M.). Journal of Pharmacognosy and Phytochemistry 2018; 7(2): 2172-2175.

Jawad, M., S.R. Malik, M.A. Sarwar, M. Asadullah, I. Hussain and R. Khalid. 2018. Genetic analysis of lentil (Lens culinaris) exotic germplasm to identify genotypes suitable for mechanical harvesting. Pakistan Journal of Agricultural Research, 32(1): 152-158.

Jaynes, D.B., Kaspar, T. C. Colvin, T. S. and James, D. E. 2003. Cluster analysis of spatiotemporal corn yield patterns in an iowa field. Agron. J. 95. https://doi.org/10.2134/agronj2003.0574

Jeberson, M.S. Shashidhar, K.S and Yanar, K. 2015. Genetic Variability, Heritability, Expected Genetic Advance and Correlation Studies of Some Economical Characteristics in Lentil. Trends in Biosciences 8(5), Print: ISSN 0974-8, 1144-1347, 2015.

Johnson, H.W., Robinson, H.F., Comstock, R.E. 1955. Estimation of genetic and environmental variability in soybean. Agron. J. 47: 314-318.

Meteology office, Jumla, 2016.

MOAD. 2018. Statistical Information on Nepalese Agriculture, 2073/74 (2016/17). Government of Nepal. Ministry of Agricultural Development, Monitoring, evaluation and statistics division, Agri-statistics section: Singh durbar, Kathmandu Nepal.

Tyagi, S. D. and Khan, M. H. 2010. Studies on genetic variability and interrelationship among the different traits in Microsperma lentil (Lens culinaris Medik). Journal of Agricultural Biotechnology and Sustainable Development Vol. 2(1) pp. 015-020, January, 2010 Available online http://www.academicjournals.org/JABSD ©2010 Academic Journals.

Pandey, S., Bhatore, A. and Babbar, A. 2015. Studies on genetic variability, interrelationships association and path analysis in indigenous germplasm of Lentil in Madhya Pradesh, India. Electronic Journal of Plant Breeding, 6(2): 592-599 (June 2015) ISSN 0975-928X.

Tambal, H.A.A., Erskine, W. Baalbaki, R. Zaiter, H. 2000. Relationship of flower and pod numbers per inflorescence with seed yield in lentil. Experimental Agriculture 36:369-378.

https://en.wikipedia.org/wiki/Lentil [accessed 10/29/ 2019].

https://www.atlasbig.com/en-us/countries-lentil-production [accessed 10/29/2019].

Access this Article in Online

Quick Response Code	Website: www.ijarbs.com
	Subject: Agricultural Sciences

DOI:10.22192/ijarbs.2019.06.11.001

How to cite this article:

Netra Hari Ghimire, Hari Narayan Mandal. (2019). Genetic Variability, Genetic Advance, Correlation and Heritability of Cold Tolerance Lentil (*Lens culinaris* Medic.) Genotypes at High Hill of Nepal. Int. J. Adv. Res. Biol. Sci. 6(11): 1-10.

DOI: http://dx.doi.org/10.22192/ijarbs.2019.06.11.001