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Himalayan College of Agricultural Sciences & Technology (HICAST)
Kalanki, Kirtipur Municipality 1, Postal Code 44618
Kathmandu, Nepal
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# Agro-morphological traits variability of lentil genotypes

**K. R. Pant[1], S. B. Gurung[1], N. B. Dhami[2], J. Shrestha[2], L.Aryal[3] and R. Darai[3]**

Nepal Agricultural Research Council, Nepal
[1]Hill Crops Research Program, Kabre, Dolakha
[2]Agriculture Botany Division, Khumaltar, Lalitpur, Nepal
[3]Grain Legume Research Program, Khajura, Nepalgunj, Nepal
Corresponding author's email: pantkhemraj07@gmail.com

## ABSTRACT

*Lentil is the highly commercialized winter pulse crop and ranked first position among the grain legumes in terms of area and production in Nepal. The study on agro-morphological variability of lentil genotypes was conducted at Hill Crops Research Program, Kabre, Dolakha. Eighteen lentil genotypes including two check varieties were evaluated in Randomized Complete Block Design with three replications.The pooled data revealed that yield and yield attributing traits varied significantly. The combined analysis revealed that highest grain yield (2.064 t/ha) was produced by Black Musuro followed by RL-4 (1.40 t/ha), ILL-3490 (1.36 t/ha), LN-0136 (1.36 t/ha), ILL-7163 (1.34 t/ha) and WBL-77(1.32 t/ha). The genotypes Black Masuro and RL-4 may be new cultivars and may serve as parental lines for use in breeding programmes to develop high yielding varieties.*

**Keywords:** Agromorphological traits, Lentil, Mid hills, Genotypes

## INTRODUCTION

Lentil (*Lens culinaris* Medikus subsp. *culinaris*) is a self-pollinating, diploid (2n=2×=14) pulse crop with a relatively large genome of 4,063 Mpb (Arumuganathan, 1991). It is the most important grain legume in Nepal. Although initially they were only cultivated on the plains (terai) of southern Nepal, recently lentils have gained popularity in the hill and mountain regions of Nepal. MoAD (2014) states total area, production and productivity of lentil in Nepal was 2, 04,475 (ha), 2, 27,492 (t.) and 1112.5 (kg $ha^{-1}$) respectively. Lentil statistics showed that area, production and productivity had increased by 100.11%, 270.80% and 85.32% in between 1984/85 and 2012/13 respectively. Lentil is the main pulse crop in Nepal accounting 62.64% area and 64.35% production of the total legume (Gharti et al., 2013). Lentil is a rich source of protein, minerals (K, P, Fe and Zn) and vitamins contribute nutritional security to the Nepalese being main pulse of the country. It is also one of the major agricultural commodities exported from Nepal. Nepal has retained its position as the world's sixth largest producer of lentil in 2012 after it logged 0.64 percent rise in production according to the FAO of the United Nations. Lentil alone accounts for 90% of the total export of pulses and contributes about 2.3% of total national exports and shares about 3.1% of the total lentil export in the world (USAID, 2011). Lentil has been identified as one of the major agricultural products among 12 goods with high export and medium socioeconomic impacts potential by Nepal Trade Integration Strategy (NTIS) (MoCS, 2010). Nepal accounts for 4.57% of the world's lentil production and ranks fifth (3.2%) in lentil export after Canada (69.5%), USA (10.3%), Turkey (7.3%) and Australia (3.8%) in the world FAO (2013).As lentil is

consumed with cereals as (Dal), and because of its high lysine and tryptophan content, it contribute as an excellent supplement to wheat or rice providing a balance in essential amino acids for human nutrition. Besides, it helps in crop diversification/intensification, improving soil fertility and breaking down disease cycles. Lentil straw is also a valuable animal feed (Erskine et al., 1990).

Selection is a basic tool of plant breeding by which genotypes with high productivity, disease resistance, better quality and climate resilience for a given environment could be developed. However, selection for high yield is made difficult because yield and yield contributing character are quantitative and vary depending on genotypes and environments (Dugasssa, et al., 2014; Tadesse et al., 2014). Various technologies such as improved varieties and different crop management practices of lentil have so far been developed and released in Nepal. Considering the importance and potentiality of this crop, this research was conducted to find out and verify the high yielding elite genotype suitable for the existing cropping systems for mid hill environment.

## MATERIALS AND METHOD

**Experimental site**

The field experiment was conducted at the research farm of Hill Crops Research Program (HCRP), Kabre, Dolakha, Nepal during 2014 and 2015. Geographically, HCRP, Kabre, Dolakha is located in the mid hill region at 27º 3' N Latitude and 86º 3' E Longitude at an altitude of 1650 meters above sea level. The soil texture class of the research site was a sandy loam.

**Plant materials**

Eighteen lentil genotypes (Table 1) including two check varieties (Sagun and Shital) received from National Grain Legumes Research Program (NGLRP), Khajura.

Table 1: List of the lentil genotypes used in the study

| SN | Genotypes | SN | Genotypes | SN | Genotypes |
|---|---|---|---|---|---|
| 1 | Black Musuro | 7 | ILL-6819 | 13 | PL-4 |
| 2 | HUL-57 | 8 | ILL-7163 | 14 | RL-4 |
| 3 | ILL-2712 | 9 | ILL-7715 | 15 | RL-79 |
| 4 | ILL-3111 | 10 | ILL-7979 | 16 | WBL-77 |
| 5 | ILL-3490 | 11 | LG-12 | 17 | Sagun(Std. Check) |
| 6 | ILL-6467 | 12 | LN-0136 | 18 | Shital (Check) |

**Experimental design, treatments and crop management**

The experiment was conducted using randomized complete block design in 3 replications. Seed was sown on flat bed @ 50 kg ha-1 on 1st week of November for both years which was coated by Bavistin @ 3 g/kg seed. A pre-sowing irrigation was given before land preparation. Spacing used was 20 cm between rows and continuous in a row. Individual plot size was 4 $m^2$ (10 rows of 2 m long). In addition to 5t FYM, chemical fertilizers @ 20:40:20 N, $P_2O_5$, $K_2O$ kg/ha was applied during final land preparation. Hand weeding was done at 45 and 60 days after sowing.

**Data observation**

Observations on days to 50% flowering, days to 90% maturity, grain yield, 1000 grain weight were recorded on plot basis by excluding 2 rows on each site. Plant height, pods/plant and seeds/pods were taken from randomly selected 5 plants from middle row. Data on days to 50% flowering, 90% maturity, pod yield, 1000 grain weight and grain yield were recorded and

analyzed. Grain yield was taken by excluding outer 2 rows on both sides of a plot. Plant height, no. of pods/plants was measured from randomly selected five plants per plot. Grain was sun dried; yield was recorded and adjusted at 12% moisture.

**Statistical Analysis**

Analysis of variance and correlation among traits were done by using R studio software. The treatment means were compared by the Least Significant Difference (LSD) test at 5% level (Gomez and Gomez, 1984; Baral et al., 2016).

## RESULTS AND DISCUSSION

To determine the magnitude of genetic variation, morphological evaluation is an important step in description and classification of genotypes (Zubair et al., 2007). During 2014, highly significant difference was observed among the tested genotypes for days to flowering, days to maturity, thousand seed weight and grain yield but only significant difference was observed for plant height and non significance difference for pods/plant. During 2015, highly significant difference was observed among the tested genotypes for days to flowering and maturity, thousand seed weights but only significant difference was observed for grain yield.

Combined analysis revealed that significant differences for heading, pods/plant, thousand seed weight and grain yield. The variations on plant height due to genotypes were also reported by various researchers (Dugassa et al., 2014; Mekonnen et al., 2014; Yadav et al., 2016). Variation on days to flowering were also reported by (Neupane, 2013; Dugassa et al., 2014; Yadav et al., 2016; Darai et al., (2017). Significant difference on lentil yield and yield attributing traits were also reported by (Singh et al., 2006; Neupane, 2013; Dugassa et al., 2014; Adhikari et al., 2018).

The days to maturity ranged from 145 to 154 days with mean value of 151 days. The early maturing genotypes were Shital (145 days) and the late maturing genotypes were ILL-6467(154 days) and LG-12 (154 days). Similarly, the plant height ranged from 27.7 cm to 37.27 cm with mean value of 31.55 cm. The shortest plant height was observed in PL-4 (27.7 cm) and tallest genotypes were ILL-6467(38.27 cm) and RL-79 (3.6 cm).The number of pod per plant ranged from 43 to 67 pods/plant with mean value of 54.The highest number of pods per plant was found in LG-12(67) followed by ILL-2712 (61) and lowest was found in LN-0136 (43). The average thousand seed weight was found 17.6 gm. The highest thousand seed weight was found in genotypes PL-4(23.5 gm) followed by RL-79 (23.2 gm). The grain yield ranged from 0.98 t/ha to 2.06 t/ha with average value of 1.27 t/ha. The highest grain yield was produced by Black Musuro (2.064 t/ha) followed by RL-4 (1.40 t/ha), LN-0136(1.363 t/ha) and ILL-7163(1.34 t/ha). The lowest grain yield was produced by PL-4 (0.98 t/ha).

Table 2: Morphological and phenological traits of Lentil genotypes at Kabre, Dolakha during 2014 and 2015

| S. N | Genotypes | DTF (Year) | | | DTM (year) | | | PH (cm) (2year) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2014 | 2015 | Combined | 2014 | 2015 | Combined | 2014 | 2015 | Combined |
| 1 | Black Musuro | 89 | 105 | 97 | 157 | 151 | 154 | 40.80 | 24.67 | 32.74 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 | HUL-57 | 65 | 98 | 82 | 151 | 142 | 147 | 32.33 | 25.00 | 28.67 |
| 3 | ILL-2712 | 66 | 92 | 79 | 159 | 146 | 153 | 43.20 | 27.67 | 35.44 |
| 4 | ILL-3111 | 60 | 87 | 74 | 153 | 140 | 147 | 34.933 | 27.00 | 30.97 |
| 5 | ILL-3490 | 67 | 92 | 80 | 155 | 146 | 151 | 36.60 | 27.00 | 31.80 |
| 6 | ILL-6467 | 77 | 93 | 85 | 160 | 148 | 154 | 46.53 | 28.00 | 37.27 |
| 7 | ILL-6819 | 74 | 99 | 87 | 149 | 145 | 147 | 41.13 | 24.67 | 32.90 |
| 8 | ILL-7163 | 65 | 99 | 82 | 153 | 148 | 151 | 36.80 | 24.33 | 30.57 |
| 9 | ILL-7715 | 77 | 92 | 85 | 161 | 145 | 153 | 27.53 | 23.67 | 25.60 |
| 10 | ILL-7979 | 74 | 88 | 81 | 151 | 146 | 149 | 30.93 | 26.00 | 28.47 |
| 11 | LG-12 | 61 | 92 | 77 | 161 | 147 | 154 | 37.20 | 24.67 | 30.94 |
| 12 | LN-0136 | 74 | 98 | 86 | 154 | 147 | 151 | 38.53 | 27.33 | 32.93 |
| 13 | PL-4 | 74 | 92 | 83 | 154 | 151 | 153 | 29.20 | 26.33 | 27.77 |
| 14 | RL-4 | 67 | 92 | 80 | 157 | 144 | 151 | 43.13 | 26.33 | 34.73 |
| 15 | RL-79 | 56 | 85 | 71 | 154 | 143 | 149 | 43.86 | 27.33 | 35.60 |
| 16 | WBL-77 | 86 | 92 | 89 | 161 | 145 | 153 | 36.06 | 26.33 | 31.20 |
| 17 | Sagun (Standard Check variety) | 76 | 99 | 88 | 161 | 143 | 152 | 34.13 | 26.00 | 30.07 |
| 18 | Shital (Check variety) | 67 | 99 | 83 | 156 | 134 | 145 | 35.73 | 25.00 | 30.37 |
| Grand Mean | | 71 | 94 | 82 | 156 | 145 | 151 | 37.14 | 25.96 | 31.55 |
| CV (%) | | 1.14 | 0.807 | 6.56 | 0.85 | 2.34 | 2.48 | 17.7 | 10.47 | 10.73 |
| LSD (0.05) | | 1.35 | 1.26 | 11.41 | 2.22 | 5.64 | 7.89 | 10.95 | 4.51 | 7.14 |
| P-Value | | <0.01 | <0.01 | 0.036 | <0.01 | <0.01 | 0.36 | 0.053 | 0.806 | 0.18 |

*DTF=days to flowering, DTM=days to maturity, PH= Plant height, GY= Grain yield, P/P= Pods/plant and TSW=Thousand seed weight.*

Table 3: Grain yield and yield attributing traits of Lentil genotypes at Kabre, Dolakha during 2014 and 2015

| **S. N** | **Genotypes** | **Pods / Plant (2014)** | **Pods /Plant (2015)** | **Combined (Pods/ Plant)** | **GY (t/ha) (2014)** | **GY (t/ha) (2015)** | **Combined (GY(t/ha)** | **TSW (g) (2014)** | **TSW (g) (2015)** | **Combined TSW (g)** |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Black Musuro | 47 | 57 | 52 | 1.93 | 2.19 | 2.06 | 18.9 | 19.1 | 19.0 |
| 2 | HUL-57 | 45 | 53 | 49 | 1.23 | 1.24 | 1.23 | 16.5 | 17.8 | 17.1 |
| 3 | ILL-2712 | 57 | 65 | 61 | 1.15 | 1.11 | 1.13 | 16.3 | 16.4 | 16.3 |
| 4 | ILL-3111 | 53 | 64 | 59 | 1.00 | 1.28 | 1.14 | 17.5 | 17.3 | 17.4 |
| 5 | ILL-3490 | 59 | 61 | 60 | 1.27 | 1.45 | 1.36 | 16.2 | 16.5 | 16.3 |
| 6 | ILL-6467 | 48 | 56 | 52 | 1.40 | 1.23 | 1.31 | 16.4 | 15.8 | 16.1 |
| 7 | ILL-6819 | 45 | 64 | 54 | 1.25 | 1.40 | 1.32 | 16.3 | 15.6 | 15.9 |
| 8 | ILL-7163 | 45 | 63 | 54 | 1.33 | 1.36 | 1.34 | 16.0 | 16.0 | 16.0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 9 | ILL-7715 | 56 | 60 | 58 | 0.92 | 1.00 | 0.96 | 16.5 | 16.8 | 16.7 |
| 10 | ILL-7979 | 44 | 53 | 48 | 1.14 | 1.43 | 1.28 | 20.8 | 22.3 | 21.5 |
| 11 | LG-12 | 57 | 78 | 67 | 0.98 | 1.26 | 1.12 | 16.4 | 15.7 | 16.0 |
| 12 | LN-0136 | 42 | 44 | 43 | 1.35 | 1.37 | 1.36 | 17.4 | 16.2 | 16.8 |
| 13 | PL-4 | 44 | 65 | 55 | 0.91 | 1.06 | 0.98 | 21.4 | 25.6 | 23.5 |
| 14 | RL-4 | 60 | 52 | 56 | 1.35 | 1.46 | 1.40 | 15.9 | 16.1 | 16.0 |
| 15 | RL-79 | 53 | 55 | 54 | 1.10 | 1.01 | 1.05 | 22.5 | 23.8 | 23.2 |
| 16 | WBL-77 | 42 | 52 | 47 | 1.37 | 1.27 | 1.32 | 16.4 | 16.2 | 16.3 |
| 17 | Sagun (Standard Check variety) | 51 | 62 | 57 | 1.07 | 1.40 | 1.23 | 17.4 | 17.2 | 17.3 |
| 18 | Shital (Check variety) | 42 | 53 | 47 | 1.18 | 1.21 | 1.19 | 16.2 | 15.0 | 15.6 |
| Grand Mean | | 49 | 59 | 54 | 1.22 | 1.32 | 1.27 | 17.49 | 17.73 | 17.6 |
| CV (%) | | 27 | 22.37 | 9.82 | 18.44 | 24.3 | 8.4 | 7.42 | 11.7 | 9.64 |
| LSD (0.05) | | 22.64 | 21.81 | 11.2 | 0.37 | 0.533 | 0.225 | 2.32 | 3.44 | 2.78 |
| P-value | | 0.824 | 0.486 | 0.035 | 0.007 | 0.041 | <0.01 | <0.01 | <0.01 | <0.01 |

*DTF=days to flowering, DTM=days to maturity, PH= Plant height, GY= Grain yield, P/P= Pods/plant and TSW=Thousand seed weight.*

**Correlation**

Correlation coefficient is a measure of the degree association and relationship between two variables. It is important in plant breeding as it can be used for indirect selection. The success of plant breeding program depends on effective selection based on the relationship between yield and yield components. Phenotypic correlation between 6 quantitative traits of 18 lentil genotypes is presented in Table 4. Days to flowering showed highly significant positive correlation with grain yield (0.655**), non significant positive correlation with days to maturity (0.333) and non significant negative correlation with plant height and thousand seed weight. Grain yield showed highly significant positive correlation with days to flowering(0.655**) and non significant positive correlation with days to maturity and plant height. Thousand seed weight showed non significant positive correlation with days to maturity and non significant negative correlation with grain yield, days to flowering, plant height.

Table 4: Pearson's Correlation coefficient among different traits of combined analysis

| Traits | DTF | DTM | PH | P/P | GY | TSW |
|---|---|---|---|---|---|---|
| DTF | 1 | 0.333 | -0.131 | -0.407 | 0.655** | -0.204 |
| DTM | | 1 | 0.13 | 0.332 | 0.174 | 0.017 |
| PH | | | 1 | 0.023 | 0.298 | -0.154 |
| P/P | | | | 1 | -0.28 | -0.116 |
| GY | | | | | 1 | -0.157 |
| TSW | | | | | | 1 |

DTH: Days to Heading; DTM: Days to Maturity; PH: Plant Height; GY: Grain Yield; P/P: Pods/Plant, TSW: Thousand Seed Weight. Values are significantly different at 5% level of significance (*) and highly significantly different at 1% level of significance (**)

## CONCLUSION

Agro-morphological variability is necessary for plant breeders for genetic improvement of any crop. The knowledge on available traits variability is important to understand and its potential use in breeding programs. On the presence of significant genetic variability among the tested genotypes the present study concluded that the genotypes Black Musuro, RL-4 and LN-0136 were found promising genotypes which could be new lentil varieties for mid hill region of Nepal. Moreover, available genetic variability shows that there is an excellent opportunity to bring desired improvement through direct selection and hybridization. Phenotypic correlation revealed that days to flowering, days to maturity, plant height, thousand grain weight and pods/plant are most important components of yield. Therefore, selection based on these yield contributing characters might be fruitful in lentil breeding program.

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## REFERENCES

Adhikary, B. N., Shrestha, J., Joshi, B. P., & Bhatta, N. R. (2018). Agronomic traits evaluation and correlation study in lentil (*Lens culinaris* Medikus) genotypes. *International Journal of Advanced Research in Biological Sciences*, 5(12): 1-10

Arumuganathan, K., & Earle, E.D. (1991). Nuclear DNA content of some important plant species. *Plant Molecular Biology*, 9: 208-218.

Baral, B. R., Adhikari, P., & Shrestha, J. (2016). Productivity and Economics of Hybrid Maize (*Zea mays* L.) in the Inner Terai Region of Nepal. *Journal of AgriSearch*, 3(1): 13-16.

Darai, R., Sarker, A., Sah, R. P., Pokhrel, K., & Chaudhary, R. (2017). AMMI biplot analysis for genotype × environment interaction on yield trait of high Fe content lentil genotypes in terai andmid-hill environment of Nepal. *Annals of Agricultural & Crop Sciences*, 2(1): 1026-1030.

Dugassa, A., Legesse, H., & Geleta, N. (2014). Genetic variability, yield and yield associations of lentil (*Lens culinaris* Medik.) genotypes grown at Gitilo Najo, western Ethiopia. *Science, Technology and Arts Research Journal*, 3(4): 10-18.

Erskine, W., & Elashkar, F. (1993). Rainfall and temperature effects on lentil (Lens culinaris) seed yield in Mediterranean environments. *J. Agric. Sci*. 121: 347-354.

FAO. (2013). Food and Agriculture Organization of the United Nations. Accessed on 20th December, 2013 from www.faostat.fao.org.

Gharti, D.B., Darai, R., Subedi, S., Sarker, A., & Kumar, S. (2014). Grain Legumes in Nepal: Present Scenario and Future Prospects. World Journal of Agricultural Research, 2(5): 216-222.

Gomez, K. A., & Gomez, A. A. (1984). Statistical Procedure for Agricultural Research (2nd edn.). Int. Rice Res. Inst. andWilley, New York pp. 28-192.

Mekonnen, F., Mekbib, F., Kumar, S., Ahmed, S., & Sharma, T. R. (2014). Agromorphological traits variability of the Ethiopian lentil and exotic genotypes. *Advances in Agriculture*, vol. 2014. Retrieved from http://dx.doi.org/10.1155/2014/870864

MoAD. (2014). Statistical information on Nepalese Agriculture 2014/15. AgriBusiness Promotion and Statistics Division, Ministry of Agriculture Development, Kathmandu, Nepal. *World Journal of Agricultural Research*, 2(5): 216-222

MoCS. (2010). Nepal trade integration strategy 2010. Government of Nepal. Ministry of Commerce and Supplies. Kathmandu, Nepal

Neupane, R. (2013). Varietal investivation on lentil for mid hills. In. Giri Y. P., Khatiwoda, S.P., Mahato, B.N., Gautam, A.K., Bhatta, M. R., Ranjit, J. D., Chettri, B.K., Paneru, R.B. and Sapkota, B (eds.). *Proceedings of 28th National winter crops workshop*, held on 9-10th March, 2011 at RARS, Lumle. Nepal Agricultural Research Council, 11421.

Singh, G., Hafiz, M., & Manzar, A. (2006). Genetic variability for economic traits in lentil (*Lens culinaris* Medik). *New Botanist*. Vol. XXXIII : 117-22.

Tadesse, T., Leggesse, T., Mulugeta, B., & Sefera, G. (2014). Correlation and path coefficient analysis of yield and yield components in lentil (*Lens culinaris* Medik.) germplasm in the highlands of Bale, Ethiopia. *International Journal of Biodiversity and Conservation*. 6 (1): 115-120.

USAID. (2011). Value chain/market analysis of the lentil sub-sector in Nepal. United States Agency for International Development, General Development Office, Kathmandu, Nepal.

Yadav, N.K., Ghimire, S. K., Sah, B. P., Sarker, A. Shrestha, S. M., & Sah, S. K. (2016). Genotype x environment interaction and stability analysis in lentil (Lens culinaris Medik.) *International Journal of Environment, Agriculture and Biotechnology*, 1(3): 354-61

Zubair, M., Ajmal, S.U.; Anwar M., & Haqqani, A.M. (2007). Multivariate analysis for quantitative traits in mungbean [*Vigna radiata* (L.) Wilczek]. *Pakistan Journal of Botany*, 39: 103-113.