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Agronomic traits evaluation and correlation study in lentil (*Lens culinaris* Medikus) genotypes

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Abstract

The performance evaluation of lentil genotypes is useful to formulate selection criteria for improvement of lentil seed yield. This experiment was conducted at research field of Regional Agricultural Research Station (RARS), Dipayal, Doti, Nepal during winter seasons of 2013/14 and 2014/15 under maize based bariland system to assess the genotypic variability and correlation among yield and yield components. Eighteen lentil genotypes including two check varieties were studied in Randomized Complete Block Design with four replications. The pooled data reveled that yield and yield attributing traits varied significantly. The highest grain yield (1667 kg/ha) was produced by RL 79, followed by Black Masuro (1592 kg/ha) and LG 12 (1413 kg/ha) respectively. These genotypes were promising genotypes and may be new cultivar or as serve as parents for use in breeding programmes to develop high yielding varieties. The correlation of grain yield with other traits namely plant height, days to maturity, thousand grain weight, seeds/pods and pods/plant were positive and significant. The selection for these traits might bring an improvement in lentil seed yield.

Keywords: Lentil, genotypes, yield, correlation

Introduction

Lentil (*Lens culinaris* subsp. *culinaris* Medikus) ranked 1st in area and production and occupies about 63% of area and 69% production under grain legumes in Nepal. It is cultivated in 205939 ha with 1113 kg/ha national productivity (MOAD, 2017). Area, production and productivity of lentil is in increasing due to the availability of improved production technologies, technical supports, export market, lentil area expansion in rice fallow and reduction in grasspea area due to ban on its marketing (NGLRP, 2010). Lentil is one of the crop among few exportable crops of Nepal. About 90% lentil area lies in terai/inner tarai where it is grown after rice (relay or post rice) and lentil entirely grown on residual soil moisture and fertility. It is also mixed with mustard, linseed, wheat and winter grain legumes. Under upland condition, it is grown after maize in mixture with tori or mustard. Lentil is a rich source of protein, minerals (K, P, Fe and Zn) and vitamins contribute nutritional security to the Neplease being main pulse of the country. 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).

Stemphylium blight, wilt complex, drought and high temperature stress during pod filling stage are major constraints on lentil production in terai region (NGLRP, 2010). Delay transplanting of rice due to late onset of monsoon subsequently delay lentil sowing which face terminal heat stress during pod filling stage cause force maturity and reduce lentil yield. Thus to increase lentil production in country, introduction of lentil in non-traditional areas (river basin and mid-hills environments) where it receive more number of growing days and escape terminal heat, could be new opportunity. Thus to increase lentil production, development of suitable varieties for different agro-ecological niches and production domains under rice and maize based cropping domains is realized.

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). In addition relationship between yield and yield attributing traits are prime important for direct and indirect selection of traits to which contributes to yield (Aditya and Bhartiya, 2013). So, knowledge on inherent variability and extent of association between yield and yield contributing character need to be known for efficient selection. Therefore this study was conducted to evaluate lentil genotypes for growth and yield performance and to find out interrelationship and contribution of different quantitative characters on lentil yield improvement.

Materials and Methods

Experimental site

This experiment was carried out in the research field of Regional Agricultural Research Station (RARS), Bhagetada, Dipayal, Doti during two consecutive winter season (November–April) of 2013/14 and 2014/15. . It is located at the latitude of N $29^0$15'16.4" and longitude of E $80^0$55'59.3" (Prasai et al., 2016). This research station is situated at the bank of Seti River with the altitude of 546 meters above the sea level General climate is sub tropical, pre-monsoon period is dry and very hot. Monsoon starts very late in July and is very erratic. Annual rainfall is 900 ml and winter rain is unpredictable. High solar radiation and wide variation in day and night temperature is the climatic features of the area. Experimental field soil was shallow in depth and porous, sandy loam, slightly acidic with pH 5.5-6.0, low in nitrogen and organic matter i.e. 1-2% and 0.6 % respectively. Because of light texture soil and low organic matter content, the water holding capacity of the soil is very low.

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 Lentil genotypes used for the study

Seed Source	SN	Genotypes	SN	Genotypes	EN	Genotypes
National Grain Legumes Research Program (NGLRP), Khajura	1	ILL 7979	7	Sagun	13	RL 79
	2	ILL 3111	8	Shital	14	RL 4
	3	ILL 3490	9	LG 12	15	IL 6466
	4	WBL 77	10	PL 4	16	ILL 7715
	5	ILL 2712	11	ILL 7163	17	ILL 6819
	6	LN 0136	12	Black Masuro	18	HUL 57

Experimental design, treatments and crop management

The experiment was conducted using randomized complete block design in 4 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 25 cm between rows and continuous in a row. Individual plot size was 6 m^2 (8 rows of 3 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 30 and 45 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. Final plant stands at harvest was recorded from 1m^2 area from the centre of the plot. Plant height, pods/plant and seeds/pods were taken from randomly selected 5 plants from middle row. Data on plant stand, days to 50% flowering, 90% maturity, pod yield, 1000 grain weight and grain yield were recorded and analysed. Grain yield was taken by excluding outer 2 rows on both sides of a plot. Plant height, no. of pods/plants and unfilled pods/plot were measured from randomly selected five plants per plot. Grain was sundried, yield was recorded and adjusted at 12% moisture.

Statistical Analysis

Analysis of variance and correlation among traits were done by using Genstat 18.0. Least significant difference (LSD $p \leq 0.05$) test was used for mean comparison to identify the significant components of the treatment means (Jan et al., 2009; Sharma et al., 2016). Significance of correlation coefficient was done as proposed by Kothari (2004).

Results and Discussion

Agronomic performance

Year wise and combine analysis of variances over years for 18 genotypes on 8 quantitative traits were presented on Table 2-4. In 2013/14 significant differences were observed for days to flowering and maturity final plant stand/m^2 at harvest, plant height, seeds/pod, plant height and grain yield while number of pod/plant and thousand grain weight were statistically non-significant. Likewise in 2014/15 season genotypic differences were found significant for days to flowering, days to maturity, seeds/pods and grain yield while final plant stand/m^2 at harvest, plant height, pods/plant and thousand grain weight remained statistically non-significant. These results showed the presence of inherent genetic variability among the genotypes which gives an opportunity for legume breeders to select most promising genotypes or improve those traits for variety development through selection and hybridization. Significant difference on lentil yield and yield attributing traits were also reported by (Neupane, 2013; Dugassa et al., 2014; Nath et al., 2014; Kumar et al., 2016).

Table 2 Performance of Lentil genotypes at Dipayal, Doti in 2013/14

SN	Genotypes	Fs/m2	DF	DM	PH	P/P	S/P	TGW	GY
1	ILL 7979	91	92	142	26	68	1.8	18.5	847
2	ILL 3111	94	93	142	28	67	1.9	15.0	913
3	ILL 3490	85	92	141	26	61	1.7	14.5	816
4	WBL 77	99	97	145	29	85	1.9	16.0	1099
5	ILL 2712	75	95	148	31	67	1.8	15.0	706
6	LN 0136	114	96	143	33	66	1.6	17.0	1156
7	Sagun	112	94	146	26	53	1.6	16.0	1013
8	Shital	111	93	142	30	56	1.9	15.5	1141
9	LG 12	100	93	142	30	63	2.0	17.5	1104
10	PL 4	53	97	143	25	57	1.3	17.0	410
11	ILL 7163	111	93	142	29	73	1.9	15.5	1238
12	Black Masuro	110	98	145	29	81	1.9	17.0	1159
13	RL 79	80	90	144	25	55	1.9	15.0	848
14	RL 4	76	96	143	21	76	1.9	15.0	861
15	IL 6466	96	92	142	28	81	1.8	15.5	983
16	ILL 7715	98	93	142	28	49	1.9	14.0	781
17	ILL 6819	115	91	141	32	79	1.9	14.5	1186
18	HUL 57	76	95	143	27	53	1.9	15.0	951
Mean		94	94	143	28	66	1.8	15.8	956
P value		<.001	<.001	<.001	0.006	0.144	0.021	0.08	0.029
CV %		18.34	1.58	o.32	10.55	27.62	12.51	7.64	30.82
LSD(0.05)		22.84	2.10	0.65	4.23		0.32		418.5

Fs/m^2 = Final stand at harvest/m^2 , DF = Days to 50% Flowering, DM = Days to 90% maturity, PH = Plant height (cm), P/P = Number of filled pods/plant, S/P = Number of seeds/plant, TGW = Thousand grain weight (g), GY = Grain Yield (kg/ha)

Combined analysis over year also revealed significant genotypic differences for final stand/m^2, days to flowering, days to maturity, plant height and grain yield whereas number of pods/plant, seeds/pod and thousand grain weight remained non-significant. Similarly response of growing years was found significant for all observed traits, however, interaction of genotypes and growing year remained non-significant except days to maturity. Significance response both studied genotypes and growing years indicated that both environmental conditions and studied genotypes influenced significantly on the performance of yield and yield components of lentil. These findings are in accordance with previous reporting by (Abo Hegazy et al., 2013; Darai et al., 2017). Non significant interaction between genotypes and years indicating the non distinct role of genotypes and years on the phenotypic expression. Very similar reporting was previously done by Darai et al., 2017.

Mean yield and yield attributing traits

Year wise and combine mean table for yield and yield attributing traits of the tested genotypes were presented on Table 2-4.

Final plant stand/m^2 at harvest

In 2013/14 season, final plant stand/m^2 ranged from 53 (PL 4) to 115 (ILL 6819) with mean value 94 while in the succeeding season it ranged from 89 (PL 4) to 156 (Black masuro). On data combining, final plant stand/m^2 ranged from 71 (PL 4) to 133 (Black masuro and LN 0136). Significant difference on combine analysis shows the existing variation among genotypes for the trait.

Days to 50% flowering

Days to 50% flowering from date of sowing ranged from 91 (ILL 6819) to 98 (Black masuro) with trial mean 94 days in 2013/14 while it ranged from 97 (ILL 3490) to 109 (Black masuro) with trial mean 102 days during 2014/15. Combine analysis over years showed that genotypes ILL 3490, RL 79, ILL 7979 were flowered early took about 98 days while Black masuro was late took 109 days to flower. Existence of variability on days to 50% flowering is confirmed by the genotypic significant for the trait from analysis of variance. Variation on days to flowering were also reported by (Neupane, 2013; Dugassa et al., 2014; Yadav et al., 2016; Darai et al., (2017).

Days to 90% maturity

Days to 90% maturity from days to sowing ranged from 141 to 148 days in the first year and 146 to 154 days in the 2nd year while combining data, it ranged from 144 to 149 days with mean 147 days. Mean table showed that genotypes ILL 3111, ILL 7979 were found early maturing types and could be selected as an early variety or can be used as parent to develop early maturing cultivars. Early maturity with good yield is desirable trait for lentil grown in terai areas as early maturing variety can escape terminal drought stress than late maturing types. Analysis of variance table confirmed the existence of genetic variability on evaluated lentil genotypes for days to 90% maturity. Singh et al., 2006; Meknnen et al., 2014; Yadav and et al., 2016; Darai et al., 2017 have also reported significant difference on this trait among evaluated lentil genotypes.

Plant height

Pooled mean showed that plant height ranged from 34 to 43 cm with mean 39 cm. Genotypes LN 0136, Black masuro were found taller and ILL 3490, ILL 7979 were observed dwarf among genotypes, while check varieties sagun and shital grew 36 cm and 40 cm respectively. Taller, erect and lodging resistance genotypes are suitable for mechanical as well as manual harvesting. Analysis of variance showed the existence of genetic variability on evaluated lentil genotypes for plant height. In agreement with this finding, variations on plant height due to genotypes were also reported by (Singh et al., 2006; Dugassa et al., 2014; Meknnen et al., 2014; Yadav et al., 2016).

Table 3 Performance of Lentil genotypes at Dipayal, Doti in 2014/15

SN	Genotype	Fs/m^2	DF	DM	PH	P/P	S/P	TGW	Grain Yield
1	ILL 7979	155	99	148	44	74	2.0	20.0	986
2	ILL 3111	134	101	150	53	76	1.9	16.5	1362
3	ILL 3490	139	97	146	43	81	1.9	17.5	1019
4	WBL 77	135	102	151	53	63	2.1	18.0	1192
5	ILL 2712	117	101	150	42	91	2.0	17.0	1230
6	LN 0136	152	103	151	54	79	2.0	18.0	1341
7	Sagun	140	101	149	45	79	2.0	18.5	1506
8	Shital	131	103	150	51	83	1.9	18.0	1472
9	LG 12	136	102	151	52	79	2.0	21.0	1721
10	PL 4	89	106	154	49	72	2.1	18.5	1179
11	ILL 7163	123	101	152	51	83	1.7	17.0	1578
12	Black Masuro	156	109	154	54	54	2.1	19.0	2025
13	RL 79	146	98	150	48	61	2.1	19.0	2486
14	RL 4	136	104	152	50	87	2.1	19.0	1318
15	IL 6466	142	102	150	54	94	1.8	18.0	1425
16	ILL 7715	150	100	151	48	73	2.1	16.5	1651
17	ILL 6819	133	103	151	49	84	1.9	17.5	1495
18	HUL 57	140	104	150	50	83	1.9	18.0	1372
Mean		136	102	150	49	77	2.0	18.2	1464
P Value		0.115	0.011	0.003	0.079	0.69	<.001	0.12	<.001
CV%		18.6	3.5	1.5	12.1	30.1	5.8	6.4	23.0
LSD(0.05)		35.8	5.1	3.18		33.12	0.08		481.3

Fs/m^2 = Final stand at harvest/m^2, DF = Days to 50% Flowering, DM = Days to 90% maturity, PH = Plant height (cm), P/P = Number of filled pods/plant, S/P = Number of seeds/plant, TGW = Thousand grain weight (g), TGW = Thousand grain weight (g), GY = Grain Yield (kg/ha)

Number of pods/plant

The number of pods per plant is very important in determining yield performance of lentil. Combined data showed that number of pods/plant ranged from 58 to 88 with trial mean 72. Non-significant difference for the trait for year wise and combined analysis reveled absence genotypic variability among tested genotypes for pod bearing capacity. This result is in conformity with to the result obtained by Darai et al., (2017).

Number of seeds/pods

Number of seeds/pod is an important factor on determining the yield of leguminous crops and basically it genetic character but may also be affected due growing environment. Pooled data over years showed that this trait ranged from 1.7 to 2.0 with mean 1.9. Analysis of variance showed the existence of genetic variability on evaluated lentil genotypes for number of seeds/pod. Similar reportings were done by (Singh et al., 2006; Meknnen et al., 2014; Yadav et al., 2016; Darai et al., 2017.

Thousand grain weight

The test weight is a very important factor for the determination of crop yield. In 2013/14 it was ranged from 14.5 to 18.5g with mean 15.8 g. Similarly in the next year, it was ranged from 16.5 to 21.0 g with mean 18.2 g, while combining data test weight ranged from 15.25 to 19.25g with pool mean 17.0 g. Pooled data showed genotypes LG 12, ILL 7979 were observed bold seeded. Analysis of variance showed the existence of genetic variability on evaluated lentil genotypes for thousand grain weight. In agreement with this finding, variations on thousand grain weight due to genotypes were also reported by (Singh et al., 2006; Meknnen et al., 2014; and Yadav et al., 2016).

Table 4 Pooled performances of Lentil genotypes at Dipayal, Doti during 2013/14-2014/15.

SN	Genotypes	Fs/m2	DF	DM	PH	P/P	S/P	TGW	GY
1	ILL 7979	123	96	145	35	71	1.9	19.25	917
2	ILL 3111	114	97	146	41	72	1.9	15.75	1138
3	ILL 3490	112	95	144	34	71	1.8	16.00	918
4	WBL 77	117	100	148	41	74	2.0	17.00	1146
5	ILL 2712	96	98	149	36	79	1.9	16.00	931
6	LN 0136	133	100	147	43	72	1.8	17.50	1249
7	Sagun	126	97	147	36	66	1.8	17.25	1260
8	Shital	121	98	146	40	69	1.9	16.75	1307
9	LG 12	118	97	146	41	71	2.0	19.25	1413
10	PL 4	71	101	148	37	64	1.7	17.75	795
11	ILL 7163	117	97	147	40	78	1.8	16.25	1408
12	Black Masuro	133	103	149	42	67	2.0	18.00	1592
13	RL 79	113	94	147	36	58	2.0	17.00	1667
14	RL 4	106	100	148	39	82	2.0	17.00	1090
15	IL 6466	119	97	146	41	88	1.8	16.75	1204
16	ILL 7715	124	96	146	38	61	2.0	15.25	1216
17	ILL 6819	124	97	146	40	82	1.9	16.00	1341
18	HUL 57	108	99	147	38	68	1.9	16.50	1162
Mean		115	98	147	39	72	1.9	17.0	1209
Year (Y)		<.001	<.001	<.001	<.001	0.002	<.001	<.001	<.001
Genotype (G)		<.001	<.001	<.001	0.004	0.448	0.136	0.174	0.002
Y × G		0.656	0.678	<.001	0.18	0.47	0.06	0.078	0.070
	LSD Y	8.05	0.968	0.55	1.55	7.07	0.06	0.085	133.0
	LSD G	24.15	2.90	1.66	4.65				399.1
	LSD Y × G			2.34					
	CV%	21.1	3.0	1.1	12.1	29.8	11.0		33.2

Fs/m^2 = Final stand at harvest/m^2 , DF = Days to 50% Flowering, DM = Days to 90% maturity, PH = Plant height (cm), P/P = Number of filled pods/plant, S/P = Number of seeds/plant, TGW = Thousand grain weight (g), TGW = Thousand grain weight (g), GY = Grain Yield (kg/ha)

Grain yield

Grain yield is a function of combined effect of gene controlling yield components and influence of growing environments and agronomic practices adopted. Therefore any variation or change in them is liable to bring a change in attained yield. Yield data in 2013/14 ranged from 410-1338 kg/ha with mean yield 956 kg/ha. During this year, genotypes ILL 7163 produced higher grain yield (1238 kg/ha) which was followed by ILL 6819 gave 1186 kg/ha but the yield was statistically at par with both checks. In 2014/15 these genotypes produced grain yield ranged from 986 kg/ha to 2486 kg/ha with trial mean 1464 kg/ha. Genotypes RL 79 produced 2486 kg/ha which is followed by Black masuro produced 2025 kg/ha found high yielders than both check varieties. Pooled yield data showed that genotypes RL 79, Black masuro, LG 12, ILL 7163 were higher yielding genotypes produced mean yields of 1667 kg/ha, 1592 kg/ha, 1413 kg/ha and 1408 kg/ha however these were at par with both check varieties except RL 79 which produced higher yield than Sagun (Table 5). On the basis of yield, seed boldness, plant height and maturity period, RL- 79, Black masuro, LG 12, ILL 7163 were found promising and could be new lentil varieties for Nepal. Analysis of variance showed the existence of genetic variability on evaluated lentil genotypes for grain yield. In agreement with this finding, variations on grain yield due to genotypes were also reported by (Singh et al., 2006; Meknnen et al., 2014; Dugassa et al., 2014; Yadav et al., 2016; Darai et al., 2017).

Significant responses were observed for yield and yield components with respect to growing years (Table 5). Mean value for yield and yield components during 2014/15 were observed higher than 2013/14 growing season (Table 3 and 4). Grand mean comparison for both years showed that final plant stand at harvest increased by about 45%, days to flowering and maturity delayed by a week, increase in plant height by 20 cm, about 15% increment on number of pods/plants and thousand grain weight. Similarly, there was increment on seeds/pods by 10% and finally in grain yield by 53% as compared to 2013/14 growing season. The noticeable increment on yield and yield components in 2014/15 season may be this season became more favorable for lentil growing because of good moisture availability due to winter rainfall during crop period. The amount of rainfall during crop period (Nov.-April) was 181 mm for 2013/14 while it was 333.5 mm for 2014/15 crop period (RARS, 2014; RARS, 2015). According to Erskine and Elashkar (1993) there will be yield loss on lentil if crop is exposed to drought stress, though lentil can be grown with 250 to 300 mm precipitation. Availability of optimum moisture during flowering stage increased growth duration and seed filling duration which improve pods/plant, test weight and ultimately grain yield. The present findings are in conformity by Lal et al., (1988) who reported increased in plant height, no. of pods/plant, no. of branches/plant, no. of seeds/pod, 100 grain weight, harvest index, grain yield and delayed maturity by 5-6 days on lentil when supplementary irrigation was provided during flowering period on silty clay loam soil. Further, (Zhang et al., 2000; Oweis et al.,2004) showed increase on lentil yield by 20-70% by avoiding water stress.

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. The study of correlation between different characters may help the plant breeder to know how the improvement of one character will bring simultaneous changes in other characters. Thus identification of important yield components and their nature and magnitude of association between them and with economic yield is very useful for selecting high yielding varieties with desired traits. Phenotypic correlation between 8 quantitative traits of 18 lentil genotypes is presented in Table 5.

Grain yield

Grain yield exhibited significant positive association with days to flowering, days to maturity, final plant stand/m^2 at harvest, plant height, filled pods/plant, seeds/pod and thousand grain weight. This indicates that lentil plant selected on the basis of more number of pods per plant, higher plant height, proper plant density, more seed/pods, bold seeded, having more vegetative and reproductive days will give high yield. In line with this result, Kumar et al. (2017) reported significantly positive association of days to flowering, days to maturity, number of pods/plant, seeds/plant and thousand grain weight. Very similar findings for days to maturity, plant height, filled pods/plant, seeds/pod and thousand grain weight with respect to grain yield has also reported by Aghili et al., (2012), however, in contrast to our finding response of days to flowering with grain yield was negative and non significant. In addition, present association for days to maturity, plant height, filled pods/plant, seeds/pod with grain yield are also supported by previous findings of Hussan et al., (2018).

Thousand grain weight

Thousand grain weight has important contribution on grain yield. Thousand grain weight has shown significant positive correlation with days to flowering, days to maturity, final plant stand/m^2 at harvest, plant height, filled pods/plant and seeds/pod. These results are in conformity with the result obtained by (Nath et al., 2014; Aghili et. al., 2012; Kumar et al., 2017). In addition positive but statistically non significant associations were presented by Tadesse et al., (2014) on these traits with respect to thousand grain weight.

Seeds/pod

Seeds/pod has also important contribution on grain yield. Seeds/pod has also shown significant positive correlation with days to flowering, days to maturity, final plant stand/m^2, plant height and non significant positive relationship with pods/plant. These findings are supported by (Aghili et. al., 2012; Kumar et al., 2017).

Pods/plant

This trait is also important contribution on grain yield. It has shown significant positive correlation with days to flowering, days to maturity, final plant stand/m^2 and plant height. Similar reporting was done by Kumar et al. (2017). In line with present findings except for days to flowering, Aghili et. al., (2012) also reported significant positive correlation between these traits.

Plant height

Significant positive correlation with plant height for days to flowering, days to maturity and final plant stand/m^2 was observed in this study. In line with present findings (Latif et al., 2010; Aghili et. al., 2012; Tadesse et al., 2014; Kumar et al., 2017) also reported positive phenotypic correlation with plant height for days to flowering and maturity.

Final plant stand

Plant stand at harvest has shown significant positive correlation with days to flowering and maturity. In line with present findings Tadessa et al., (2014) reported non significant positive correlation between plant stand and days to maturity.

Days to maturity

Days to maturity has shown positive significant correlation with days to flowering. Similar reporting were previously done by (Latif et al., 2010; Kumar et al., 2014; Dugassa et al., 2014; Kumar et al., 2017.

Degree of association between economic yield and yield attributing characters is of utmost importance as it provides the basis for effective selection to develop superior cultivar. From the result, it was observed that days to flowering, days to maturity, plant height, pods/ plant, seeds/pods, proper plant stand and thousand grain weight had positive and significant contribution on lentil grain yield.

Table 5. Pearson's Correlation coefficient among different traits of lentil genotypes at Dipayal, Doti, Nepal

Traits	DF	DM	Fs/m^2	PH	P/P	S/P	TWG
DF	1.000						
DM	0.9193**	1.000					
Fs/m^2	0.6247**	0.6534**	1.000				
PH	0.8689**	0.9035**	0.822**	1.000			
P/P	0.4152**	0.381**	0.398**	0.455**	1.000		
S/P	0.4082**	0.4755**	0.5396**	0.4971**	0.1888ns	1.000	
TWG	0.701**	0.6747**	0.6283**	0.7049**	0.3279**	0.3562**	1.000
GY	0.5837**	0.6488**	0.7564**	0.7153**	0.2403*	0.5489**	0.5528**

Values are significant difference at 5 % level of significance (*) and highly significant at 1 % level of significant (**), Fs/m^2 = Final stand at harvest/m^2 , DF = Days to 50% Flowering, DM = Days to 90% maturity, PH = Plant height (cm), P/P = Number of filled pods/plant, S/P = Number of seeds/plant, TGW = Thousand grain weight (g), TGW = Thousand grain weight (g), GY = Grain Yield (kg/ha)

Conclusion

Genetic variability is necessary for plant breeders for genetic improvement of any crop. The knowledge on available genetic variability and relationships between economic yield and yield associate traits is important to understand and its potential use in breeding programs. The present study concluded on the presence of significant genetic variability among the tested genotypes. On the basis of yield, seed boldness, plant height and maturity period genotypes RL 79, Black Masuro and LG 12 were found promising and could be new lentil varieties for 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 plant height, days to maturity, thousand grain weight, seeds/pods 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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