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(RESEARCH ARTICLE)

Genetic variability, correlation and principal component analysis for agronomic traits in lentil genotypes

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Abstract

The investigation was carried out in a RCBD with 3 repeats on 15 lentil genotypes for 7 agro morphological characteristics. A wide range of divergence of plant characteristics were recorded for the lentil genotypes. The parameters (Days to fifty percent flowering, Days to fifty percent maturity, plant height, Biological yield, Grain yield, H.I and Hundred Seed Weight) showed weighty differences ($P \leq 0.05$). The promising genotype ILL11 (918.9 Kilo gram per hectare) and ILL8081 (847.4 Kilo gram per hectare) fashioned the highest yield than the other genotypes tested. Correlation and PCA was also conducted on 15 lentil genotypes over one year for 7 characters. Harvest Index (0.807) and biological yield (0.389) showed a helpful significant correlation with seed yield while a analogous positive correlation with seed yield was recorded for plant height (0.062). An adverse non-significant connection was logged for days to flowering (-0.248) and days to maturity (-0.312). These 3 principal components (PC) accounted for 82 % of the total dissimilarity. PC1 was positive correlate with the flowering interval, days to maturity, plant height and hundred seed weight while it was negatively correlated with biological yield, seed yield and H.I. PC2 was positively correlated with grain yield and harvest index. PC3 was positively correlated with days to flowering, H.I. and hundred seed weight. With the analysis of the agronomic features over the 1st and 2nd principal modules, the lentil genotypes were designated into 4 different groups.

Keywords: Genetic correlation; *Lens culinaris*; Principal component analysis (PCA); Yield components

1. Introduction

The pulse lentil (*Lens culinaris*, Medik) is a leguminous, self-pollinating diploid (2n = 2x = 14) crop, domesticated earlier (Erskine, 1997). Lentil is rich in proteins, micronutrients and vitamins that are important for human diet. The vegetative part of lentil is used as a unique feedstuff for wildlife (Sarker and Erskine, 2006). Pulse Lentil is mostly cropped in rain-fed areas where the rainfall is insufficient in rotation with cereals. Lentil fixes the atmospheric nitrogen thus reduces the nitrogen requirement for other cereal crops (Fikiru et al., 2007). For meaningful breeding program, the prerequisite is the collection of germplasm and description for wide range of genetically diverse crop (Naghavi and Jahansouz, 2005; Poonam et al., 2006). Numerous revisions have been accompanied on the collection and description of lentil germplasm and landraces in the world and these germplasm was used in lentil breeding packages (Fikiru et al., 2007). The international center for agricultural research in the dry areas (ICARDA) has maintained the major and most illustrative pool of lentil landraces in the world (Ford et al., 2007). The lentil germplasm showing high yielding, have good root and shoot traits, drought tolerant are measured to be the appreciated gene pool for the breeding program (Sarker et al., 2005). The objective of this study was to govern the genetic variability, correlation and principal component analysis for agronomic traits in lentil genotypes.

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2. Material and methods

This study was accompanied at Balochistan Agricultural Research & Development Centre Quetta (BARDC) during the 2017–2018 crop cycles. The research materials were comprised of 14 genotypes and 1 check improved variety (ShirAz-96). Each treatment was seeded by hand drill in 4 rows of 4 meter long with a 35 cm distance between them in a RCBD with 3 repeats. The kernel rate of 50 Kg ha^{-1} was used. Observations were recorded as a sole mean value for each plot on days to fifty percent flowering (days from seeding to appearance of fifty percent flowers), days to 50% maturity (days from sowing to physiological maturity), plant height (cm), biological yield (Kg ha^{-1}), grain yield (Kg ha^{-1}) and hundred seed weight (g). Simple statistics of the means were computed using the recorded data and the observations were made as per ICARDA methods (2017). A principal component analysis (PCA) and correlation was accomplished for 7 traits using the Minitab-16 statistical software (give reference).

3. Results and discussion

The main breeding intention of this schoolwork was to develop new cultivars that would show resistance too different biotic & A biotic stresses and would be suitable to mechanical harvesting with a high and stable yield of lentils. The collection, description and utilization of genetic resources for agronomic and morphological plant characteristics are essential steps to be taken for fruitful and actual breeding programs for the mainstream of crops (Naghavi and Johansouz, 2005).

The arithmetical analysis of the data showed that there were weighty differences ($P < 0.05$) (Table 1) in days to flowering (50%) among all genotypes tested. The days to flowering was ranged from 122 to 135 day, however, early flowering (122 days) was recoded in treatment 1LL46, ILL7686, ILL11 and ILL8081 that was. Late flowering (135 days) was recorded in treatment ILL438.

Table-1 revealed that different lentil lines had a substantial effect on days to maturity ($P < 0.05$). The results showed that line ILL11, ILL1196 and line ILL8081 attend maturity at short time (167, 170.5 and 171 days) while line ILL250 took maximum days to maturity (179 days). Shrestha et al 2006 reported that the high temperature and water scarcities persuade swift senescence and prompt maturity.

The effect of lentil lines was significant on plant height (Table-1). The genotypes plant height range between 25 cm (line ILL46) to 44 cm (line ILL312). Maximum plant height (44 cm) was obtained from line ILL312 which was at par with the genotypes ILL7686 (40 cm), ILL438 (37 cm), ILL465 (37.5 cm) and ILL8081 (35 cm) respectively while the least plant height (25 cm) was logged in line ILL46.

Table 1 Mean performance of agronomic traits of lentil genotypes

Sr.#	Genotypes	Days to flowering (50%)	Days to Maturity (50%)	Plant height (cm)	Biological yield (Kg ha^{-1})
1	ILL1196	128bcde	170.5ef	28cdef	3125ab
2	1LL46	122e	172cde	25f	3350ab
3	ILL262	128bcde	172cde	25.5ef	3420ab
4	ILL254	123de	174.5abcde	27.5def	3126.5ab
5	ILL1399	129.5abcd	176.5abc	34.5abcdef	3337.7ab
6	ILL7686	122e	176abcde	40ab	3571.4a
7	ILL648	130abc	175abcde	34bcdef	3001ab
8	ILL11	122e	167f	29cdef	3571.4a
9	ILL465	134a	177ab	37.5abc	3007ab
10	ILL312	134a	175.5abcd	44a	2784.3b
11	ILL438	135a	176.5abc	37abcd	2911.8ab
12	ILL45	126cde	174bcde	32.5bcdef	3040.3ab

13	ILL250	133abc	179a	35abcde	3571.4a
14	ILL8081	122e	171.5def	35abcde	3125ab
15	ShirAz-96	127cde	174bcde	30cdef	3286.5ab
LSD value		6.98	4.92	9.81	768.19

Values within the same column followed by the same letters are not significantly different, using LSD Range Test at 5% level.

According to means comparison of genotype effect on biological yield (Table-1), ILL7686, ILL11, ILL250 fashioned the uppermost biological yield (3571 Kilo gram per hectare) and ILL312 produced the lowest one that was 2784.3 Kg ha^{-1}. Momentous upsurge in yield was recorded in genotype ILL11 (918.9 Kilo gram per hectare) which was balance with the genotype ILL8081 (847.4 Kg ha^{-1}), ILL648 (845.5 Kilo gram per hectare), ILL7686 (824.3 Kg ha^{-1}), ILL1196 (824.1 Kilo gram per hectare) and ShirAz-96 (774.4 kilo gram per hectare) separately (Table-2). The lowest produce was recorded in genotype ILL254 that was 586.6 Kg ha^{-1} (Figure-3). Shrestha et al., 2005 reported that the lentil race obtained from cross between South and West Asian lines have hasty canopy cover, primary phenology and high harvest index as result increase dry matter production and harvest index.

Table 2 Mean performance of agronomic traits of lentil genotypes

Sr.#	Genotypes	Grain yield (Kg ha^{-1})	Harvest Index (%)	100 Seed weight (g)
1	ILL1196	824.1abcd	26.58ab	2.94ab
2	1LL46	650.2bcde	19.38cd	2.91ab
3	ILL262	611.9cde	17.84cd	3.04ab
4	ILL254	586.6e	18.89cd	3.91ab
5	ILL1399	654.5bcde	19.77cd	4.23a
6	ILL7686	824.3abcd	23.08abcd	2.36b
7	ILL648	845.5abc	28.17a	3.53ab
8	ILL11	918.9a	25.73ab	3.08ab
9	ILL465	659.0bcde	21.89bcd	2.74ab
10	ILL312	613.5bcde	22.06bcd	3.21ab
11	ILL438	626.5bcde	21.72cd	3.31ab
12	ILL45	590.9de	19.5cd	3.17ab
13	ILL250	616.0bcde	17.24d	3.85ab
14	ILL8081	847.4a	27.19ab	2.67ab
15	ShirAz-96	774.4abcde	23.31abc	2.58ab
LSD value		234.1	5.88	1.79

Values within the same column followed by the same letters are not significantly different, using LSD Range Test at 5% level.

Higher economical yield percentage (Table-2) was observed in treatment ILL648 (28.17 %) statistically similar yield was observed in genotype ILL8081 (27.19%), ILL1196 (26.58%), ILL11 (25.73%), ShirAz-96 (23.31 %) and ILL7686 (23.08%) respectively. ILL250 with grain yield of 17.24% significantly produced the lowest economical yield percentage.

The hundred seed weight (Table-2) oscillated from 4.23g to 2.36g and found significant differences among the treatment means. Treatment ILL1399 significantly produced higher 100 seed weight (4.23g) and lower seed weight was observed in treatment ILL7686 (2.36g). Joshi et al 2005 tested 110 native and exotic lines of lentil for various traits and reported that the hundred seed weight ranged between 1.1g to 7.2g.

Highly significant correlation (Table-3) was recorded between grain yield and harvest index which was 0.874 on the other hand nonsignificant adverse correlation was noted between biological yield and harvest index (-0.227). Correlation was detected with plant height (0.1093) and days to maturity (0.0796). On contrary, biological yield per plant exhibited negative but non-significant association with number of seeds per pod (-0.0752), days to 50% flowering (-0.0233). Bhattacharya et al. (2004) tested 14 advanced lentil genotypes under irrigated condition and described that economical yield had resilient positive correlation with harvest index. Joshi et al (2005) conducted experiment on 110 indigenous and exotic lines of lentil for various yield components and reported that days to flowering and maturity and hundred seed weight showed undesirable correlation with economical yield. Karadavut (2009) explored associations between produce and produce components by using a correlation in a population of 24 small seeded lentil varieties, positive and significant correlations were found between the yield and harvest index. The genetic parameter were investigated in 25 genotypes of lentil, seed produce was positively correlated with harvest index (Tyagi and Khan 2010). Harvest index was strongly correlated with grain yield (r=0.8072) which is agree with Dutta and Mondal (1998). This character could be a good index for selecting high yield genotypes in normal condition. The correlation coefficient of days to flowering with days to maturity (r=0.4474) and grain yield with biological yield was momentous and optimistic (Table 3).

Table 3 Estimate of simple correlation coefficients between different characters in lentil genotypes

	DF	DM	PH	HI	BY	GY
DM	0.4474*					
PH	0.2868^{ns}	0.2891^{ns}				
HI	-0.0219^{ns}	-0.3370^{ns}	0.0880^{ns}			
BY	-0.3654*	0.0047^{ns}	-0.0063^{ns}	-0.2226^{ns}		
GY	-0.2488^{ns}	-0.3125^{ns}	0.0625^{ns}	0.8072**	0.3894*	
HSW	0.0770^{ns}	0.3020^{ns}	-0.2370^{ns}	-0.1455^{ns}	0.0048^{ns}	-0.1398^{ns}

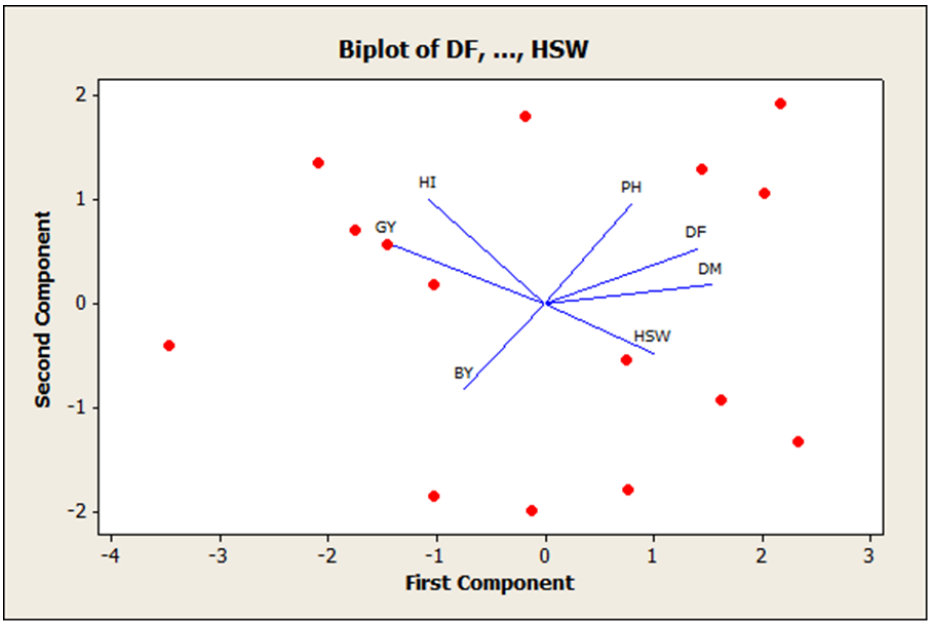
*, ^{ns}, Significant and non-significant at 5 % probability level, respectively

The contribution of the agronomic characteristics in the principal component and scatter diagrams for the first 2 principal components are shown in Table 4 and Figure 1. The first 3 principal components explain the 82.7% of total variance. Principal 1, which is the most central section, accounts for 44.7% of the total dissimilarity and is really related to the days to flowering , days to maturity , plant height and hundred seed weight. Principal 2 accounted for 71.2% of the total difference and the main characteristics of this component were positively correlated to the days to flowering, days to maturity, plant height, grain yield and harvest index but negatively associated with biological yield and hundred seed weight. Principal 3 accounted for 82.7% of the total deviation and were positively related to the days to flowering, harvest index and hundred seed weight. Figure 2 show that the first and second PCA components allow the lentil landraces 4 groups for the researched traits. Asghar et al. (2010) tested 30 lentil genotypes to investigated genetic diversity and distributed 10 distinct groups a attraction index was constructed to evaluate the worth of particular genotypes for different traits.

Table 4 Principal component analysis, eigenvalue, percent of variation accounted for first three principal components (Pcs)

Character	Principal 1	Principal 2	Principal 3
Eigen value	3.127	1.857	0.803
Proportion of variance (%)	44.7	26.5	11.5
Cumulative variance (%)	44.7	71.2	82.7
Days to flowering (50%)	0.448	0.280	0.081
Days to maturity (50%)	0.491	0.096	-0.371
Plant height	0.256	0.513	-0.496
Biological Yield	-0.239	-0.445	-0.673

Grain Yield	-0.465	0.311	-0.157
Harvest Index	-0.342	0.537	0.182
100 seed weigh	0.321	-0.256	0.315



DF days to flowering (50%), DM days to maturity (50%), PH plant height (cm), BY biological yield (Kg ha^{-1}), GY grain yield (Kg ha^{-1}), HI harvest index (%), and HSW 100 seed weight (g)

Figure 1 Scatter diagram of lentil genotypes and agronomic traits

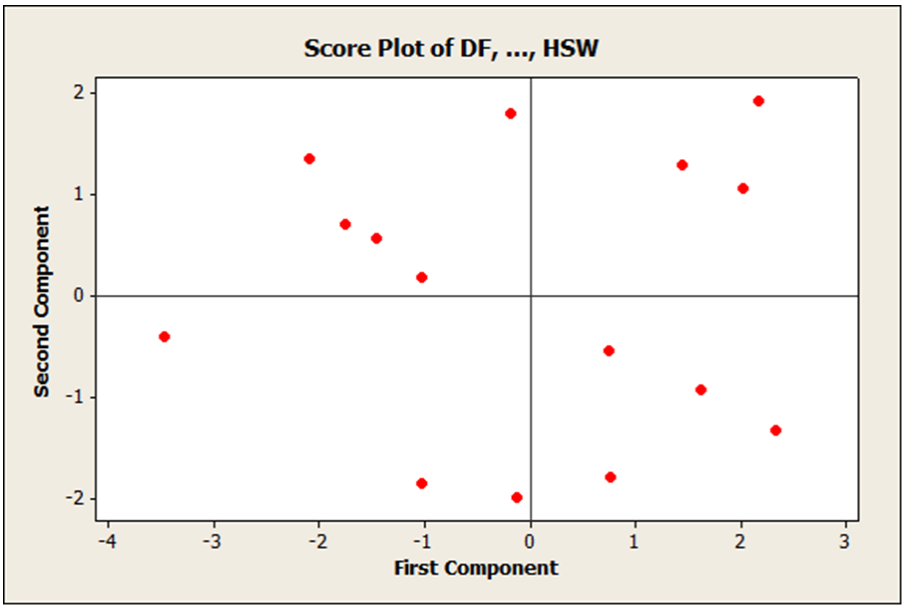


Figure 2 Graphic representation of the behavior of 15 line of lentil according to first two principal components and identification of clusters

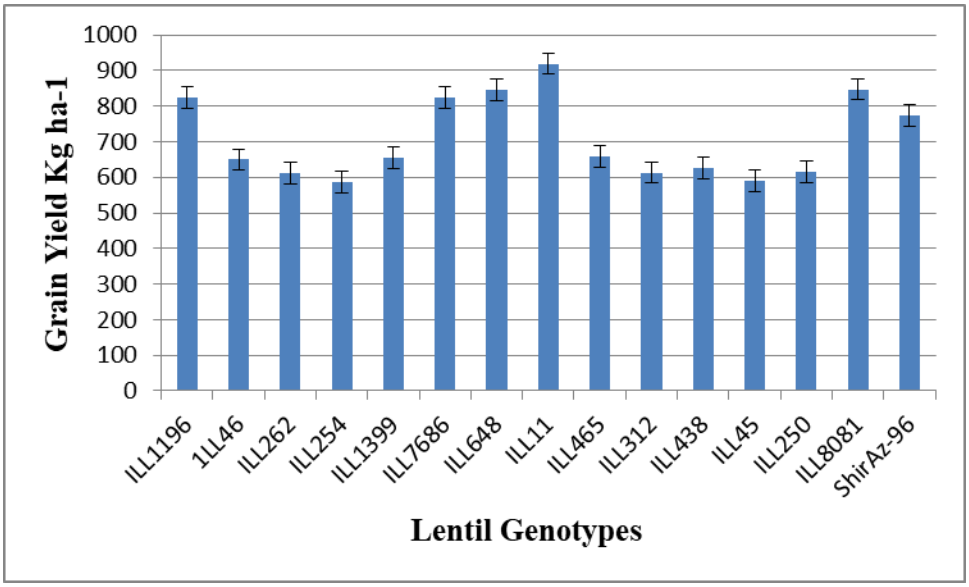


Figure 3 Graph between lentil genotypes and grain Yield Kg ha^{-1}

4. Conclusion

Pakistan is deficient in lentil production and imports from Canada to feed huge population of our county through introduce new cultivars which improve our production to fulfill our needs and save foreign exchange.

Compliance with ethical standards

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Disclosure of conflict of interest

There is no conflict between the authors.

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