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Characterization and correlation analysis of economically important parameters of lentil exotic germplasm

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The basic aim of this study is to evaluate the exotic lentil germplasm (BIGMP LIEN-MH-18) received from ICARDA. Economically desirable characters were studied and correlated to select the genotypes for the targeted breeding programme. Thirty-six lentil exotic entries were studied. The exotic genotypes 36102 and 36108 yielded 665 and 625 kg/ha respectively similar to our local recommended check (Punjab Masoor-09) that produces 884 kg ha^{-1} seed yield. There were high differences for the traits that were studied. The number of pods per plant, plant stand and first pod height were significantly ($P < 0.05$) associated with yield. The plant height was non-significantly associated with yield while number of branches was negatively and non-significantly associated with yield. Disease attack was negative and highly significant. This association of the characters could be used in future breeding programs to enhance the yield potential for exploiting the production of the lentil crop.

Key words: Lentil, correlation, exotic germplasm, yield.

INTRODUCTION

Pulses contain high protein content and good amino acid balance in several forms worldwide; therefore, they are important source of protein and necessary in routine life (Sharma et al., 2014). Lentil is one of the important pulse crops and sometimes it is called poor man's meat (Bhatty, 1988). It is a bushy annual autogamous diploid (2n=2x=14) legume crop. Its family is Fabaceae. It is generally grown as rain fed crop during winter season. Its protein content ranges from 22 to 34.6% (Sharma et al., 2014). Ash, crude fiber, starch, amylase and total carbohydrates contents in lentil are 3.1, 4.6, 44.3, 36.1 and 63.1% respectively (Bhatty et al., 1976). It also contains 420 cal. per 100 g gross energy (Sahi et al., 2000). Lentils are lower in anti-nutritional factors such as haemoglutinins, oligosaccharides and favogens compared to most other legumes. The area of the world under lentil production is 2.5 million ha and the contribution of Indian sub-continent (India, Pakistan and Bangladesh) is about 38% (Composition and quality). Its local name is Masoor in Pakistan and mainly grown in Gujranwala and

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Rawalpindi divisions in Punjab, Swat and Bajaur in North West frontier province of Pakistan (Hussain et al., 2008). In Pakistan, the area under lentil cultivation is 14.2 thousand ha with production of 6.4 thousand tonnes and average yield is 5.23 kg per ha during 2016-2017 (Anonymous, 2016). Lentil has been cultivated since 8000 BC, but it remained an under exploited crop, compared to other early domesticated crops. The principal aim of lentil production is to gain high yield (Karadavut, 2009). For any crop improvement program, systematic study and evaluation of germplasm is of great importance for agronomic and genetic improvement of the crop. The aim of the study was to identify high yielding genotypes that could be further used in hybridization programs.

MATERIALS AND METHODS

Thirty six genotypes of lentil, obtained from ICARDA, were used. Pb.M-2009, a local check variety, was used in the experiment as a check. This experimental study was conducted under irrigated condition at Ayub Agricultural Research Institute (AARI), Faisalabad during 2017-2018. There was no supplemental fertigation used in this experiment. Randomized Complete Block Design with 2 replications was used in this experiment. Each plot consisted of two rows with 30 cm width and 4 m length. The experiment was sown in the 1st week of November 2017 and was ready for harvest in the 2nd week of April, 2018. Five plants of each genotype were selected randomly from each replication at maturity to record the data on following pre and post-harvest traits; example plant stand, plant type, prominent property, 50% flowering, disease attack, plant height, number of branches, 1st pod height, number of pods per plant, seed testa, cotyledon color, seed shape and seed yield were recorded for statistical analysis.

Statistical analysis

The recorded data were subjected to analysis of variance following Steel et al. (1997) to estimate the genetic variability in the breeding material. Least significant difference Test (LSD) was used to compare the means of accessions as used by Williams and Abdi (2010). Correlation among various attributes was computed according to Kown and Torrie (1964).

RESULTS AND DISCUSSION

The genotypes 36102 and 36108 giving the yield of 665 and 625 kg ha^{-1} were comparable with the local check (Pb.M-09) that gave 884 kg ha^{-1} seed yield. There was a high variation among the genotypes for the traits used for the study to evaluate them (Table 1). The plant stand and number of pods per plant significantly correlated with the seed yield.

Disease attack was negatively and non-significantly ($P < 0.05$) correlated with plant stand (Table 2).The plant stand and number of pods per plant are the major yield contributors. Sufficient vegetative growth and branching provide an opportunity to the plants to provide sufficient number of pods and become responsible for high yield. Asghar et al. (2012) reported on the basis of their study that number of pods per plant were highly significantly and positively correlated with seed yield. Singh et al. (2009) studied correlation and path coefficient analysis among different characters of lentil genotypes and concluded that as seed size increases, the number of seeds per pod and pods per plant decreases noticeably that adversely affect the seed yield. Khan et al. (2001) concluded that seed yield had significantly positive correlation with pod plant, number of branches per plant and number of seeds per pod. Pods per plant and number of seed per pod can be used while selecting lentil varieties for this zone. Plant height also showed very interesting correlation: reducing plant height meant more number of seeds per pod and biological yield. However, early maturing, shorter varieties with more number of branches per plant and number of seed per pod may be considered an index for selection in the germplasm under study for yield. Begum and Begum (1996) reported the positive and significant correlation of plant height to seed yield in lentil. Abo-Shetaia (1997) confirmed these results later. Rajput and Sarwar (1989) showed highly positive significant correlation of number of pods per plant and seed yield. Tyagi and Sharma (1985) and Begum and Begum (1996) confirmed the results of highly positive and significant ($P < 0.01$) correlation of biomass to seed yield in lentil.

The disease attack was highly and negatively correlated with the seed yield. Furthermore, disease attack causes the stunted growth of the plants and poor pod and seed formation. Therefore, negative association of these traits with the seed yield can be expected (Table 3). Plant height was significantly associated with plant stand while non-significantly associated with disease attack. Number of branches per plant was negatively and highly significantly correlated with plant stand and plant height but it was negatively and non-significantly associated with disease attack. There was negative and non-significant association of number of pods with disease attack and plant height. Number of branches was highly significantly associated while plant stand was negatively and significantly associated with number of pods. First pod height had negative and highly significant association with number of branches and number of pods, highly significant association with plant height while non-significant association with all other characters.

Normally, it is not possible for the exotic germplasm to compete with the locally well-adapted genetic material but it provides some unique and useful genes like its bold seededness for incorporation into desirable genetic background. The genotypes 36102 and 36108 were almost at par with the check in yield but can be used as a diverse parent in the breeding programme to broad the genetic base as such germplasm has been used successfully in the earlier research work for developing varieties resistant to abiotic stresses (Ali et al., 1991). Out of 36 exotic genotypes plant types 21 entries were

Table 1. Mean values of different traits of exotic lentil germplasm studied during 2017/2018 cropping season under natural environmental conditions at PRI, AARI, Faisalabad.

S/N	Acc. No.	Plant stand (%)	Disease attack	PH (cm)	NOB (#)	NOP (#)	FPH (cm)	Yield (kg/ha)
1	36101	60	5	37	9	44.75	21.05	343.75
2	36102	70	3	30.45	11.75	60.75	24.7	664.58
3	36103	70	5	39.9	11.25	119	22.575	433.33
4	36104	70	3	42.275	10.5	119.75	22.6	247.92
5	36105	90	1	44.525	9.25	82.25	24.525	487.5
6	36106	80	1	51.85	11	101.25	17.9	608.33
7	36107	70	3	38.6	12.25	119.9	22.3	234.38
8	36108	80	1	38.5	8.75	88.25	20.075	625
9	36109	80	1	39.875	7.25	76.5	20.825	285.42
10	36110	80	3	43.775	6.25	138	20.625	472.92
11	36111	80	3	44.15	10.5	93	21.3	433.33
12	36112	80	3	45.3	8.75	99	22	489.58
13	Pb.M-09	80	1	43.8	9.5	85.5	21.7	884.38
14	36114	80	1	42.5	8.55	135.5	21.725	229.17
15	36115	80	3	42.9	9.25	81.25	22.075	493.75
16	36116	80	3	44.25	8.8	78.25	28.7	345.83
17	36117	80	5	51.925	8.5	103.5	22.125	418.75
18	36118	80	3	44.225	10.75	37.5	27	327.08
19	36119	80	3	51.85	8.75	110.25	30.2	395.83
20	36120	80	3	44.2	7.5	120.25	25.275	393.75
21	36121	80	3	44.1	11	97.25	24.625	375
22	36122	70	5	41.6	7.75	101	27	312.5
23	36123	80	5	47.35	6	49.25	32.7	383.33
24	36124	80	3	47.15	9.95	79.25	24.825	602.08
25	36125	80	1	41.8	6.75	114	24.35	420.83
26	36126	70	3	52.5	8.75	59.5	32.675	358.33
27	36127	80	3	48.025	7.5	76.25	31.55	377.08
28	36128	80	5	47.375	10.25	60.25	24.65	185.42
29	36129	80	1	45.9	9.25	83	25.7	483.33
30	36130	80	3	49.725	8.75	37.25	31.125	220.83
31	36131	70	3	53.675	15.25	154	24.1	437.5
32	36132	80	3	42.75	13	62.5	23.35	293.75
33	36133	80	5	40.8	8	71.75	21.85	441.67
34	36134	80	3	39.975	21.75	171.5	22.15	512.5
35	36135	70	3	38.5	11.25	109.5	20.4	425
36	36136	60	3	36.625	33.25	113	20.875	239.58

Diseases attack: recorded on 1-9 scale, where 1 was no disease symptoms (resistant) and 9 with full of disease infection symptoms (highly susceptible); PH.: Plant height; NOB.: No. of Branches; NOP: No. of pods per plant; FPH: First pod height.

semi-erect, 8 were bushy type and 7 genotypes were of erect type. One of the prominent properties of these genotypes were the number of pods per node. Generally lentil crop has 3 pods/nodes but in this germplasm 8 entries were found with 4 pods/nodes. As we talked about type of seed testa the following types of variations were found; spotted brown, spotted light brown, brown, spotted orange, spotted dark orange, creamy and spotted blackish gray. Similarly, seed shape of these genotypes was also studied; seed shape of 22 entries was normal, 10 bold seeded and rest of 4 genotypes were of medium bold seeded. Usually lentil seed has orange cotyledon color. It is preferred in Pakistan; out of these 36 genotypes, 32 were of orange colored cotyledon; only 2 has light orange while the rest 2 has yellow (not preferred) cotyledon color.

The acquisition of new germplasm and its evaluation is essential to select the new useful genotypes in the breeding program to incorporate desirable genes into desirable genetic background for the development of new

Table 2. Correlation of traits studied in exotic lentil germplasm during 2017/2018 at PRI, AARI Faisalabad.

Variable	Plant stand	Disease attack	Plant height	NOB	NOP	FPH	yield
Plant stand	1.0000						
Disease attack	-0.1160^{NS}	1.0000					
Plant height	0.2470*	0.0872^{NS}	1.0000				
NOB	-0.6500**	-0.0286^{NS}	-0.3868**	1.0000			
NOP	-0.2641*	-0.2017^{NS}	-0.1928^{NS}	0.4155**	1.0000		
FPH	0.1609^{NS}	0.1394^{NS}	0.5875**	-0.3973**	-0.4877**	1.0000	
Yield	0.2705*	-0.3135**	0.0080^{NS}	-0.1715^{NS}	0.2628*	-0.2438*	1.0000

* P< 0.05, ** P< 0.01.

Table 3. Mean values of different traits of exotic lentil germplasm studied during 2017/2018 cropping season under natural environmental conditions at PRI, AARI, Faisalabad.

S/N	Acc. No.	Plant type	Prominent property	Seed testa	Cotyledon color	Seed shape
1	36101	Semi erect	3 pod/node	Spotted brown	Orange	Normal
2	36102	Bushy	3 pod/node	Spotted brown	Orange	Normal
3	36103	Erect	3 pod/node	Spotted light brown	Orange	Bold
4	36104	Erect	3 pod/node	Spotted orange	Orange	Bold
5	36105	Bushy	4 pod/node	Spotted brown	Orange	Normal
6	36106	Semi erect	4 pod/node	Orange	Orange	Normal
7	36107	Semi erect	3 pod/node	Spotted orange	Orange	Bold
8	36108	Semi erect	4 pod/node	Spotted brown	Orange	Normal
9	36109	Semi erect	3 pod/node	Spotted brown	Orange	Normal
10	36110	Semi erect	4 pod/node	Spotted orange	Orange	Normal
11	36111	Semi erect	3 pod/node	Spotted orange	Orange	Normal
12	36112	Semi erect	3 pod/node	Spotted dark orange	Orange	Normal
13	Pb.M-09	Erect	3 pod/node	Spotted brown	Orange	Normal
14	36114	Erect	3 pod/node	Spotted blackish gary	Orange	Bold
15	36115	Erect	3 pod/node	Spotted creamy	Orange	Normal
16	36116	Semi erect	3 pod/node	Brown	Orange	Bold
17	36117	Semi erect	3 pod/node	Orange	Orange	Bold
18	36118	Bushy	3 pod/node	Light orange	Orange	Bold
19	36119	Erect	3 pod/node	Brown	Orange	Bold
20	36120	Erect	4 pod/node	Brown	Orange	Medium bold
21	36121	Semi erect	3 pod/node	Creamy	Orange	Medium bold
22	36122	Semi erect	4 pod/node	Light orange	Orange	Medium bold
23	36123	Bushy	3 pod/node	Creamy	Orange	Bold
24	36124	Semi erect	3 pod/node	Light orange	Orange	Medium
25	36125	Semi erect	3 pod/node	Creamy	Orange	Bold
26	36126	Semi erect	3 pod/node	Brown	Orange	Normal
27	36127	Bushy	3 pod/node	Creamy	Orange	Normal
28	36128	Semi erect	4 pod/node	Creamy	Yellow	Normal
29	36129	Semi erect	4 pod/node	Spotted orange	Orange	Normal
30	36130	Bushy	3 pod/node	Creamy	Orange	Normal
31	36131	Semi erect	3 pod/node	Light brown	Light orange	Normal
32	36132	Semi erect	3 pod/node	Light orange	Light orange	Normal
33	36133	Semi erect	3 pod/node	Creamy	Orange	Normal
34	36134	Bushy	3 pod/node	Creamy	Orange	Normal
35	36135	Semi erect	3 pod/node	Brown	Yellow	Normal
36	36136	Bushy	3 pod/node	Orange	Orange	Normal

improved varieties. The germplasm used in the study had a great variation among the genotypes as noted from various growth and yield characters. The number of pods per plant, plant stand and first pod height were significantly ($P < 0.05$) correlated with the seed yield. This information can be exploited for enhancing the productivity of the lentil by target oriented variations.

Conclusion

The germplasm used in the study had a great diversity among the genotypes for the studied characters. The genotypes 36102 and 36108 performed well. The number of pods per plant, plant stand and first pod height were significantly ($P < 0.05$) associated with the yield. This information could be exploited for increasing the yield potential of lentil by target oriented variations.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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