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Assessment of Yield and Agronomic Traits of New Variety of Lentil (lens culinaris medik.)-"Chakwal Masoor" in Pothowar Plateau of Pakistan

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Abstract
A study was initiated in Pothowar Plateau of Pakistan to identify high yielding, disease and drought tolerant lentil genotype from the available genetic stock of lentil. A genotype was selected from Lentil International F3 nursery and designated as 98CL008. During Preliminary Yield Trial, the genotype 98CL008 produced 60% and 52.9% higher seed yield than the check varieties Masoor-85 and Masoor-93 respectively. In Regular and Micro Yield Trials the genotype produced 16% and 48% higher yield than the standard check variety of Masoor-93 respectively. On three year average basis in National Uniform Yield Trials the genotype produced 25% and 32% higher seed yield as compared to check varieties NM-2006 and Masoor-93 respectively. High yield potential, better morphological features and tolerance against diseases were the major attributes that led to adoption of genotype 98CL008 with the commercial nomenclature of "Chakwal Masoor"
Keywords: Lentil, Genotype, Performance, Rainfed, Chakwal Masoor,

Introduction

Lentil (*Lens Culinaris* Medik.) is the fourth most important legume crop in the world. The lentil seed is a rich source of protein (upto 28%) in human diet across the world (Karimizadeh *et al*., 2012). The contribution of lentil planted under rainfed conditions is 79% of total area and 67% of total production in Punjab (GOP-2010). The achievement is substantial considering that area under lentil has decreased from 69,481 hectares in 1997 to 27,000 hectares in 2012 resulting in decrease in production from 34,980 tons to 15,000 tons respectively (FAOSTAT, 2012). Presumably it happened mainly due to large number of acreage being brought under irrigation and also the farmers had found main crops like wheat and rice as more remunerative than pulses. One of primary objective of lentil breeders is to increase seed yield. Generally, yield represents the final characters resulting from many developmental and biochemical processes that occur between germination and maturit (Abdipar *et al*., 2011). Before yield improvement can be realized, breeder needs to identify the cause of variability in seed yield in any environment, since fluctuation in environment, generally affects yield primarily through its components (Tyagi and Khan, 2010). Many other researchers also analyzed yield through its components i.e. plant height, number of primary branches per plant, number of pods per plant, number of seeds per pod and 1000 grain weight etc. (Chuhan and Singh, 2001; Yadav *et al*., 2003; Younis *et al*., 2008 and Bicer and Sarkar, 2010). Accordingly, this study focussed on analysis of yield components of new variety of lentil under rainfed conditions. Furthermore, the drought and disease resistance features of this variety were also assessed. The study will strengthen the on-going research on developing high yielding and disease tolerant varieties of lentil suitable for rainfed cultivation. The outcome of the reasearch will benefit promotion of high yielding and disease tolerant lentil variety not only in Pothowar Plateau of Pakistan but also other rainfed areas of Punjab.

Methodology

A promising progeny of single plant was selected from a cross between ILL-1 x ILL-936 in Lentil International F3 nursery and named as 98CL008 (Table-1). The seed yield was measured from 1998-99 to 2001-02 during Preliminary, Regular and Micro yield trials. The agronomic trials to determine appropriate sowing date and fertilizer requirement were conducted during 2002-03 and 2004-05. A total of seven genotypes including four check varieties i.e. Masoor-85, Masoor-93, M-2002 and NL-2006 were used. The study was conducted at experimental field of Barani Agricultural Research Institute (BARI), Chakwal, Pakistan under medium rainfall conditions with annual average rainfall ranging between 300mm to 500mm. At Fateh Jang, Sub-Centre of BARI high rainfall conditions prevailed with more than 500mm of annual average rainfall. Randomized Complete Block Design was used in sowing seed of genotype with three replications in Preliminary and four replications in Regular and Micro Trial. The plot sizes were 5m x 1.2m in Preliminary Yield Trial, 4m x 1.8m in Regular Yield Trial and 5m x 1.8m in Micro Yield Trial. The seeds were sown with a single row drill and row to row distance

was kept at 30cm. The sowing of seed was completed during first fortnight of October and harvested in second week of April. The fertilizer requirement was tested between genotype 98CL008 and check variety of Masoor-2002 by applying ten different concentrations of fertilizers. The study was conducted during 2004-05 on sandy loam soil having organic matter (0.5%) and available phosphorus (5.3 mg/kg). Measurement was made of plant height (cm), days to 50% flowering, number of pods per plant, days to maturity, and seed yield per hectare (Kg/ha). On the basis of performance in local trials, the genotype 98CL008 was included in National Uniform Yield Trials (NUYT) for further testing during 2004-05, 2006-07 and 2007-08. The data were statistically analyzed to determine the significance of difference between genotypes (Steel & Torrie, 1980). Least significant difference test (LSD) was applied to compare the individual genotypes at 5% probability.

Results

Yield Trials:

The yield of genotype 98CL008 was significantly higher than Masoor-85 and Masoor-93 during Preliminary Yield Trial (Table-2). The genotype produced 60% and 52.9% high yield as compared to check variety Masoor-85 and Masoor-93 respectively. The yield of genotype 98CL001 was significantly higher than the check variety of Masoor-93 during Regular Yield Trial (Table-3). The genotype produced 60% higher yield than Masoor-93. The performance of genotype 98CL008 was comparatively insignificant during RYT. However, during Micro Yield Trial, the yield of genotype 98CL008 emerged to be significantly higher than the check variety of Masoor-93 at both Chakwal and Fateh Jang sites (Table-4). The genotype produced 82.3% higher yield than Masoor-93 at Chakwal site whereas it was 25.1% higher at Fateh Jang site. Interestingly, the yield of genotype 98CL001, 98CL007 and 98CL008 was significantly higher than Masoor-93 at Fateh Jang site. During National Uniform Yield Trial, the yield of genotype 98CL008 was significantly higher than the check variety of Masoor-93 and NM-2006 during all three years (Table-5). The genotype produced 66.1% higher yield than Masoor-93 during 2004-05, 15.9% higher yield in 2006-07 and 13.7% higher yield in 2007-08. Interestingly, the yield of genotype 98CL001, 98CL007 and 98CL008 was considerably higher in 2004-05 as compared to the other two years, whereas, that of Masoor-93 remained consistent during the same period.

Agronomic Trials

Sowing Date

The yield of different cultivars was significantly high when sown between 1st and 16th of October during 2002-03 (Table-6) whereas it was significantly high when sown on 16th of September during 2004-05 (Table-7). The yield of genotype 98CL008 was significantly high when sown between 1st and 16th of October (Table-6 & 7). The yield of check variety Masoor-2002 was significantly lower than all genotypes sown during 2002-03 whereas it was lower than genotype 98CL008 and 99CL007 during 2004-05 (Table-7). However, there was no significant difference in yield of 98CL008 and 99CL007 during 2004-05 (Table-7). The yield of 99CL007 was significantly higher than all other cultivars during 2002-03 (Table-6).

Row Spacing

The average yield of seed sown at a spacing of 22.5cm was significantly high as compared to other two spacing's (Table-8). The yield of genotype 99CL007 was significantly higher than others and was followed with genotype 98CL008. The mean yield of cultivars under different spacing indicated a similar trend.

Fertilizer Requirements

The mean yield of genotype 98CL008 was significantly higher than check variety of Masoor-2002 (Table-9). The yield of 98CL008 was significantly higher when concentration of P^2O^5 was at highest level followed with equal concentration of P^2O^5 and K^2O.

Contributing Traits

The plant growth, height and primary/secondary branching of genotype 98CL008 was at par with other check varieties (Table-10). However, it developed tertiary branches that were missing in the check varieties, hence the canopy size was slightly large. Accordingly, higher number of pods per plant developed. The phenology of flower and maturity of genotype 98CL008 was almost similar to other check varieties.

Discussions

The yield of genotype 98CL008 was comparatively higher during PYT than the MYT and NUYT presumably due to the reason that F3 genotype was used in the initial trial whereas during the selection process loss of few of the genetic features might have occurred. The decrease in yield with loss of gene pool during selection process has been observed in other studies as well (Muehlbauer, F.J., W.J. Kaiser, S.L. Clement, R.J. Summerfield, 1995; Coyne, C., Rebecca McGee, 2013; Erskine, W, S. Rihawi, B.S. Capper, 1990). However, it is pertinent to mention that the yield of genotype 98CL008 remained consistantly higher than the check varieties in the range of 30 to 60%. Similar results have also been reported by other scientists (Bicer and Sarkar (2004); Anjam *et al.* (2005); Tariq and Mahmood (2007); Tariq *et al.* (2013). The yield of few of the other genotypes occationally

improved during the trial process, however, that of genotype 98CL008 remained consistant. The intermittent increase in yield of few of the other genotypes might be due to changes in mirco-evironment as has been reported in different studies conducted under similar conditions (Singh, R.P., P. V. Vara Prasad, K. Raja Reddy, 2013; Sharma, S.K., B. Sharma, 1984; Bermejo, C., María Andrea Espósito, Vanina Cravero, Fernando López Anido, Enrique Cointry, 2012). The higher yield of different genotypes in any particular year was presumably due to better resistance to diseases. It has already been concluded in another study that genotype 98CL008 has tolerance against Pea seed-borne mosaic virus (PSBMV), Cucumber mosaic virus (CMV), Bean yellow mosaic virus (BYMV), Broad bean stain virus (BBSV) and Faba bean necrotic yellow virus (FBNYV) (Bashir *et al*, 2005). Furthermore, the same genotype also showed resistance against Ascochyta blight (*Aschochyta Lentis)*, Rust (*Uromyces Viciae-Fabae*), Botrytis gray mold (*Botrytis Cinerea*), Stem rot (*Sclerotinis Sclerotiorum*) and Fusarium wilt (*Fusarium oxysporum*) during two years of testing i.e. 2008-09 and 2009-10 (Bashir *et al*. (2005). The persistanly high yield of genotype may also be due to adoptation to local environment as concluded in other studies (Dehghain *et al*., 2008).

The findings of agronomic trials were consistent with the results of yield trials. The yield of genotype 98CL008 was significantly higher than the check varieties for different sowing dates, row spacings and fertilizer levels. The highest yield of genotype as obtained on sowing between 1st and 16th of October, presumably due to optimum moisture and temperature conditions as reported in other such findings (Kayan, 2010). The higher yield of genotype 98CL008 at 22.5 cm was probably corelated to contributing traits of the variety that included higher number of pods per plant, larger number of tertiary branches and slightly wider canopy. Furthermore increase in spacing reduced the yield due to decrease in plants per unit area. The increase in application of NPK increased the yield of 98CL008 from 24% to 96% as compared to control. The increase in NPK improves the soil nutrients and plant metabolic processes that proportionately increases seed yield (Tufail *et al*., 1995; Sadiq *et al*., 2002; Mahmood *et al*., 2010).

Conclusions

The seed yield trials and agronomic studies conducted to test the efficacy of different lentil genotypes over the past decade inferred that genotype 98CL008 performed consistently better than the past and latest check varieties and other genotypes of lentils under rainfed conditions of Pothowar Plateau. An increase of 30% to 60% in seed yield as compared to past and latest check varieties of lentils is substantial to convince end users to adopt this variety. Optimum yield is expected from this genotype if row spacing is maintained at 22.5 cm and higher concentration of NPK is applied. In view of the comparatively better productive, morphological and phenological characteristics, the genotype 98CL008 was recommended for commercial adoption as “Chakwal Masoor”.

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TABLE -1: Chronological stages during progeny testing of genotype 98CL008

Year	Pedigree	Remarks
1998-99	Selection from cross: (ILL-1 x ILL-936).	Selection from Lentil International F3 Nursery (ICARDA)
1998-99	98CL008	Preliminary Yield Trial (PYT)
1999-00	98CL008	Regular Yield Trial (RYT)
2001-02	98CL008	Micro Yield Trial (MYT)
2002-03	98CL008	Evaluation in Agronomic Trials (Sowing Date Trial)
2004-05	98CL008	Evaluation in National Uniform Yield Trial (15 locations)
		Evaluation in Agronomic Trials (Sowing date & Fertilizer Requirement Trial)
2006-07	98CL008	Evaluation in National Uniform Yield Trial (NUYT) (14 locations)
2007-08	98CL008	Evaluation in National Uniform Yield Trial (14 locations)

TABLE-2: Seed Yield in kg/ha of various Lentil Genotypes in PYT 1998-99

Sr. No.	Entries	Seed yield	% age increase/decrease over M-85	% age increase/decrease over M-93
1	**98CL008**	**2694**	**+ 60.0**	**+ 52.9**
2	98CL001	2567	+ 52.5	+ 45.7
3	98CL004	2217	+ 31.7	+ 25.9
4	98CL007	2156	+ 28.1	+ 22.4
5	**M-93 (c)**	**1761**	**+ 04.6**	**-**
6	**M-85 (c)**	**1683**	**-**	**- 04.4**
7	98CL005	1656	- 01.6	- 05.9
		LSD(0.05) 754	CV(%) 14.3	

TABLE-3: Seed Yield in kg/ha of various Lentil Genotypes in RYT 1999-00

Sr. No.	Entries	Seed yield	% increase/decrease over M-93
1	**98CL008**	**1139**	**+15.8**
2	98CL001	1576	+60.3
3	98CL004	1351	+37.4
4	98CL007	1083	+10.2
5	**M-93 (c)**	**983**	**-**
		LSD (0.05) 398 CV(%) 6.3	

TABLE-4: Seed Yield in kg/ha of various Lentil Genotypes in MYT 2001-02

Sr. No.	Entries	BARI,Chakwal	% age increase/decrease over M-93	BARI, Fateh Jang	% age increase/decrease over M-93
1	**98CL008**	**1331**	**+82.3**	**1375**	**+ 25.1**
2	98CL007	1259	+72.5	1299	**+ 18.2**
3	98CL001	780	+6.8	1281	**+ 16.6**
4	**Masoor-93 (c)**	**730**		**1099**	**-**
5	98CL004	776	+6.3	1028	**- 6.46**
	LSD (0.05)	155		25	
	CV (%)	9.6		1.2	

TABLE-5: Average Yield of 98CL008 in NUYTs from 2004-05 to 2007-08

Year	Locations	Seed Yield (kg/ha)			LSD (0.05)
		98CL008	Masoor-93(c)	% age increase/decrease over Masoor-93	
2004-05	15	1261	759	+66.1	171
2006-07	14	876	756	+15.9	58
2007-08	14	823	724	+13.7	66
Average		987	746		
Average Yield of 98CL0098 Increase/Decrease (%) over Checks.				**+32**	

TABLE-6: Mean Seed Yield (kg/ha) of cultivars sown on different Dates during 2002-03

		Sowing Dates (Yield in Kg/ha)				
Sr.No.	Cultivars	16th Sept	1st Oct	16th Oct	1st Nov	Mean
1-	97CL004	1366	1394	1309	1104	1293
2-	98CL008	1588	1884	1955	1402	1707
3-	99CL007	2387	2427	2431	1957	2300
4-	Masoor-2002	973	1273	1247	899	1098
	Mean	1578	1745	1736	1341	
	Sowing Date		Varieties		Sowing Date x Variety	
	LSD (0.05) = 68		LSD (0.05) = 69		LSD (0.05) = 137	
	CV (%) = 3.7					

TABLE-7: Mean Seed Yield (kg/ha) of cultivars sown on different Dates during 2004-05

Sr.No.	Cultivars	Sowing Dates (Yield in Kg/ha) 16th Sept	1st Oct	16th Oct	1st Nov	Mean
1-	98CL008	591	678	446	376	523
2-	99CL007	813	777	548	413	638
3-	99CL009	533	432	243	127	334
4-	Masoor-2002	807	472	164	100	386
	Mean	686	472	350	254	
	Sowing Date		Varieties		Sowing Date x Variety	
	LSD (0.05) = 83		LSD (0.05) = 118		LSD (0.05) = 237	
	CV (%) = 29.8					

TABLE-8: Average Seed Yield (Kg/Ha) of cultivars sown at variable Row Spacing

Sr.No.	Row Spacing	Varieties (Yield in kg/ha) 97CL004	98CL008	99CL007	Masoor-2002	Mean
1-	15 cm	1254	1533	1680	1197	1416
2-	22.5 cm	1417	1740	2149	1254	1640
3-	30 cm	1277	1541	1713	1206	1434
	Mean	1316	1604	1847	1219	
	Row Spacing		Varieties		Row Spacing x Variety	
	LSD (0.05) = 43		LSD (0.05) = 82		LSD (0.05) = 86	
	CV (%) =2.4					

TABLE-9: Average Seed Yield (kg/ha) of cultivars under different concentrations of Fertilizers

	Genotypes (Yield in Kg/ha)					
Sr. No.	Fertilizer levels (kg/ha) N	P^2O^5	K^2O	98CL008	M-2002(c)	Mean
1-	0	0	0	320	281	291
2-	0	60	30	410	338	360
3-	12.5	60	30	482	389	418
4-	25	60	30	541	441	473
5-	37.5	60	30	500	399	434
6-	25	0	30	433	368	378
7-	25	30	30	449	370	388
8-	25	90	30	683	521	570
9-	25	60	30	464	381	402
10-	25	60	60	614	484	521
		Means		490	397	
		Varieties		Fertilizer		Interaction
	LSD (0.05) = 49			26		44
	CV% = 4.8					

TABLE-10: Comparison of Means of Contributing Traits of 98CL008 with Standard Cultivars

Trait/character	**98CL008**	**Masoor-93**	**Masoor-2006**
Growth habit	Semi erect	Semi erect	Semi erect
Plant height (cm)	30	27	33
Primary branches/plant (No.)	2	2.2	2
Secondary branches (No.)	2.2	2.2	2
Tertiary branches (No.)	3	0	0
Canopy width (cm)	6.4	5.3	4.6
Days to Flowering (50%)	136	140	136
Pods/plant (No.)	47	24.2	35
Days to maturity (90%)	175	184	175

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