Shiraz-96, First Improved Lentil Variety for the Arid Highlands of Balochistan, Pakistan

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Abstract
The objective of this study was to develop a dual-season high yielding, bold-seeded lentil variety with cold, drought and disease resistance to replace the local ultra small-seeded variety in the arid highlands (≤1000m altitude) of Balochistan which are equal to 25 per cent of the total land area of Pakistan. SHIRAZ-96 significantly (P<0.05) out-yielded the check Balochistan Local) in 20 and remained non-significant (P>0.05) in seed yield at 7 sites. The seed increase of SHIRAZ-96 over local lentil ranged from 10-81 per cent. The maximum average yield of 1637 kg ha⁻¹ (33 per cent > local) was obtained under irrigated conditions and 410 kg ha⁻¹ (47 per cent > local) in rainfed environments. SHIRAZ-96 provided at least the seed back in the most dry (≤100mm precipitation) conditions when the local lentil could not produce any seed at all in those environments. SHIRAZ-96 survived -18 °C which is little less cold tolerant than the local which survived -19 °C under controlled freezing tests. These findings were analogous to the results obtained under natural environments in upland Balochistan. SHIRAZ-96 is Fusarium wilt resistant and tolerant to Ascochyta blight. It is almost same in cooking time, taste reference and protein contents but more than double in seed size as compared to the check, Balochistan local.

Introduction
Lentil (Lens culinaris Medik.) is an annually sown cool season food legume crop with high protein content available in its grains and comparatively low market price (choohoben, 1995). It is regarded as one of the best sustitutes of meat which is easy to afford by the poor people. It is the second major winter pulse crop after chickpea in Pakistan (GOP, 1998). During the last 48 years, the total annual area for lentil cultivation increased gradually until the decade of 1970-80 and then started a decline which is still continuing. However, the total annual production for this crop has remained almost the same as last population has increased four times (GOP, 1998). During the last 18 years (1980-1998), the total area for lentil cultivation decreased but the total annual production remained the same because of the increase in the per unit area yield (GOP, 1984; GOP, 1998). This may be attributed to the release of new improved varieties and production technologies. The total annual production of lentil since 1980 has been stagnant. Consequently, the country imports a large quantity of lentil to meet domestic requirements which puts a large burden on the national exchequer. During 1995/96, 34,000 t of lentil costing Rs. 334 million were imported (GOP, 1998). It also indicates the total national requirement is about 68,000 t which double the local production. Due to the increasing price of lentil, this poor man’s meat will soon not be affordable to poor people. It is the need of the hour that the production of lentil should be increased at least by three times to bring down the price of this commodity, to save the money being spent now on its importation and to meet the nutritional demand of the increasing population. Furthermore, due to the nitrogen fixation process in legumes, lentil can be highly useful for soil rehabilitation and also in crop rotations to break disease cycles. Approximately, 16-100 kg ha⁻¹ nitrogen can be fixed in one crop growth season (Shah et al., 1997) which minimizes the expenditure (approximately 20-40 per cent) on nitrogen fertilizer use for succeeding crops after lentil. It supplies the high protein contents (25 per cent) in its grains; and the straw contains 12 per cent protein, making it highly useful for the animals during acute feed deficit periods in the cold and dry areas of the country such as Balochistan highlands (≤1000m altitude).

Lentil production can be increased by two means; i) by providing further improved high yielding varieties along with improved production technologies for old lentil growing areas (where the potential seems to be limited); ii) developing cold and drought tolerant varieties for the yet un-exploited arid uplands of the country. Lentil is a very hardy plant and can be grown in very harsh (cold and dry) and stressful environments. As 33 per cent of the total area of the country constituted by cold and dry uplands, there is a big scope for extending lentil areas into the Balochistan uplands. These marginal areas are very cold and dry, receiving precipitation mainly in winter yet with little disease pressure and can thus be fully exploited by growing lentil. Since availability of natural precipitation and soil moisture for sowing are uncertain, only those lentil varieties can be grown which have winter and drought hardness.
with flexibility to plant over a large time span. The farmers at present are practicing planting ultra small-seeded local lentil at different periods, depending upon the rainfall. This endurance is very difficult to clean in the kitchen and is susceptible to many diseases. Bold-seeded lentils are preferred over small seeded ones because of their high yield and higher market price (Keating et al., 1990). No improved variety for arid uplands of Balochistan existed, hence, the farmers greatly needed a variety with these traits which could be planted in the prevailing harsh conditions.

Materials and Methods

SHIRAZ-96 was developed at the Pakistan Agricultural Research Council’s Arid Zone Research Centre (AZRC), Quetta. The advanced breeding lines were received from ICRAD (International Centre for Agricultural Research in the Dry Areas, Syria) under a germplasm exchange programme started in 1983 between AZRC and ICRAD. The variety was derived from ILL 5865 which came out from a cross between ILL 470 (Syrian origin) and ILL 1334 (Iranian origin). The genetic material was first selected and purified under natural stresses at the research station and then advanced to multi-locational preliminary testing to on-farm trials. To test the genetic material under farmer’s conditions, all sites other than Quetta used farmer’s fields throughout the study.

The experimental sites were Quetta (altitude 1750 m), Khuzdar (altitude 1250 m), Loralai (altitude 1050 m) and Kan Mehtarazi (altitude 2350 m) covering a range environments typical of upland Balochistan. Meteorological data were recorded at each site. An absolute minimum air temperature of -19 °C (Kan Mehtarazi in 1986/87) and a minimum annual rainfall of 60 mm (Khuzdar in 1987/88) were recorded during the course of study (Ali et al., 1991). Two planting times, winter (September-October) and spring (January-February), were used to expose the genetic material to low air temperatures. It was essential to have emergence before freezing temperatures in the field as experienced. Therefore, wherever the rainfall or residual moisture was not available for early (winter) planting, irrigation water equal to 20-50 mm rainfall was used and later the experiments received only natural precipitation. The lines along with local check were also evaluated for their cold tolerance potential potential under controlled as well as field conditions (Ali et al., 1991; Ali, 1994). The advanced experiments were planted in 6-row plots with 5 m row length and 25 cm row spacing in a Randomized Complete Block Design (RCBD). Fertilizer 20:60 NP (kg ha⁻¹) was applied at the time of planting. The seeds were inoculated with Rhizobium inoculum before sowing. The central 4 rows of each plot were harvested for yield data. The experiments were harvested in the months of May and June. Fusarium wilt screening was performed under field conditions whereas single spore culture of the most severe strain Ascochyta lentis was used under controlled conditions to see reaction against the disease. Conventional methods were used to determine the cooking time and taste preferences (Ali et al., 1991; Ali et al., 1997).

Results

Out of 27 experiments across the locations, SHIRAZ-96 significantly (P<0.05) out-yielded the check (Balochistan Local) in 20 and remained non-significant (P>0.05) at 7 sites. Overall the seed increase of SHIRAZ-96 over local lentil was 10-81 per cent. The maximum average yield of 1637 kg ha⁻¹ (33 per cent > local) was obtained under irrigated conditions and 410 kg ha⁻¹ (47 per cent > local) under rainfed environments. SHIRAZ-96 provided at least 30% more yield than the seed back in the most dry conditions experienced during the course of study (Table 1). SHIRAZ-96 has cold tolerance to -18 °C which is little more cold tolerant than local lentil but better in drop tolerance. It is Fusarium wilt resistant and tolerant to cold temperature.
Table 2: Performance of SHIRAZ-96 against different biotic and abiotic stresses as compared with Balochistan Local (check).

<table>
<thead>
<tr>
<th>Stresses</th>
<th>SHIRAZ-96</th>
<th>Balochistan Local</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold tolerance</td>
<td>-18 °C</td>
<td>-19 °C</td>
</tr>
<tr>
<td>Drought tolerance</td>
<td>Seed formation in &lt;100mm precipitation</td>
<td>No seed formation in &lt;100mm precipitation</td>
</tr>
<tr>
<td>Fusarium wilt</td>
<td>Resistant</td>
<td>Susceptible</td>
</tr>
<tr>
<td>Ascochyta blight</td>
<td>Tolerant</td>
<td>Susceptible</td>
</tr>
</tbody>
</table>

Table 3: Quality characters of SHIRAZ-96 as compared with Balochistan Local (check).

<table>
<thead>
<tr>
<th>Characters</th>
<th>SHIRAZ-96</th>
<th>Balochistan Local</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein content (%)</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>Cooking time (minutes)</td>
<td>30</td>
<td>29</td>
</tr>
<tr>
<td>Taste preference</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>Cotyledon Colour</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>1000-seed weight (g)</td>
<td>35</td>
<td>16</td>
</tr>
</tbody>
</table>

Ascochyta blight (Table 2). SHIRAZ-96 is almost same in cooking time, taste preference and protein content but more than double in seed size when compared to the check, Balochistan local (Table 3).

Discussion
The yield of SHIRAZ-96 is generally low but when we see the severity of the environments, it is highly encouraging. The variety was approved for release by the Balochistan Seed Council in December, 1996 and registered with the Department of Seed Certification and Registration in March, 1997 (Gazette of Pakistan, 1998). The variety has many desirable traits and is substantially higher yielding than local extra small-seeded lentil. The variety even gives seed back in less than 100 mm precipitation (highly water stress conditions). Its seed size is more than twice the size of local lentil. It is resistant to Fusarium wilt and tolerant to Ascochyta blight whereas local lentil is susceptible to both these diseases. This is the first improved variety for the arid highlands of Balochistan and the fourth in the country. Before this variety, three other varieties have been released or the comparatively warm areas of Pakistan. This is a unique variety which has been developed exclusively for the cold and dry areas which cover almost 33 per cent of the total land area of the country.

This variety is basically suitable for winter-planting in highland Balochistan under rainfed conditions. Its cold tolerance potential is -18 °C whereas the local lentil survived at -19 °C under controlled conditions which is a big difference (Ali, 1994). Additionally, since there is no spring variety available for the moment and natural environments are quite uncertain, this variety has sufficient flexibility with a large planting window (time-span for planting). Late-planting in January to February also gives some yield which can provide additional benefit to the farmers from the unutilized marginal lands. However, the best planting time for this variety is the first week of October but it can be sown from September to November successfully. Successful crop can be obtained in 200 mm or more of well distributed rainfall.

SHIRAZ-96 has proved its superiority and local lentil can be replaced easily with this new variety. The country’s lentil production can be increased on a sustainable basis by growing SHIRAZ-96 in the cold and dry areas of Balochistan. At the same time, variety improvement programmes should work continuously and generate further high yielding varieties for both the plains and highland areas. Increase in production will ultimately bring down the market price and enhance per capita consumption of lentil. It may convert Pakistan from lentil importing to a lentil exporting country. Additionally, lentil straw can be used to feed animals during acute feed deficit periods in winters which may stop the migration of farmers towards warmer areas which is done due to the shortage of feed for their animals in winter.

References