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

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\bstract

'he objective of this study was to develop a dual-season high yielding, bold-seeded lentil variety with cold, drought and lisease resistance to replace the local ultra small-seeded variety in the arid highlands (≥1000m altitude) of Balochistan which re 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 ver local lentil ranged from 10-81 per cent. The maximum average yield of 1637 kg ha^{-1} (33 per cent > local) was btained under irrigated conditions and 410 kg ha^{-1} (47 per cent > local) in rainfed environments. SHIRAZ-96 provided at east the seed back in the most dry (≤100mm precipitation) conditions when the local lentil could not produce any seed at l in those environments. SHIRAZ-96 survived -18 °C which is little less cold tolerant than the local which survived -19 °C nder controlled freezing tests. These findings were analogous to the results obtained under natural environments in upland alochistan. SHIRAZ-96 is *Fusarium* wilt resistant and tolerant to *Ascochyta* blight. It is almost same in cooking time, taste eference and protein contents but more than double in seed size as compared to the check, Balochistan local.

ntroduction

entil (*Lens culinaris* Medik.) is an annually sown cool ason food legume crop with high protein content available its grains and comparatively low market price choonhoven, 1995). It is regarded as one of the best bstitutes of meat which is easy to afford by the poor ople. It is the second major winter pulse crop after ickpea in Pakistan (GOP, 1998). During the last 48 years, total annual area for lentil cultivation increased gradually til the decade of 1970-80 and then started a decline ich is still continuing. However, the total annual duction for this crop has remained almost the same ilst population has increased four times (GOP, 1998). ing the last 18 years (1980-1998), the total area for il cultivation decreased but the total annual production ained the same because of the increase in the per unit yield (GOP, 1984; GOP, 1998). This may be attributed he release of new improved varieties and production nologies. The total annual production of lentil since 0 has been stagnant. Consequently, the country orts a large quantity of lentil to meet domestic irements which puts a large burden on the national equer. During 1995/96, 34,000 t of lentil costing Rs. million were imported (GOP, 1998). It also indicates the total national requirement is about 68,000 t which uble the local production. Due to the increasing price ntil, this poor man's meat will soon not be affordable oor people. It is the need of the hour that the uction of lentil should be increased at least by three 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 alongwith 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 hardiness able 1: Seed Yield of SHIRAZ-96 in comparison with Balochistan Local in different experimental tests under rainfed and irrigated conditions of upland Balochistan during 1986/87 to 1995/96.

rial Type and Locations	No. of Locations	Year	Avg. Seed Yield (kg ha^{-1})		% Increase	Site Sig. (P<0.05)	
			SHIRAZ-96	Local		Sig.	NS
Vinter-planting (rainfed)							
A: Qta, Khu, K.Meh*	3	1986/87	224	291	0	0	3
B: Qta, Khu, K.Meh	3	1987/88	410	219	47	3	0
C: Qta, Khu, K.Meh	3	1988/89	216	113	48	2	1
Adaptation: Qta, Lor	2	1991/92	735	250	66	2	0
Adaptation: Qta, K.Meh	2	1995/96	370	246	34	2	0
On-farm							
Rainfed: Qta, Lor, K.Meh	3	1991/92	751	272	64	3	0
rrigated: Qta	1	1991/92	1577	1111	30	1	0
rrigated: Qta	1	1992/93	1637	1101	33	1	0
Spring-planting (rainfed)							
A: Qta, Khu, K.Meh	3	1986/87	355	191	46	2	1
B: Qta, Khu, K.Meh	3	1987/88	21	4	81	2	1
C: Qta, Khu, K.Meh	3	1988/89	30	27	10	2	1

* Qta: Quetta; Khu: Khuzdar; K.Meh: Kan Mehtarzai; Lor: Loralai; Sig.: Significant; NS: Non-significant.

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 landrace is very difficult to clean in the kitchen and is susceptible to major diseases. Bold-seeded lentils are preferred over small-seeded ones because of their high yield and higher market price (Keatinge *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 ICARDA (International Centre for Agricultural Research in the Dry Areas, Syria) under a germplasm exchange programme started in 1983 between AZRC and ICARDA. 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 Mehtarzai (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 Mehtarzai 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 are 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 alongwith local check were also evaluated for their cold tolerance 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 of *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 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 less cold tolerant than local lentil but better in drought tolerance. It is *Fusarium* wilt resistant and tolerant to able 2: Performance of SHIRAZ-96 against different biotic and abiotic stresses as compared with Balochistan Local (check).

tresses	SHIRAZ-96	Balochistan Local
old tolerance	-18 °C	-19 °C
rought tolerance	Seed formation in $\leq$100mm precipitation	No seed formation in $\leq$100mm precipitation
usarium wilt	Resistant	Susceptible
scochyta blight	Tolerant	Susceptible

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

haracters	SHIRAZ-96	Balochistan Local
rotein content (%)	17	17
ooking time (minutes)	30	29
aste preference	50% individuals preferred over B. Local	50% individuals preferred over SHIRAZ-96
otyledon Colour	Red	Red
000-seed weight (g)	35	16

scochyta blight (Table 2). SHIRAZ-96 is almost same in ooking time, taste preference and protein contents but iore than double in seed size when compared to the check, alochistan local (Table 3).

)iscussion

he yield of SHIRAZ-96 is generally low but when we see ie severity of the environments, it is highly encouraging. 'he variety was approved for release by the Balochistan ieed Council in December, 1996 and registered with the)epartment of Seed Certification and Registration in March, 997 (Gazette of Pakistan, 1998). The variety has many esirable traits and is substantially higher yielding than local ltra small-seeded lentil. The variety even gives seed back 1 less than 100 mm precipitation (highly water stress onditions). Its seed size is more than twice the size of local entil. It is resistant to *Fusarium* wilt and tolerant to *Ascochyta* blight whereas local lentil is susceptible to both hese diseases. This is the first improved variety for the arid iighlands 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 inique variety which has been developed exclusively for the old and dry areas which cover almost 33 per cent of the otal land area of the country.

This variety is basically suitable for winter-planting in iighland Balochistan under rainfed conditions. Its cold tolerance potential is -18 °C whereas the local lentil survived at -19 °C under controlled conditions which is not 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.

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