TÜRKİYE'NİN YÜKSEK ALANLARI İÇİN KIŞA DAYANIKLI ÇEŞİTLERİN GELİŞTİRİLMESİ

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Özet

Türkiye'nin yüksek alanlarında mercimeğin verimliliğini sınırlayan temel faktörler düşük sıcaklıktır. Bu nedenle Türkiye'nin böyle alanları için kışa dayanıklı çeşitlere ihtiyaç bulunmaktadır. Yüksek alanlara adapte olabilen kırmızı mercimek çeşidi geliştirmek için Güneydoğu Anadolu Bölgesinden yerel çeşitler toplandı ve tek bitki seleksiyon metodu uygulandı. Islah çalışmaları sonunda geleneksel yazlık tiplere göre önemli verim artışları sağlayan kışlık kırmızı Kafkas, Özbek ve Çiftçi mercimek çeşitlerinin geliştiridi.

Anahtar Kelimeler: Kışlık Mercimek, Kışa Dayanıklık, Çeşit, Yerel Çeşit, Yüksek Alanlar,Kafkas**,** Özbek, Çiftçi

IMPROVEMENT OF WINTER HARDY LENTIL VARIETIES AT HIGH ELEVATIONS OF TURKEY

Summary

Low temperature is the major limitation to the productivity of lentil as winter crops at high elevations of Turkey. Therefore, winter- hardy lentil cultivars are needed for such areas of Turkey. For this purpose, Landraces were collected from Southeastern Anatolia and single plant selection procedure was used to develop germplasm with red lentil cultivars adapted to highland areas. Breeding efforts led to development and release of 'Kafkas, Özbek and Çiftci' winter lentil cultivars ensuring significant yield increase over traditional spring types.

Keywords: Winter lentil, Breeding, winter hardiness, Cultivar, Landraces, Highlands, Kafkas**,** Özbek, Çiftçi

Introduction

Two types of Lentil (*Lens culinaris* Medik.) are grown in Turkey. Yellow cotyledon lentil *Lens culinaris* var. *macrosperma*) is traditionally grown as a spring crop in highlands of Central Anatolia while the red cotyledon (*Lens culinaris* var. *microsperma*) is mainly grown as a winter crop in the lowlands such as southeastern Anatolia. Total lentil production of Turkey is 520,000 t. Yellow and red cotyledon lentil are accounting for 12 % and 88 % of the total production respectively in Turkey (Sıs, 2001). Red lentil is produced not only for domestic consumption but it is produced mostly for exportation.

However, it is expected that implementation of an extensive irrigation program in the GAP (South Eastern Anatolia Project) will result in substitution of dry land crops such as lentil, with more profitable irrigated crops (Tekinel et al., 1990). Indeed, in irrigated areas of southeastern Anatolia, cotton areas were increased rapidly lately (Timurağaoğlu, 2001). This probable substitution of lentil in southeastern Anatolia presents a risk to Turkey to lose its competitiveness in world export markets, but this market share could be maintained if alternative production zones could be brought into utilization in the central Anatolia highlands (Küsmenoglu and Aydın, 1995).

Central Anatolia is characterized by higher altitude (mean elevation 1025 m) and colder in winter than South Eastern Anatolia (mean elevation: 790 m). In these highland areas, it almost covers

with snow in winter. February is the coldest month. More than 65 % of the raining is received in winter and spring (Annual main rainfall is 425 mm in long period). In addition, temperature raises and it becomes hot rapidly in spring. Summer is dry season (Mızrak, 1983 and Guler *et al*., 1990).

Green lentil is planted in spring in central Anatolia whereas red lentil is sown in late autumn in southeastern Anatolia. The average yield of the spring and sown lentil is lower than 1 t ha^{-1} (Sis, 2001). Because of dry period is suitable to produced period. In regions where lentil is grown moisture supply is limited, excessive vegetative growth of food legume may lead to increased evapotranspiration. Flowering and pod filling stages are sensitive phases of development in all legume crops, and seed yield could be reduced due to greater moisture stress during (Cooper *et al*., 1988).

However, shifting of lentil sowing time from spring to winter facilitated yield improvement of over 50 % in fall planted winter hardy types in cold highland areas of Turkey (Sakar *at el*., 1988). The major limiting factors to crop growth are the cold temperature in winter and both low moisture availability and high temperature stress in spring. In highland areas spring –sowing is practiced at elevations above 800 m. because of the severe winter cold.

Our specific objectives were to: determine the tolerance genotypes to winter injury and develop winter hardy lentil varieties, are productive and have desirable quality properties for consumer and market demands for use at high elevation of Turkey and regional countries.

Materials and Methods

Single plant selection procedure was used to identify winter- hardy and lentil cultivars adapted to the central Anatolia Highland.

A total of 156 land race lentil collected from southeastern Anatolia were evaluated at Haymana in 1 m x 1 m row plot in two replications and at three different planting times in the fall of 1990. In the summer of 1991, a total of 5064 single plants were selected. These single plants were planted in a 1 m single row nursery in the 1991/92 crop season, and 880 lines of them were selected for winter hardiness and desirable morphological traits. An experiment with these selected lines was conducted in 2 m x 2 rows plots without replication in the 1992/93 crop season. The lines were rated for cold tolerance and some were selected morphologic traits. After analysing the results, 340 lines were selected. In the 1993/94 crop season, based on seed availability, 211 lines were planted in two replications and 129 lines without replication in 5 m and four-row plots. 322 lines of 340 lines were selected for cold tolerance and some agronomical traits. In the fall of 1994, selected 322 lines were planted in Haymana and 292 lines of 322 selected lines in Sivas-Ulaş with two replications. Of the season, 172 lines were selected for cold tolerance and some morphological traits.

In 1995/96 crop season, 8 winter lentil regional yield trials including 172 selected lines were conducted in 4 locations (Hayman, Yozgat, Konya and Sivas). Of the season, 45 lines were selected and in fall of 1996/97 crop season, were evaluated in Haymana and at 3 locations using lattice design with four replications. During the fall of 1997-98, 1998-99 and 1999-2000, 7 promising lines and 3 checks, for cold tolerance yield and some agronomical traits were evaluated in variety release trials in randomised complete block design. Seed was drilled in 4 row plots, 5m-long at a rate of 375 seed/m^2 with row 20 cm apart. Fertilizer was applied at rate of 12 kg/da DAP (Diammonium phosphates). Inoculation was not undertaken but nodulation was adequate throughout.

Following characters were measured during growth, as described by Erskine & Witcombe (1984): time to 50% flowering (days), time to 90% pod maturity (days), plant height (cm). The rating

scale used for cold tolerance was as described by Singh et al. (1989) (1: Resistant-no symptoms, 9: all plants killed). The program MSTATC was used for variance analysis.

Results and Discussion

156 land race lentils were firstly evaluated for cold tolerance at Hayman from 1991 to 1994. Minimum temperatures during that period, were –16, -18.9, -20, -21.3 ^{o}C respectively. 1 992/93Crop seasons, minimum cold score was 2 whereas maximum cold score was 9 in 880 lines from 5064 selected single plants in 1991/92. At the end of season, 340 lines were selected for cold tolerance, days to first flower, days to maturity and plant height**.** For Haymana location from 1992 to 1997, minimum and maximum days to first flower, days to maturity and cold tolerance data for are given in Table 1. Cold score was not taken because of poor crop emergence before winter in 1993/94 crop season but 340 lines were evaluated for morphologic traits. Flowering days and maturity days were ranged from 218 to 239, from 253 to 269. Plant height (cm) in these selected lines changed from 12 to 31 in this year. After analysing the results, 322 lines were selected.

Table 1. The minimum and maximum values of winter hardiness and morphological traits at Haymana.

	1992-1993		1993-1994		1994-1995		1995-1996		1996-1997	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Cold tolerance	4	9	-	-	2	6	2	6	2	4
Days to first flower	212	235	218	239	193	213	231	241	222	231
Days to maturity	259	276	253	269	232	245	263	270	260	271
Plant height (cm)	20	46	12	31	22	56	18	32	25	46
Yield (kg/ha)	-	-	262	1830	1112	4847	934	2496	1333	3230

In period of 1994 and 1997 number of tested and selected lines in each reaction group to winter cold at Haymana and Sivas are given in Table 2. For winter hardiness, in the coldest year (1996/97, Sivas), 3 lines scored 3 whereas 6 lines scored 6. As a result of cold damage observation, of 1996/97 season, total of lines was 7 whereas this number was 322 in 1994/95-crop season.

Table 2. Number of tested and selected lines in each reaction group to winter cold at Haymana and Sivas.

Cold Score	1994-1995		1995-96		1996/97		
	Haymana Min.Tem.(^{O} C) -21.3	Sivas Min.Tem.(^{O} C) -23.8	Haymana Min.Tem.(^{O} C) -19.6	Selected	Haymana Min.Tem.(^{O} C) -16.7	Sivas Min.Tem.(^{O} C) -29	Selected
1	-	-	-	-	-	-	-
2	31	102	18	3	18	-	3
3	168	145	92	6	21	3	4
4	105	44	58	24	6	16	-
5	17	1	1	12	-	20	-
6	1	-	-	-	-	6	-
7	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-
Total	322	292	172	45	45	45	7

Winter Hardiness 1 = winter Hardiness 9 = winter susceptible (Singh et al, 1989)

Selected 7 lines in 1997 had excellent winter hardiness and they were evaluated for additional years in different environments (Haymana, Konya and Yozgat) for during the winters of 1997-98,1998-99 and 1999-00. Analysis of variance table for 7 lines tolerant to cold and 3 checks three years and locations are given Table 3. Differences between locations was not significant. But among genotypes and AxB (locations X genotypes) were significant ($P<0.01$). Replication (among years) was significant ($P<0.05$). This indicated that the variation for yield in these sets of experiment were due to years and genotypic differences rather than location differences.

Table 3.Analysis of variance table for three years and locations.

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
Replication	2	233946.208	116973.104	10.0853	0.0274
Factor A	2	47152.048	23576.024	2.0327	0.2460
Error	4	46393.653	11598.413		
Factor B	9	25300.153	2811.128	3.4872	0.0019
AB	18	37056.126	2058.474	2.5538	0.0041
Error	54	43531.337	806.136		
Total	89	433379.523			

Replication (Var 1:rep.) with values from 1 to 3
Factor A (Var 2: location) with values from 1 to 3
Factor B (Var 3: varieties) with values from 1 to 10

The lines TUR 01174 (AkM 62), TUR 01261 (AkM 196) and TUR 01661 (AkM 302) and checks were especially promising for cold tolerance, high yields and crop quality over a three-year period 1998 to 2000 (Table 4). When compared to spring planted lentils, promising lines when planted in the fall out yielded all spring planted lines by 37 % and the best yielding spring lentil lines including varieties by 19%. This advantage for yield is derived from establishment in the fall and early spring growth when evapo- transpiration demand is minimal thus improving water-use- efficiency. Also, winter-sown plants are exposed to better water-distribution than spring sown plants in vegetative and generative stages (ICARDA, 1988). Because of winter planting, plant indicates more vegetative development and in reproductive stage, plant is supported by the more vegetative development. Therefore, the yield is 20-60% higher in winter planted than spring planted (Andrews, 1987)

Table 4. Compared to spring planted and registered winter lines.

Lines and Checks	Y e a r s			
	1998	1999	2000	Mean
AkM 49	244,3	103,3	147,5	165,1
AkM 62 (Çiftci)	231,4	121,8	197,2	183,5
AkM 196 (Kafkas)	259,3	108,3	187,0	184,8
AkM 302 (Özbek)	207,8	99,9	174,8	160,8
AkM 362	192,3	104,6	191,3	162,7
AkM 363	232,6	104,4	173,0	170,0

AkM 395	200,1	92,8	165,8	152,9
Yerli Kırmızı	231,4	115,1	147,4	164,6
Seyran 96	200,1	75,5	115,2	130,3
Fırat 87	231,4	112,5	196,4	180,1
Means of promising lines	232,8	110	186,3	176,4
All winter	223,1	103,8	169,6	165,5
All spring	169,7	73,4	143,1	128,7
Best Spring	197,7	97,1	149,4	148,1

As a result of the study, TUR 01261 (AkM 196), TUR 01661 (AkM 302) and TUR 01174 (AkM 62) were released under the names "Kafkas", "Özbek" and "Çiftçi" respectively as winter lentil varieties where mostly spring green lentil is grown in the highland areas of Turkey.

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