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Lentil: Origin, Cultivation Techniques, Utilization and Advances in Transformation

Alihan COKKIZGIN[1]* and Munqez J. Y. Shtaya[2]

[1]University of Gaziantep, Vocational School Of Higher Education In Nurdagi, Gaziantep, 27840, Turkey

[2]An-Najah National University, Faculty of Agriculture, Plant Breeding and Genetic Engineering, Palestine

*Correspondence: Alihan COKKIZGIN. University of Gaziantep, Vocational School Of Higher Education in Nurdagi, Gaziantep, 27840, Turkey. Fax: +90-342-671-33-82; E-mail: acokkizgin@gantep.edu.tr

Abstract: Lentil (*Lens culinaris* Medik.) is the most ancient cultivated crops among the legumes. It is indigenous to South Western Asia and the Mediterranean region. There is archaeological evidence of lentil, dated back to 7.500 - 6.500 BC. It is cultivated worldwide, with 4.2 million ha of harvest area, producing 4.6 million tons with an average yield of 110 kg/da. It is commonly used for human nutrition, animal feed and soil fertility. The aim of this study is to give information about cultivation, origin and utilization of lentil.

Keywords: Lentil (*Lens culinaris* Medik.); origin; taxonomy; cultivation techniques

1. Origin and Production

1.1. Taxonomy of the Cultivated Lentil and Geographical Distribution

Lentil is one of the early domesticated plant species, as old as those of einkorn, emmer, barley and pea (Harlan, 1992). The plant was given the scientific name *Lens culinaris* in 1787 by Medikus, a German botanist and physician (Cubero, 1981; Sehirali, 1988; Hanelt, 2001). The morphological characteristics of the Lens species as well as synonyms are given by Cubero (1981). The most detailed and complete study of the cultivated lentil was made by Barulina (1930). Varietal identification was realized by choosing convenient, non-geographical and sometimes utilitarian characteristcs. In the description, macrosperma has 12 varieties and microsperma has 46 varieties. Lentil in taxonomy is as follows: Kingdom *Plantae*-Plants, Subkingdom *Tracheobionta*-Vascular plants, Superdivision *Spermatophyta*-Seed plants, Division *Magnoliophyta*-Flowering plants, Class *Magnoliopsida*-Dicotyledons, Subclass *Rosidae*, Order *Fabales*, Family *Fabaceae*-Pea family, Genus *Lens* Mill.-lentil, Species *Lens culinaris* Medik.- lentil (Anonymous, 2012).

Lentils is a deployed species (2n = 14) (Muehlbauer, 1991). It is self-pollinating annual species with a haploid genome size of an estimated 4063 Mbp (Arumuganathan & Earle, 1991).

It is the oldest cultivated legume plant (Bahl et al. 1993, Rehman et al. 1994). Its origin is the Near East and Egypt at the Central and Southern Europe, the Mediterranean basin, Ethiopia, Afghanistan, India and Pakistan, China and later spread to Latin America (Cubero 1981, Duke 1981).

1.2. World Lentil Harvest Area, Production and Yield Values

The important lentil-growing countries of the world are India, Canada, Turkey, Bangladesh, Iran, China, Nepal and Syria (Ahlawat, 2012). The total cultivated area in the world as around 4.6 million hectares producing 4.2 million tons of seeds with an average production of 1095 kg/ha (FAO, 2010). The main lentils producers are Armenia, China, Turkey and Croatia (Figure 1-2-3).

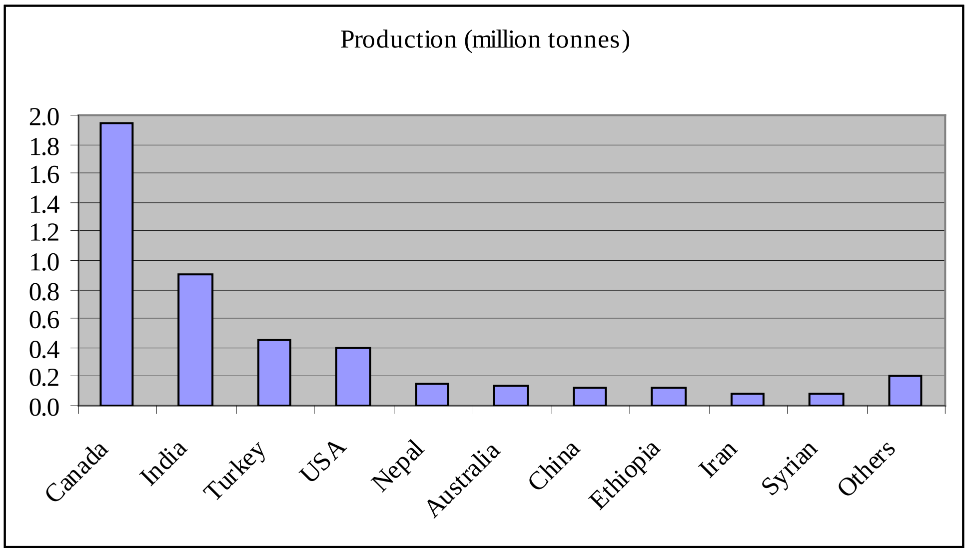

Figure 1. Top Ten Lentil Producing Countries and Total Value of Other Countries (Fao, 2010)

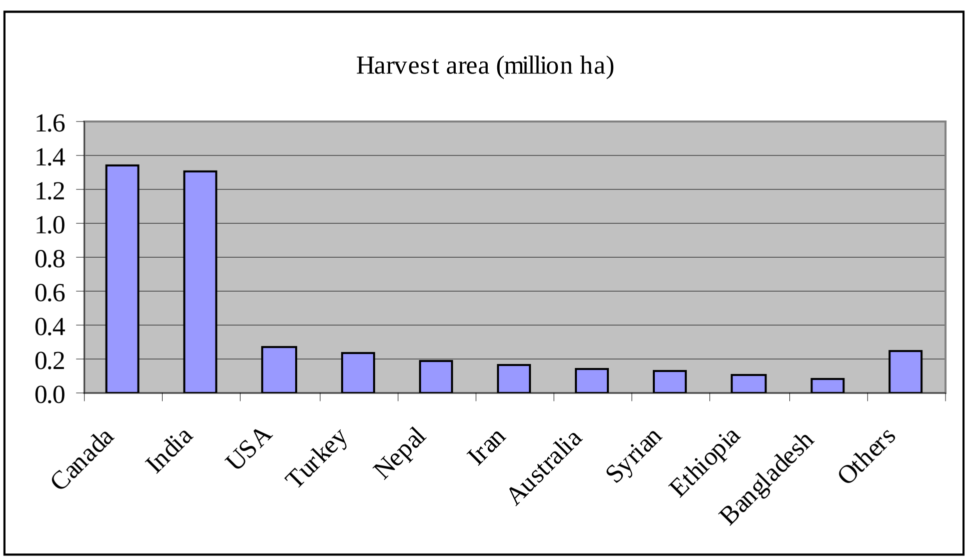

Figure 2. Top Ten Countries and Total Value of Other Countries in Lentil Harvest Area (Fao, 2010)

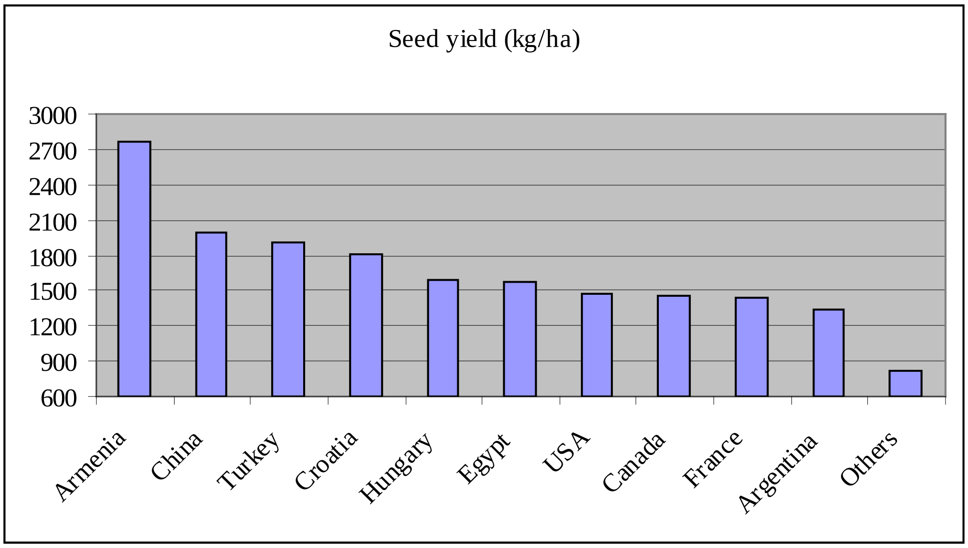

Figure 3. Top Ten Countries and Average of Other Countries in Lentil Seed Yield (Fao, 2010)

2. Cultivation Techniques

2.1. Climate and Soil Qequirements

Lentil is one of the less selective legumes in terms of climate and soil features. It can be grown to a altitude of 3000 meters. On the other hand the seed yield per area decreases when the altitude increases (Whyte et al., 1953). Lentil is a well adapted plant that grows in a wide range of soil types. However, the heavy textured soils causes yield reduction, whereas sandy-loam soils are the most suitable for lentil growth (Sehirali 1988, Ozdemir 2002).

2.2. Sowing Time

Lentil is a winter crop usually grown in fall and harvested in summer and some varieties can also be sown in spring. However, late sowing will decrease yield and increase protein content (Sehirali, 1988). Freezing temperatures below -25 ºC damage the plants (Ozdemir, 2002) so that lentil should not be cultivated at very low temperatures.

2.3. Fertilization and Fertilizer Requirements

Farmers usually do not use nitrogen fertilizers for lentil production. This is due to the ability of lentil to fix atmospheric nitrogen. It is reported that lentil can fix 46-192 kg N per ha (Rennie & Dubetz, 1986; Smith et al. 1987; McNeill et al. 1996; Rochester et al. 1998; Shah et al. 2003). However, in order to encourage the bacterial activity, the application of 1 kg/da of nitrogen and 2.5 kg/da of phosphorus is recommended during the growing season, and fertilizer application should be passed on soil analysis (Cokkizgin et al., 2005).

2.4. Lentil Management

Weed control is the most important management procedure. In many countries, herbicides are used for weed control in lentils fields (Sehirali, 1988). Weed control is an important agricultural practice that affect seed yield (Aydogan et al., 2008). Yenish et al. (2009) reported that weeds may reduce lentil yield by 20-80%.

2.5. Harvesting

Although lentil is a long day plant, neutral types are also available (Hawtin et al. 1980). For this reason harvesting may be done by the end of the spring and the beginning of summer. In many countries lentils are harvested manually but mechanical harvesting is also possible and for that reason vertically grows varieties are available.

2.6. Diseases and Pests

Several diseases affect lentil causing yield losses. Common fungal diseases of lentil are Fusarium wilt caused by *Fusarium oxysporum* f. sp. *Lentis*, rust caused by *Uromyces fabae*, and ascochyta blight caused by *Ascochyta lentis*. Bacterial disease caused by *Mycobacterium insidiosum* also affect lentil. Lentil is also affected by parasitic flowering plants like *Cuscuta* sp. and *Orobanche* sp. Several viral diseases affect lentil, including pea enation mosaic virus, bean yellow mosaic virus and pea seed borne mosaic virus (PSbMV). Among them, PSbMV is potentially dangerous for lentil (Muehlbauer et al., 1995). Nematodes also affects lentil (Van Emden et al., 1988). The most important pests that affect lentil and cause economic losses are gram caterpillar (*Heliothis obsoleta*), white ants (*Clotermes* sp.), gram cutworm (*Ochropleura flammatra*), the weevil (*Callosobruchus analis*) and hand bean seed beetle (*Bruchus ervi* ve *Bruchus lentis*) (Duke, 1981; Sehirali, 1988).

2.7. Cultural Practices

The highest yield can be gained by 300 seeds per m^2 sowing rate but this value may vary according to the climate and soil conditions (Togay et al., 2008). Crop rotation and the use of hybrid or improved seeds will positively affect lentil yield. Over-irrigation has a negative effect on lentils by causing lodging. However, during dry springs, supplementary irrigation should be done in order to prevent yield losses.

2.8. Seed Yield

Several factors affect lentil seed yield including local climate, soil conditions and genetic features. It is reported that lentil seed yield ranged from 1057-2880 kg ha^{-1} (Sharaan et al. 2003; Turan, 2003; Colkesen et al. 2005; Bicer & Sakar, 2010 The average value of the world lentil seed yield is 1095 kg ha^{-1} (FAO, 2010).

3. Utilization

Because of its high average protein content and fast cooking characteristics lentil is the most desired legume in many regions (Raghuvanshi & Singh, 2009). Lentil seeds contain 1-2% fat, 24–32%

proteins and minerals (iron, cobalt and iodine) and vitamins (lysine and arginine) (Kowieska & Petkov, 2003; Bhatty, 1988; El-Zoghbi, 1998). Lentils are prepared in several methods including soaking, boiling, sprouting/germination, fermentation, frying and dry-heat methods. Other ways to benefit from it is processed lentil, lentil snacks and medicinal uses (Raghuvanshi & Singh 2009). Lentil straw is also a valued animal feed due to low cellulose-containing (Erskine et al., 1990). On the other hand lentil vegetative parts can be used as green manure (Kara, 2008).

4. Advances in Lentil Propagation

Several methods of propagation were used in lentils. Tissue culture has been conducted (Polanco et. al. 1988) using shoot apical meristem tips (Bajaj et al., 1979; Williams et al., 1986), and intact seedlings (Malik et al., 1992). The highest frequency and genotype independence for shoot regeneration were achieved using cotyledonary nodes (Warkentin & McHughen, 1993; Gulati et al., 2001). Transient expression of the reporter gene GUS was achieved by electroporation, particle bombardment and by *Agrobacterium* transfer methods (Maccarrone et al., 1995; Mahmoudian et al., 2002). Transgenic lentil plants were produced through bombarding cotyledonary nodes with a mutant gene from tobacco for resistance to sulfonylurea herbicides (Gulati et al., 2002). Future direction of lentil genomics can be summarized and includes (1) new marker development and fine mapping, (2) development of new genetic materials applicable to advanced genomics and (3) application of advanced genomic tools for lentil genomics.

5. Conclusion

Lentil is an important legume crop and plays an important role in human, animal feeding and soil improvement. Increasing lentil production should be considered. Agricultural and breeding research should be done and its genetic characteristics should be clarified.

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