Introduction

Citrus are one of the most important tree fruit crop groups in the world, and these fruits are regarded as important household foods in more than 100 countries around the world, as well as the world juice industry, of which citrus juices have the greatest volume. Citrus is considered as the leading industry in many regions, such as the mountainous regions of China and coastal plains in several countries, such as California and Florida in USA, Valencia in Spain, Sicily in Italy, and the Cukurova region in Turkey (Cimen and Yesiloglu, 2016).

Alexander the Great introduced citrus to Turkey, as well as many other areas of the Middle East, in the fourth century BC. Since then, Turkey has planted considerable areas of citrus, including most of the cultivars grown in many other citrus production areas of the world (Faber et al., 2010).

In 2013, Turkey was among the top three citrus producing countries in the Mediterranean Basin and ranked ninth in the world, accounting for about 2.7% of the 137 million tons of citrus produced globally (Faostat, 2017). Total citrus production of Turkey was 4,293,007 t in 2016 (TUİK, 2017). Oranges are the main citrus fruit grown in Turkey, accounting for about 63% of total production (1,850,000 t). Orange production is followed by mandarins (1,337,037 t), lemons (850,600 t), grapefruit (253,120 t) and others (2,250 t).

Data on annual citrus production in Turkey since 1965 is presented in Figure 1. There has been a rapid and steady expansion in citrus output in Turkey over the last fifty years, with approximately 2% increase per year. In 2015, Turkey's citrus production was nine times the production in 1965 (TUİK, 2017). Mandarins and their hybrids are currently the preferred citrus crop for new plantations. Therefore, while all citrus production is tending to increase, the proportion of mandarins is increasing more rapidly. Recently, field crops, such as cotton, are being replaced with citrus. However, citrus farming requires initial investments, and therefore not all farmers are ready for growing citrus. Unstable market conditions observed during recent years may be a factor that is limiting the trend of expansion of citrus.

The citrus area in Turkey has expanded rapidly, increasing from 39,488 ha in 1970 to about 135,466 ha in 2016. This expansion is driven by domestic and export demands. It is believed that Turkey has a production potential at least five times the present level. The growers in major growing areas like Cukurova and Antalya, where the Mediterranean climate is more suitable for high quality citrus, continue to shift to citrus from field crops (cotton and grains) because of its more attractive returns. In these regions, high quality citrus fruit production is oriented particularly towards fresh fruit markets and consumption. According to statistics, 52,696 ha were planted in oranges, 46,569 ha in mandarins, 30,033 ha in lemons and 6,155 ha in grapefruits in 2016. Currently, Turkey has over 4,236,546 citrus trees. Non-bearing trees account for about 11.6% of the total trees (TUİK, 2016).

Citrus growing areas of the world are located mainly in tropical, semi tropical and subtropical regions, between the equator and latitudes 40°N and 40°S. Citrus growing areas of Turkey are situated in the northern hemisphere of this citrus belt. Frost risk exists to some extent in citrus farming. The major citrus producing areas are located along Turkey's southern Mediterranean and Aegean coastal plains, where typical mild or cool Mediterranean subtropical climate prevails. The majority of the citrus growing areas are located in the Mediterranean region (Figure 2). Approximately 85% of oranges, 85% of mandarins, 94% of lemons, and 98% of grapefruit are being produced in this region. The Mediterranean region is generally divided in two main sub-regions: Eastern and Western Mediterranean. The Eastern Mediterranean region covers mainly coastal parts of Cukurova plain and accounts for 73% of Turkey's total citrus production, 57% of oranges, 83% of mandarins, 87% of lemons and 96% of grapefruit. In Cukurova, production of late cultivars may be problematic because of frequent winter rains, which can increase fungal diseases and winter frosts. In Cukurova, the Mersin province specializes in lemon production, while oranges are mainly produced in Adana and Hatay provinces. Adana is also the main grapefruit producing province. Mandarins are mainly produced in Hatay and Adana provinces. The western part of the Mediterranean is the second largest citrus area of Turkey. This sub-region includes the Antalya province, located in the western part of the Mediterranean coast. It produces about 14% of Turkey's total citrus crop, mainly oranges (about 28% of the total Turkish orange production).

The third largest citrus area in Turkey is the Aegean region, composed of Mugla, Izmir and Aydin provinces, encompassing 12% of the total citrus production, and specializing mainly in orange and mandarin production. This region provides 15% of the total orange production and 14% of the total mandarin production.

The other citrus areas, located in Western Marmara and Eastern Black Sea regions, have a negligible production (0.3% and 0.2% respectively). In Aegean and Mediterranean regions, farm sizes are generally small. On the other hand,
there are big citrus farms of approximately 700-800 ha in Adana province. Because of the new plantations in the Eastern Mediterranean region, citrus trees are generally young in this part of Turkey. Modern agricultural techniques are being employed in newly established plantations and especially on the larger citrus orchards. Recently, the division of farms by inheritance has been prevented by legal regulations. Regulations of the “soil protection and land use act” were published in May 15, 2014 in the Official Gazette. According to these regulations, the minimum land size has been determined by the Ministry of Food, Agriculture and Livestock and plots of land are not allowed to be divided any smaller than this minimum. In addition, land consolidation programs are being implemented by the Ministry more intensively in recent years.

**Cultivars and rootstocks**

Seventy-five percent of sweet orange production are navels such as ‘Washington’, ‘Navelina’, ‘Lane Late’, ‘Navelate’, ‘Fukumoto’, and ‘Cara Cara’ (Figures 3 and 4). The rest of orange production are Valencia cultivars, ‘Shamouti’ and other local selections. Sixty-three percent of the mandarins are Satsuka cultivars, such as ‘Owari’, ‘Okitsu Wase’, ‘Mihowase’ and ‘Dobashi Beni’; the rest of the plantings include ‘Clementine’, ‘Nova’, ‘Robinson’, ‘Minneola’, ‘W. Murcott’, ‘Tango’, ‘Ortanique’ and ‘Primasol’ (Figures 5-8). Fifty percent of the lemons are ‘Kutdiken’ lemon (Citrus limon L., a local selection), and 20% are ‘Interdonato’ (Italy), which are less susceptible to a fatal fungal disease, Mal Secco (Phomopsis tracheiphila). The third most popular cultivar, ‘Meyer’, is gaining popularity rapidly because of high yields and even more resistance to Mal Secco and to cooler conditions (20%, Figure 9). The remaining important lemon cultivars are ‘Aydin’ (20%), ‘Italian Memeli’, ‘Lamas’ and ‘Eureka’. ‘Star Ruby’ is the dominant grapefruit cultivar (about 43%) in Turkey. It is followed by ‘Rio Red’, which represents about 40% of production. The other main grapefruit cultivars are ‘Henderson’, ‘Ray Ruby’, ‘Flame’, ‘Marsh Seedless’ and ‘Redblush’. Lemons are the earliest citrus species to be harvested compared with other citrus crops in Turkey. The lemon harvest begins in September and continues through to late-March. Mandarins and their hybrids are harvested from mid-September through to mid-March. Most of the oranges mature during winter months, starting in late-October and continue through to early-April. The grapefruit are harvested from mid-October through to mid-March. Citrus wholesalers often prolong the season by storing citrus, mainly lemons and some oranges and grapefruits, in cold storage in the Mediterranean region or in natural volcanic ash caves, particularly in Cappadocia (Central Anatolia) and Mersin province. Sour orange is the main rootstock (about 85%) used in citrus growing in Turkey, because it has resistance to root rot and tolerates the high soil clay content, high pH (causing iron, zinc and manganese chlorosis), and high rainfall (in places over 760 mm). It is followed by ‘Carrizo citrange’ (7%), ‘C-35 citrange’ (5%), ‘Troyer citrange’ (2%) and trifoliolate orange (1%). In recent years, use of ‘Carrizo citrange’ and ‘C-35 citrange’ rootstocks for oranges, mandarins and grapefruit has been increasing in the Mediterranean and Aegean regions.

**Main uses**

About 43% of the citrus production in Turkey is consumed in the Turkish market as fresh fruit. Turkey’s citrus consumption per capita is about 24 kg. About 37% of the production is exported. Turkey’s processing industry consumes a minor part of the citrus production. About 4% of citrus production is processed for juice. Turkey exports 8,191 t of citrus juice concentrate annually. However, Turkey imports some citrus juice concentrate as well (about 9,698 t) to support a rapidly growing tourism sector and for re-export (Faostat, 2013). Imports are mostly from Spain, Italy, Israel and Brazil.
Importance of the citrus industry

Turkey has a comparative advantage in high quality fresh fruit production, compared with the other Mediterranean countries producing citrus, because of the suitable environmental conditions for fresh fruit production. Most of Turkey’s citrus production is used for the local fresh fruit market and for export. Turkey has a significant place in international citrus trade, particularly in fresh citrus fruit exports. In the total global fresh citrus fruit export, Turkey was the third in the world and the second in the Mediterranean Basin in 2016. In recent years, exports of citrus, especially mandarin, have steadily increased (Figure 10). In 2016, about 1,672,205 t of citrus fruits were exported, of which 650,722 t was mandarin, 450,458 t lemon, 387,642 t oranges and 183,329 t grapefruit. The Commonwealth of Independent States was the top importer, importing 46% of Turkish citrus exports in 2016. It was followed by the Middle East countries (30%), European Union countries (18%), other European countries (4%) and other countries (3%). Russia and Ukraine import about 40% of Turkey’s total citrus exports (AKİB, 2017a).

‘Interdonato’, ‘Kutdiken’, ‘Italian Meme-li’, ‘Aydin’ and ‘Meyer’ lemons are exported mainly to Eastern (Russia, Romania and Ukraine) and Western European (The Netherlands, Germany, the UK) and Near East markets (Iraq, Saudi Arabia). Satsuma cultivars, ‘Nova’, ‘Robinson’ and ‘Minneola’ tangelo are exported mainly to the Eastern European markets (Russia, Ukraine and Belarus) and especially ‘Fremont’ mandarin to the Near East markets (Iraq, Saudi Arabia). Grapefruit exports are dominated mainly with colored flesh cultivars, especially ‘Star Ruby’ and ‘Rio Red’ to The Netherlands, Germany, the UK in Western Europe and Russia, Poland, Romania and Ukraine in Eastern markets. Main exported orange cultivars are navel cultivars, Valencia cultivars and ‘Shamouti’ to Iraq, Russia, Ukraine, Georgia, Romania, Germany and the UK (AKİB, 2017a).

In 2016, citrus exports accounted for 47% of total fruit and vegetable exports from Turkey (AKİB, 2017b). Export earnings were 880 million US dollars (Figure 11). Mandarins and lemons have the highest shares with 35.5 and 34.8%, respectively, in total export earnings, followed by orange (19.7%) and grapefruit (10.0%). Fresh citrus imports to Turkey are approximately 50,000 t (FAOSTAT, 2017).

New challenges and approaches

During recent years, environmental aspects of food production have become important issues. Hence, producers need to consider environmental dimensions of food products they produce in addition to traditional issues, such as quality, price, consumer demand and preferences, and standards. Although EU countries do not control food products according to HACCP, this certificate is considered an important assurance...
According to the "Turkish Food Codex Regulations" and "Regulation on Production, Consumption and Control of Food" issued by the Ministry of Food, Agriculture and Livestock, HACCP is a legal obligation for food processing companies. These regulations were published on November 16, 1997 and June 6, 1998 issues of the Official Gazette. The Ministry has given priority to meat, milk and fisheries products.

Another dimension to be considered in exports is the increasing demand for organic food. At present, Exporters’ Unions, Chamber of Agricultural Engineers, universities, etc. arrange seminars and training courses on HACCP and EUREPGAP for processors, exporters, and all other actors in the marketing chain (Yeşiloğlu et al., 2007).

Abiotic and biotic constraints

Soil

In Turkey, citrus is grown mainly on clay-loam-textured soils, causing drainage and fungal disease problems. For this reason, ridge planting has become widespread recently, on both shallow soils and heavy soils that have drainage problems. Calcium content of the soils is generally high in the Mediterranean region. Soil pH is rather high and varies between 7.0 and 8.5. Soils have high calcium and hence bicarbonate ion. Bicarbonate ion adversely affects Fe uptake and hence efficiency of photosynthesis of citrus trees. In addition, Zn, Mn and Mg deficiencies are common problems because of high lime content. Therefore, use of sour orange rootstock is widespread since it is resistant to alkaline soils. ‘Trifoliate orange’ cannot be used as rootstock in this region because it is very sensitive to Fe chlorosis. Our rootstock trials showed that ‘Carrizo citrange’ rootstock is suitable for soils with pH up to 7.8. As a result, farmers have started to use this rootstock under suitable pH conditions. It is reported that this causes some loss in quality, such as thicker skin formation and less desirable skin color. Heavy clay soils in the region have also been noted to result in similar quality issues. However, we determined that fruit yield and quality was high for orange, mandarin and grapefruit cultivars on ‘Carrizo citrange’ rootstock. So, this problem is being eliminated by choosing the most appropriate cultivars and rootstocks.

Climate

As previously mentioned, citrus growing areas of Turkey are situated in the northern hemisphere of the world citrus belt. Climate is typically mild or cool along the Mediterranean and Aegean regions of Turkey. There is a frost risk to some extent for citrus in some regions. In Cukurova, late cultivars are being grown in some sub-regions in order to avoid frost damage. In addition, wind machines are used in regions with frost damage risk (Figure 12). The Mersin province has a milder climate than some of the other citrus regions. Therefore, the great majority of the lemon production of Turkey is found in Mersin. On the other hand, in production regions like Aegean (covering Izmir, Mugla and Aydın provinces), growers specialize mainly in mandarin farming because of the high frost damage risks.

Production of late maturing cultivars is problematic due to frequent winter rains, which increases fungal diseases and makes fieldwork more difficult. This problem is solved by choosing favorable cultivars.

Hot and dry winds occur occasionally during flowering and early fruit development, which can cause flower drop, particularly in ‘Okitsu was’ mandarin and ‘Meyer’ lemon cultivars, and yields can be significantly lower as a result. Hot and dry winds in June and July cause severe June drop in seedless (navel cultivars) and less seedy cultivars (‘Okitsu was’ and ‘Ovari’ mandarins, ‘Shamouti’ orange, etc.). For this reason, the cultivars that have a tendency of fruit drop are sprayed with 10-20...
Furrow irrigation systems are sometimes causing problems. This situation has forced demands in these regions are increasing and cultural plants and field crops. Therefore, water environmental conditions for other horticultural areas also have favorable throughout the whole year, irrigation is nec-

Because rains are not regularly distributed and citrus growing media for the plantlets. Older citrus orchards have some disease related problems. However, disease free young plants have been produced since 1992. The government is encouraging the use of disease free young plants in new orchards, and it is expected that it will become obligatory in the near future.

A citrus tree is normally composed of the rootstock and scion, and is vegetatively propagated. Citrus nursery stocks are commercially propagated through budding/grafting of the scion of the desired cultivar onto the seedling rootstocks (Figure 15). The rootstocks have a great impact on scion vigor and fruit size, fruit yield and juice quality, as well as tolerance to salt, cold and drought. Citrus rootstocks also have a considerable effect on leaf mineral content of the scion. Production of citrus nursery plants has greatly increased in recent years because of the increasing demand from newly established orchards, and there are several highly developed citrus nurseries in Turkey. The most important issues to consider in nursery stocks can be listed as follows: using virus and disease-free propagation material, nursery certification, sophisticated infrastructure, and healthy growing media for the plantlets. Pruning is a common cultural practice that is necessary for the economical production in citrus culture as it is in many fruit tree crops. Most citrus trees are pruned; to invigorate the tree, to improve branch configuration (thus make branches less likely to split under a heavy crop), to improve fruit quality, and/or to reduce the crop load, which will improve the potential size of individual fruits. There are generally three types of pruning in citrus, which can be described as canopy pruning, yield pruning and rejuvenation pruning. Briefly, sprouts, canopy density, and damaged and dead branches are the main issues to consider while pruning a citrus tree, in all types of pruning, in order to increase fruit yield, fruit quality and disease control. Hand pruning of citrus orchards is very labor-intensive, resulting in high production costs. On the other hand, mechanical pruning has numerous advantages over classical pruning, such as enabling control over the tree size and providing mechanization in large and dense orchards. Therefore, mechanical pruning is often carried out in Turkey, especially on large farms (Figure 14).

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Nursery
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Breeding
At present, cultivars grown in Turkey are also being produced in almost all citrus growing countries in the world. Because of favorable climatic conditions, very high quality citrus fruit are grown in the Mediterranean region of Turkey. Germplasm resources are great, because of continued importation of new plant material and rootstock, and cultivar breeding is ongoing. Richness of genetic resources allows Turkey to develop new cit-

Pests and diseases
The main fungal diseases are: brown root gummosis [Phytophthora citrophthora (Sm. et Sm.) Leonian], mall secco [Phoma tracheiphila (Petri) Kanc et Ghik], Alternaria root (Alternaria citri Ell. Pierce) and citrus blast (Pseudomonas syringae Van Hall). Main virus diseases are: psorosis, exocortis, xylorosporosis, corky-leaf, Citrus variegation virus and a mycoplasma-like disease, stubborn (Spiroplasma citri). Tristeza has been present since 1920, but no vector transmission has been demonstrated yet. Main pests of economic importance are: citrus whitefly [Dialeurodes citri (Ashm.)], wooly whitefly [Aleurothrixus floccosus (Maskell)], California red scale [Aonidiella auranti Mask], citrus mealybug [Planococcus citri (Risso)], cottony-cushion scale [Icerya purchasi Mask.], Mediterranean fruit fly [Ceratitis capitata Wied.], citrus red mite (Panonychus citri McGregor), citrus rust mite [Phyllocoptera oleivora (Ashm.)], and citrus leafminer (Phyllocnistis citrella Stainton). The citrus nematode (Tylenchus semipenetrans Cobb) can occur in some citrus growing areas in Turkey (Yeşiloğlu et al., 2007).

Cultural practices
Irrigation
Because rains are not regularly distributed throughout the whole year, irrigation is necessary from mid-May to the end of October. Citrus growing areas also have favorable environmental conditions for other horticultural plants and field crops. Therefore, water demands in these regions are increasing and causing problems. This situation has forced farmers to use water more economically. Furrow irrigation systems are sometimes still used in old citrus orchards. However, the majority of farmers has switched to drip irrigation systems. In all of the newly established orchards, drip irrigation is installed. This method is the only alternative irrigation system in ridge planted citrus orchards, which has become widespread recently (Figure 13). Farmers also want to apply fertilizers together with irrigation (fertigation systems). This is another reason why farmers prefer drip irrigation in newly established groves. This is partly because the government pays for a portion of the system, on the condition that growers plant trees that have been certified as free of disease. Prior to 1992, plantings were often contaminated with diseases from the nursery. By subsidizing the pressurized irrigation systems, infection sources are being cleaned up. This is the only government support for growers.

Pruning
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rus cultivars, acceptable for world markets (Figure 16). In the past decade, the world’s citrus production has increased steadily to meet growing international demands. Seedlessness is one of the most important characteristics for citrus fruit, especially for mandarins sold on the fresh-fruit market, because of increasing consumer demand for this trait. In addition, seedlessness, excellent fruit quality (fruit size and yield, high sugar content, soft and juicy flesh, aroma, easy peeling, attractive appearance, uniform fruit shape and smooth rind) is the major objective in citrus breeding programs of Turkey. In addition, harvest timing is of great importance, especially for mandarins, in world fresh citrus markets. With late-maturing cultivars, cold-resistance is also required, to improve supply chain management systems.

Another problem is the lack of good connections between different actors within the market chain. At present, Turkish exporters rely on cultivars that are common in almost all citrus producing countries. However, Turkey should be ready to switch to the most preferred cultivars according to the changing demands resulting from changing tastes and preferences of consumers.

Conclusion
Turkey has a great potential for expanding its citrus production because of the favorable climatic conditions and the opportunity for breeding new cultivars. Citrus areas, production and yields are steadily increasing. However, Turkey is still very far from reaching its full potential.

A good supply chain with traceability facilities requires investment in human capital, as well as in IT systems. The government needs to take necessary steps to encourage investments in these areas. Development of processing facilities is also required, to improve supply chain management systems.

References

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