

PISTACHIO PRODUCTION IN THE WORLD AND SOME NEW PROBLEMS RELATED TO IRRIGATION IN TURKEY

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Abstract

Pistachio can be grown in only some part of the world due to special climatic requirements. The most important pistachio producer countries in the world are Iran, U.S.A., Turkey and Syria, respectively. Growing and processing techniques after harvest in Iran and U.S.A differ from those in other countries. Modern growing and processing techniques are performed in only U.S.A. In this presentation, the production values, growing problems and solutions, harvest and post-harvest processing techniques are compared that pistachio producer countries. In Turkey, growing of pistachio is intensified to the Southeast of Anatolia. After irrigation facilities start to be used in this area with GAP Project, it is expected to be important changes in new and old orchards. The farmers know the effect of water for pistachio trees. They are trying irrigation methods. An additional to this growing system, post harvest processing is start to be modernized during last decades.

Keywords: *Pistachio, production, yield, quality, irrigation.*

Introduction

Some of the species play an important role in vegetation at the Mediterranean and Asian regions and most of them have proved successful as rootstocks for top working the cultivated pistachio nut. Except *Pistacia vera* the other ones are not economical. They are called wild pistachio. In Afganistan, Iran, Pakistan, Turkey and all The Mediterranean countries there are millions of wild pistachio trees or bushes which belong to different *Pistacia* species. Pistachio is grown most intensively in Iran, Syria, Turkey and U.S.A. The other pistachio producing countries are in the Near East, North Africa and the Southern Europe. According to four years avarega (2013-2016), the production values in Iran is over 352 000 tons which is half of the world production (Table 1). The second country, USA, produces approximately 300 000 tons covers 32 % and next one is Turkey with yield of 120 000 tons with 13.24 % of total world production.

Table 1. Pistachio production in the World

Country	2013	2014	2015	2016	Average	Rate %
Iran	225 001	440 814	430 000	315 151	352 742	38.70
USA	213 188	233 146	313 811	406 646	291 698	32.01
Turkey	88 600	80 000	144 000	170 000	120 650	13.24
China	74 000	75 554	79 455	83 310	78 080	08.57
Syria	54 516	28 786	32 574	56 833	43 177	04.74
Greece	7 122	8 566	5 540	6 338	6 892	00.76
Italy	3 227	3 555	3 868	3 649	3 575	00.39
Afganistan	2 769	2 784	2 799	2 814	2 792	00.31
Tunusia	2 100	2 500	3 000	3 400	2 750	00.30
Spain	2 489	2 428	2 423	2 418	2 440	00.27
Madagascar	1 900	1 821	1 506	1 730	1 739	00.19
Australia	1 334	1 304	1 343	1 378	1 341	00.15

Others	--	---	---	---	---	00.67
WORLD	679 556	884 654	1 023 865	1 057 566	911 410	100.00

Source:FAO web page

Pistacia vera is grown 30-40 altitude and suited in microclimate areas in the world. The biggest (420 000 ha) production areas belong to Iran. Second country is Turkey. But its yield is very low when compared the production areas (Arpaci et al., 2005). This situation makes the scientist to think about the problems and solutions.

Pollination

Pollination occurs by the transport of pollens from male to female trees by wind. Pistachio flowers have no petals which attract insects. Therefore pistachio orchards must contain male trees and ratio of male to female should be 1/8 or 1/11 (Kaska, 1990, Ak,1992). It is necessary to have enough male trees to insure adequate pollination. Male and female flowers of pistachio are on separate trees. This situation has been recognized since 1697, (Whitehouse and Stone, 1941) that means pistachio trees (*Pistacia vera* L.) are dioecious. However male tree number can be enough in orchard. But, pollen shedding time should be with female flowering period. (Ak et al., 1998; Ak, 2001).

Rootstocks

In Turkey, there are four common *Pistacia* species (*P.vera*, *P.atlantica*, *P.khinjuk*, *P.terebinthus*) used as rootstocks. Except *P. vera* the others are not used commonly as seedling because of their low percentage of seed germination. According to observation, Siirt cultivar seeds have better growth and development than the other cultivars.

P.vera seedlings are stronger and more homogenous than the other rootstocks. Budded trees'on this rootstock grow slowly during the first year but growth becomes faster in the following years. There is no incompatibility in budding with cultivars of pistachio. In the budded trees the juvenility period lasts long; therefore, the trees bear fruit quite late. In arid zones the trees reach the bearing stage 15 to 20 years after planting. They can withstand drought, high lime content and salinity in the soil but are sensitive to high soil moisture. The trees of *P.terebinthus* are grown generally as bushes. The plant has a strong and deep root system. Therefore it can be grown in poor rocky and stony soils. It is a kind of dwarfing rootstock for *P.vera*, L. so the trees budded on this rootstock can be easily recognized. *P.terebinthus* is as hardy as *P.vera* but hardier than *P.atlantica*. Therefore it is preferred to *P.atlantica* in cold areas. In Turkey it can be grown successfully at elevations up to 1200 m. *P.terebinthus* is suitable for planting in calcareous soils along the Mediterranean coast. It grows very well in places where the annual precipitation is about 400 to 600 mm (Kaska, 1995).

Irrigation

James (1993) stated that between 60 and 95% of living plant biomass is water. Although plants need water primarily for transpiration, it also require water for other processes including photosynthesis, transport of minerals, structural support, and growthPistachio orchards were established in dry and unirrigated lands in Turkey besides the soils are very bad, unfertile and calcareous. The farmers believe in that pistachio should be grown without irrigation so far. This idea comes from their grandfathers. These old men have a bad experience about this matter. Because they were irrigated the result pistachio trees were died. And they teach this knowledge to their sons. But this situation had been occurred by wrong irrigation method. However last decades Research Institutes which are depend on Ministry of Agriculture, Universities start to make experiment on irrigation researches of Pistachio trees. Now, the positive effects of irrigation are told to farmers. The region where pistachio is

growing areas have not irrigation facilities until 1980's. Now in Southeast Anatolia project (GAP) provide to irrigation facility. The water is distributing by control. In the very near future new and irrigated pistachio nut orchards in the Southeast Anatolia Project (GAP) region will expand Turkey's pistachio nut areas. It is expected that when the project is completed the Turkish pistachio nut production will be at least doubled. As it is well known that irrigation is a very important factor in obtaining high yields on good quality.

In order to preserve the water from the winter and spring rains and snows, the soils are ploughed in Autumn. On the other hand in order to prevent evaporation, the soils are cultivated by chisel ploughs in whole spring and summer months. This type of soil workings destroy the weeds as well (Kaska, 1995).

As it is well known, some expected changes by irrigation, leaf size, number of current year's shoot and length of shoot will be increased. The result with irrigation increasing the yield, bigger nut size, high splitting percentage, low blank nut rate and lesser alternate bearing will be obtained. Arpacı et al., (1995) determined that in irrigated conditions with Siirt cultivar's yield 262 kg/da while 60-80 kg/da in dry conditions. This experiment shows that yield will be increased at least three or four times when pistachio orchards were irrigated.

As it is mentioned above pistachio orchards established under dry and very bad soil conditions. But, high yielding can be obtained irrigated and fertile soil conditions. According to Ak and Agackesen (2003) reported that pistachio trees should be established under irrigated and fertile or good soil conditions to get high yield and quality. The yield is compared. The yield of Kirmizi pistachio cultivar either fresh weight or dried weight in good conditions that means irrigated and fertile soil is higher than other conditions. As it is seen fertile soil without irrigation is better than poor soil with irrigation. The very important obtained results as below:

(i) Fresh fruit weight was determined in arid soil irrigated conditions 21.80 kg, unirrigated conditions 15.50 kg. The yield were obtained fertile soil irrigated conditions 31.00 kg, unirrigated conditions 25.87 kg, respectively. 1 kg fresh fruit was determined 559.63 g after sun dried. According to this calculation, the highest dry weight was determined 17.043 kg per tree grown under fertile soil at irrigated conditions. (ii) The shell splitting rate was determined analyzing 300 fruits each tree. According to results of arid soil irrigated conditions 58.89 %, unirrigated conditions 37.45 %, at fertile soil 61.43 % obtained irrigated conditions, 61.10 % unirrigated conditions. The blank fruit rate was lowest, shell splitting and total filled fruit number rate increased with irrigation. (iii) 100 fruit weight determined the highest value under fertile soil irrigated conditions in splitted fruits. 100 fruit weight was determined statistically different from each others. Fruit weight and kernel weight were increased with irrigation. General average were obtained 86.64 g in nut, 44.37 g in kernel.

Blank or empty nut can be occurred by lack of pollination and fertilization. But mainly irrigation can effect to fill in. Irrigated condition blank fruit rate was 17 % when unirrigated trees were 30 % averagely. Likewise poor soil was 29.71 % while fertile soil 17.70 %.

Irrigation has been started but to apply suitable irrigation method is very important. Generally it should be drip irrigation system. This may be lying on soil surface or lying or buried sub soil sytem. There are advantages and disadvantages both systems. The amount of water is the key factor to prevent the trees from diseases.

Irrigation by underground drip systems are being used on olive plantations in Spain. This system has been started to be used for pistachio and almond orchards in Turkey. However farmers are not confident with this method. The advantages of underground drip irrigation system are mentioned as follows: lower water consumption, better water distribution, greater uniformity, waste water can be used, less evaporation, greater transpiration, location of fertilizer, less calcification, less diseases, possibility of tillage, The depth of the watering line is at approximately 20-25 cm deep, under the soil surface. This sytem is applying in Iran

because of lack or due to limited water. Excessive water or weak drainage systems or very high water table kill the trees (Figure 1).



Figure 1. Excessive water kills the pistachio trees.

Fertilization

The soil in area under pistachio plantation is mostly inadequate to N, P, K and organic matter. A survey conducted in 30 pistachio orchards in Southeast Anatolia, Tekin et al., (1985) revealed that in many orchards the trees were markedly deficient in phosphorus and zinc and slightly deficient in nitrogen, iron and manganese. The level of potassium was found adequate in many orchards though there were some districts where the trees showed slight deficiencies. In this region pH of the soils varies between 7.5 and 9.3 and the organic matter content is very low. Especially zinc deficiency effects on fruit set (Ak and Parlakci, 2006).

Crane and Maranto (1988) claimed that pistachio is not a luxury N consumer when it is abundantly available in the soil. Chemical form of nitrogenous fertilizers should be chosen depending on the soil pH. For instance, in the GAP (Southeast Anatolia Region) area only ammonium sulfate is recommended as a source of N because of the alkaline soils. Nitrogenous fertilizers should be given at the end of February or the beginning of March at the rate of 1.5 to 4 kg per tree (Kaska, 1995). In U.S.A. boron plays a unique role in pistachio. Responses to foliar B application include increased pollen viability and germination rate, increased fruit set and yield, decreased blanking percentage and increased leaf B concentration (Brown, 1995a). Generally nutrient statutes of pistachios should be criticized according to leaf analyzes. Leaf samples should be taken 16-31 July by Tekin et al. (1990).

Cultivars And Harvesting

The most important characteristics of the pistachio nuts desired by the markets are the should be; large size, high percentage of shell splitting, low percentage of blank nuts, high oil and protein content, regular bearing, high percentage of green kernels. In pistachio green kernel is one of the most desired characteristics. Green kernel nuts are always at a premium. Though the green kernel is a varietal characteristic it is also related to altitude and harvest time. Generally the nuts of early harvested trees and plants grown on high plateaus produce greener kernels than those of late harvested and low land grown plants. On the other hand greenish is affected by pollen source. According to observation *Pistacia terebinthus* pollens causes metaxenia and xenia (Ak, 1992)

There are major cultivars each main producing countries. According to Sheibani (1995) there are 60 named cultivars in Iran. But main production cultivars are Ohady and Kaleh Ghochi. In Turkey, Kirmizi, Uzun, Halebi and Siirt are the major cultivars.

Alternate bearing is one of the important features of pistachio. Alternate bearer cultivars produce heavy crops in "on" years and little or no crop in the "off" years. In contrast to other fruit species such as olive, apple etc (Ak and kaska 1992). This situation can be change from

one cultivar to another one. For example Siirt variety is less alternating one (Ak, 1998). This means the tendency of alternate bearing of cultivars different. This can be decreasing by irrigation and fertilization.

Pistachio is harvested from late August to late October depending on cultivar maturation. During maturation the under colour of exocarp changes from a light green to pale straw or whitish, opaque appearance. The hulls can be removed from the fruits by being squeezed between the fingers. Another sign of maturity is splitting of shell. Decreasing in fruit removal force. Kernel dry weight and crude fat content are increase (Ak, 1998).

Conclusions

Pistachio nut culture is centuries old in Iran, Turkey and Syria. In this country the area under pistachio nut is the largest and the number of trees is the highest in the world. In spite of these facts the production is very low in Turkey and Syria. But the taste is good but the nuts are small and their splitting percentage is low. However, one should bear in mind that Turkey is the only country in the world that pistachio nuts are grown in such marginal lands with dry climate and poor, rocky and calcareous soils (Ak, 2002).

Turkey is full of other types of *Pistacia spp* called as wild pistachios. The topworking has done in 1980's. These trees are on the hill or mountains as irregular orchards. Some of them are very small, some of them not applied cultural practices. This situation makes the total yield very low. But These areas are not suitable for other agricultural crops. Because of this reason this type of areas gain as valuable. Except this situation the regular orchards will be supported by government of Turkey and growing techniques will change to modern system. On the other hand, Turkey has very important advantage about aflatoxin. Because of low humidity and high temperature during growing and harvest season, the fruits are free from aflatoxin. It can be seen or contaminate during processing. Processing systems are also modernizing. That means Turkish pistachios has no aflatoxin and high quality about flavour and taste. Turkish cultivars are preferred in many European and U.S.A. markets due to their good taste and uniformly green kernels (Ak et al., 2016).

The researches had been showed that effects of irrigation 70 %, fertilization 50 %, variety 45 % and light pruning 17 % on yield of the pistachio trees . Pest and disease problems should be solved using chemicals wisely. The ecology of the tree is changing by irrigation so the pest which economically important types is changing as well. Near future, when the problems are solved pistachio will gain big importance such as hazelnut in the world. Turkey's production will be increased three or four times when irrigation system established all the pistachio orchards either old trees or young new plantations.

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