



THE EVALUATION OF THE AGRICULTURE OF HAZELHAZELNUT IN DUZCE ACCORDING TO CLIMATE PARAMETERS

Mücahit COŞKUN¹⁺
Erol SÖZEN²

¹Assoc. Prof. PhD. Karabük University, Geography Department, Turkey
²Assistant Prof. PhD. Düzce University, Faculty of Education, Turkey



(+ Corresponding author)

ABSTRACT

Article History

Received: 28 November 2016

Revised: 29 December 2016

Accepted: 9 February 2017

Published: 7 March 2017

Keywords

Hazelhazelnut
Climate
Agriculture
Düzce
Turkey.

Agriculture is a highly important economic activity in the world. Among the agricultural products of Turkey, hazelhazelnut is an important product for Turkey's economy. More than 60 percent of the world hazelhazelnut production is made in Turkey. In this study, hazelhazelnut production in Düzce is examined in terms of possible climate effect in future. Because, Düzce is one of the important provinces in hazelhazelnut production. In th study, as a method, descriptive survey model has been used. In this method, existing situation on a subject is interpreted by searching. For this purpose, interpretation has been made by taking datum as to research from Ministry of Food, Agriculture and Livestock and Turkey Statistical Institute. These datum have been compared with weather data. In Düzce and in Turkey, hazelhazelnut production changing by years has been determined. It is seen that the largest factor to this is unexpected freeze and change of rainfall. It is reasoned that possible temperature increase in future and the effect of drought in Turkey and in Düzce that can effect agriculture of hazelhazelnut. Because, hazelhazelnut is selective and sensitive plant in terms of climate.

Contribution/ Originality: In the study, it has been evaluated hazelnut production of World and Turkey by comparing. Besides, in Düzce it has been contacted between hazelnut production and climate parameters. From this aspect, this study is the first in geography area.

1. INTRODUCTION

Agriculture is an activity that enables humans to make use of natural sources like plants, animals, water and forest in an economic manner for production in order to cover their needs. With agriculture, humans cover their needs such as food, clothing, and accommodation. According to Çalıřkan *et al.* (2012) depending on the fast population increase in the world the hunger problem, which is experienced in some countries in today's world and which has the risk of appearing in some other countries in the future, worries the societies all over the world. This trouble has brought the opening of the areas that were once considered as being infertile to agriculture, and applying new techniques that might increase the production rates in current arable areas. Agriculture means

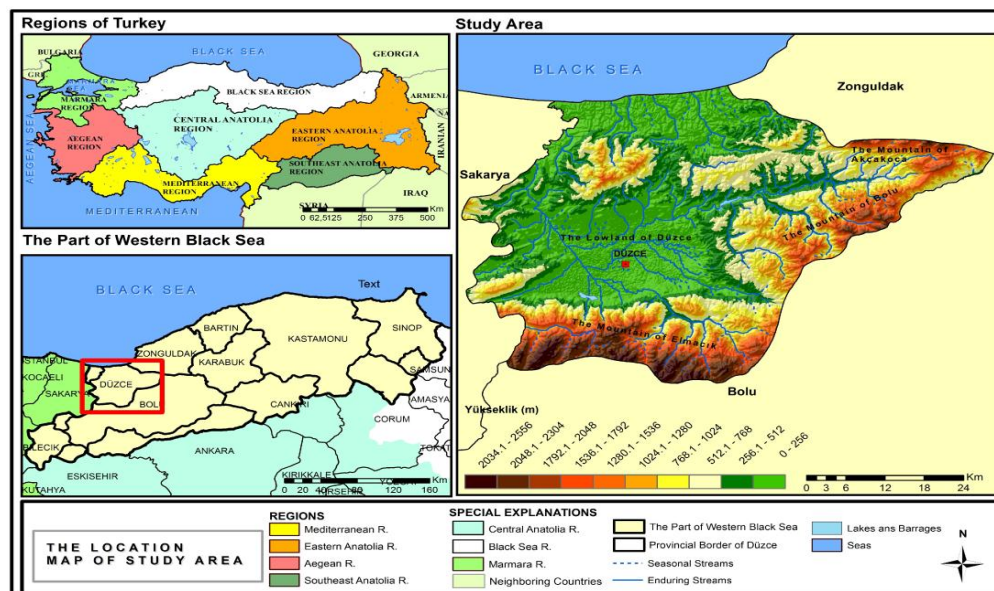
performing the production for industry. It has become an important element for labor force, capital, raw materials and trade by guiding the service sector. The share of agriculture in Gross National Product (GNP) is over 10% in Turkey. Hazelnut is one of the important agricultural products in the economy of Turkey. It is grown widely in Ordu, Giresun, Sakarya, Trabzon, Samsun and Düzce.

In this study, the purpose is to explain the possible effects of climate change stress, which stems from the changes in the climatic parameters, in Düzce, which is an important city in the cultivation of hazelnut. For this purpose, firstly, the present status of hazelnut production in Turkey and in the world is explained. Then, the situation in the face of climatic parameter changes and the share of hazelnut cultivation in Düzce within the total production rates in Turkey are explained, and the conclusions and recommendations are made. Some of the studies conducted on the cultivation of hazelnut in Turkey are as follows in chronological order: Açıktur (1996); Bozoğlu (2003); Özcüre (2006); TMO (2010); Çalışkan *et al.* (2012); Doğanay (2012); Güngördü (2012); Özcüre (2012); Siray (2013). The determination of possible effects of the changes in climatic parameters on hazelnut cultivation in Düzce in the past years makes the study become even more important.

2. STUDY AREA

The city of Düzce is located in the Western Black Sea part of the Black sea Region of Turkey. It is one of those cities that have coastal areas to the Black Sea (Map 1). Düzce is surrounded with Sakarya in the West, Bolu in the South and East, Zonguldak in the Northeast. Düzce has a coastal area of 35 km in the Black Sea. The surface area of the city is 2574 km².

The population of the city was 360.388 people in 2015, and 181.197 of this population was male, 179.191 was female. The annual population increase of the city is 1.20 in average. The city has several parts and counties which are; the Centrum, Akçakoca, Kaynaşlı, Gölyaka, Çilimli, Yığılca, Gümüşova and Cumayeri. The Ministerial Cabinet gave permission for hazelnut cultivation in 16 cities with the law “Planning of Hazelnut Cultivation and Determination of Planting Areas”. Düzce centrum and all of its counties are included in these areas that are allowed for hazelnut cultivation.



Map-1. Location of the City of Düzce

Source: www.viewfinderpanoramas.org/ / [accessed: 20.10.2016](https://doi.org/10.1016/j.ijars.2016.12.001) (DEM were generated from data downloaded and ESRI Documents)

3. MATERIAL AND METHOD

Firstly a literature review was made in the study. Then, the climatic properties of Düzce were determined in the light of the data received from General Management of Meteorology. In preparing the cartographic material of the study, the ArcGIS 10.3 GIS (Geography Information System) package program was made use of. In addition, relevant data were received and interpreted from TUIK, Ministry of Food, Agriculture and Animal Husbandry, TMO and General Management of Meteorology.

The descriptive review method was made use of in the study. In this method, a situation on a topic is investigated and interpreted. These kinds of research are conducted by collecting systematic and regular information on the study topic. In a descriptive study, the aim is to reveal the existence or inexistence of a certain situation. The results of descriptive studies, the tables, graphics are interpreted, and the issue of whether there is a correlation between the variables or not is investigated (Arseven, 2001). Graphics and percentage tables may be made use of. The descriptive surveys try to explain what certain properties of events are in a one-by-one manner, or explain how two or more attributes are at relational level.

4. FINDINGS AND DISCUSSION

4.1. The Ecology of Hazelnuts and the Properties of Cultural Species

Hazelnut is a husked fruit and belongs to the *Corylus* species in *Betulaceae* of the *Fegales*. Mamkoğlu (2011) stated that hazelnut was a plant that made more than one trunk, and it rarely had 50-60 cm diameter, and with these properties it was accepted to have the qualities for being considered as a tree. A hazelnut tree is a bushy tree and loses its leaves in winter, has a wide top and may have a height of 6-7 meters. It is observed very rarely and it has a height of 15-20 m. An important part of the hazelnut types that are taken under culture production in Turkey are the hybrids of *Corylus maxima* and *Corylus avellana*. These species still spread naturally in humid forest media in bushy form as a forest fruit. It is stated in historical documents that hazelnuts were produced 2300 years ago in the Black Sea shores in the northern part of Turkey. It is known that hazelnut has been exported to other countries for the past 6 centuries from the Ottoman period until our present day.

Since the hazelnut tree under culture production has problems in growing in smooth areas because of the lack of ground water, the areas that have an inclination at a rate of 5% are the best production areas for hazelnut. The hazelnut tree likes loamy soil, humus and the soil types that are rich in plant hazelnutrients as the texture of the soil to grow in. It is important that the pH level of the soil is between 5,5-7. In case the values are below or over this limit, the hazelnut tree cannot grow well in the desired amount.

Since the hazelnut tree is a plant of areas with a good precipitation, it has a fibrous root system. The roots may develop in the direction of the slope and towards the sides at a rate of 2-3 m; or opposite the slope at a rate of 1-1,5 m; or in plain areas, towards any direction at a rate of 2-3 m. Although 70% of the roots are located in the 15 cm in the soil, it is ideal that the depth of the soil is 80 cm for the purpose of covering the water and hazelnutrients in dry periods, and to hold the plant against winds and snow piles.

The precipitation in our country is over 700 mm, the areas where precipitation regimen is distributed regularly over months cover the water needs of the hazelnut tree. The temperature and humidity demands of the hazelnut tree are between average temperature 13-16°C, when the minimum temperature does not go below -8 and -10°C (*at -15°C, the branches of the hazelnut tree dies completely*), and when maximum temperature does not exceed 36-37°C. The relative humidity must not fall below 60% during summer months, which is the ideal medium for hazelnut cultivation. In places with high humidity, hazelnut cultivation gives better results. In areas where the temperature drops below 2°C, the yield is lower. In addition to the abovementioned climatic conditions, the hazelnut cultivation is made in an economic manner where the elevation is between 0-750 m. It is possible to claim that the cultivation of hazelnut is not economic in areas that are over 750 m because late frost events are experienced more frequently in these areas and there are lower temperature values. These areas are considered as the examples of misused fields.

The hazelnut types that are cultivated in an economical manner are in the form of branches, and they may grow up to 5-6 m when they find proper ecological conditions. However, the most important thing in the cultivation of hazelnut is the sideward development of the branches and the twigs rather than the vertical growth of the tree; and the tree must have fruits from the branches that are higher than 50 cm from the ground to the top. For this purpose, the plants must receive adequate light.

There are three groups of hazelnuts, which are *round hazelnuts*, *sharp hazelnuts*, and *almond hazelnuts*. The most commonly cultivated type is the round (plump) hazelnut. The hazelnuts are divided into classes in commercial and quality terms which are *Giresun Quality* and *Levant Quality*.

Giresun Quality: The round and the plump hazelnut that are cultivated in the whole of Giresun, and the ones grown in Beşikdüzü, Vakfikebir, Çarşıbaşı and Akçaabat counties of Trabzon. The highest quality hazelnuts in the world are grown in these areas.

Levant Quality: This is the name given to all hazelnut types grown in areas except for the Giresun Quality hazelnuts. These hazelnuts are named after the areas where they are grown, like Levant Akçakoca (Düzce), Levant Ordu, Levant Trabzon and Levant Samsun; and although they contain less plump than the Giresun Quality hazelnuts, they still have plump more than the other countries and are more delicious than them.

It is known that the history of the cultivation of hazelnuts is based on ancient times along the Eastern Black Sea Region, and the cultivation started in other areas by the people who migrate from these areas. In newly-established gardens, The Çakıldak Hazelnut, which is common in Ordu, has several qualities like high yield. It is not influenced by late frost events in spring and is not selective in terms of the soil to grow in. It can grow even in high areas although the taste and plump quality of it is lower than the others (the plump rate of the round hazelnut is 69-72% while it is 58-63% in Çakıldak Hazelnut). This is preferred by the producers in new gardens because it is an attractive type with the abovementioned properties. It is called Delisava in Western Black sea Region, and has another characteristic, which is the lower need for light when compared with the other types. For this reason, it is possible to receive a good yield even in gardens that are not cared well. With all these superior characteristics, it is cultivated widely in the Western Black Sea Region.

4.2. Hazelnut in the World and in Turkey

Turkey ranks the first in Hazelnut production in the whole world with nearly 65%. Nearly 80% of the hazelnuts produced in Turkey are grown in the Black sea Region. Although it varies between years, the top 5 cities where hazelnuts are produced at the highest rates are Ordu, Giresun, Samsun, Düzce and Sakarya. These 5 cities produce nearly half of the world hazelnut production. There are more than 350 million hazelnut trees in Turkey. The planting areas are around 650 thousand ha (<http://www.fiskobirlik.org.tr/findigin-kullanim-alanlari/>). Hazelnut is used in chocolate industry, biscuit, candy, sweet, pastry and ice-cream industries at a rate of 80%. In addition to these, it is also used for oil production for cooking and as eating for pleasure i.e. appetizer. Its shell is used as firewood, in contralite production, and in paint industry. Its leaves and involucre are used as fertilizers in hazelnut gardens and in cultivation areas.

Hazelnut cultivation is generally performed in small areas in Turkey as family businesses. Hazelnut cultivation has been the field of commercial activity for about 400 thousand farmers in an area more than 600 thousand hectares in Turkey. It influences more than 6 million people in Turkey directly or indirectly (Özcüre, 2012; Siray, 2013). The production and commerce of hazelnut have had a great importance in the economy of Turkey since very old times. The dried form -whether it is hulled or not- is among the traditional products of Turkey sold outside Turkey. It is one of the three important products in the foreign trade of Turkey together with cotton and tobacco. This is a result of the rank of Turkey in the world as the first hazelnut producer (Doğanay, 2012). The hazelnut is wrapped with a hard shell and may be consumed both as a fresh fruit and as a dried fruit, and it may also be consumed as an additive in chocolate making, or in various creams, smashed appetizers and in similar forms. It is a

hazelnutritious food for human diet. It is rich in proteins and vitamins, and the fruit contains 60% and 80% plump, 12% and 14% protein, and 12% carbohydrates (Açkurt, 1996).

Turkey is the first country in the world in terms of hazelnut production. Nearly 65% of the hazelnut production in the world is covered by Turkey every year. Italy, Azerbaijan, USA, Georgia and Spain come after Turkey in hazelnut production in the world (Table 1). Climate is an important factor in the fluctuation in hazelnut production in years. Late frost events in spring are also among the major reasons for the fluctuation in hazelnut production.

Table-1. Hazelnut Production in the World (Tons)

	2010	2011	2012	2013	2014	2015
Turkey	600000	430000	660000	549000	412000	646000
Italy	107000	140000	84000	132000	100000	125000
Azerbaijan	39000	55000	40000	30000	25000	50000
USA	24500	35000	32000	35000	36300	43500
Georgia	40000	30000	28000	35000	35000	40000
Spain	20000	22000	16000	19500	19500	20000

Source: Turkey: TUIK Other Countries: FAO 2015, INC (International Hazelnut Council)

Turkey is the country with the highest rate of cultivation area for hazelnut in the world. The most important factor in this is the fact that the ecological conditions of Turkey fit this plant (Table 2). Ordu and Giresun are monoculture areas as a planting area for hazelnuts in the Black sea Region. It is a condition to have hazelnut production areas as well as to have quality hazelnuts in the world. Turkish hazelnuts have these requirements in the world in this sense.

Table-2. Hazelnut Production Areas in the World (Ha)

Years	Turkey	Italy	Spain	Azerbaijan	USA	Georgia	Other	Total
2003	571791	68113	21583	17812	11331	5500	28143	724243
2004	614993	67506	20590	17971	11502	4600	38426	775588
2005	622525	67743	20343	18228	11432	9000	41044	790345
2006	629798	69685	20000	17379	11462	13000	39848	801172
2007	663817	72314	16802	19994	11574	12000	40000	808900
2008	663192	71050	15411	21577	11493	10000	32500	830635
2009	642866	70526	14536	22193	11614	12000	33000	841333
2010	667865	55904	13802	22691	11736	15000	34900	870331
2011	696964	70492	14067	23242	11938	15500	35100	903864
2012	701407	57992	14000	23768	11890	12400	37186	878643
2013	702144	70492	15000	23250	11462	15500	40000	877840
2014	701141	71200	15000	23000	12500	18000	43350	904191

Source: Turkey: TUIK Other Countries: FAO 2014 Data: Turkey-EU Hazelnut Counseling Meeting 2015

Turkey ranks the first in the world in hazelnut production, and has the biggest share in exporting hazelnuts (Table 3). Turkey exports hazelnuts firstly to Germany (25,23%); Italy (20,25%) and France (10,21%) (<http://www.ordutb.org.tr/pdf/FINDIK%20IHRACATI%20/>). The most important reason for this is the fact that these countries have a developed chocolate industry. Turkey exports the majority of its hazelnuts in hulled form because EU has 3% customs duty for husked hazelnuts (Özcüre, 2012; Siray, 2013). Turkey ranks the first in hazelnut production in the world according to the average data of 2001-2011 with over 65% share. Turkey has an important share in hazelnut trade; and received a profit from hazelnuts at an amount of \$1,8 billion in 2012. According to the average values of 2002-2012, the share of hazelnut and hazelnut products in the agricultural sector in Turkey was 12,45% (Özcüre, 2012; Siray, 2013). Hazelnuts are grown in nearly 650 thousand hectares of land in Turkey by nearly 400 thousand families; and more than 1700 tradesmen perform hazelnut trade, and

hazelnuts are processed in 156 factories. It is obvious that hazelnut production is an important sector in Turkey (Bozoğlu, 2003; Özcüre, 2006).

Table-3. The Place of Turkey in Hazelnut Production in World Trade

Year	Production of Turkey (Tons)	Production of the World (Tons)	Turkey's Share (%)	Turkey's Export (Tons)	Turkey's Export Revenue (\$)
2001	625000	879705	71	257548	636027000
2002	600000	883651	72	259522	593690721
2003	480000	680266	70,6	223562	915616061
2004	350000	615521	56,9	194811	1554156298
2005	530000	759244	69,8	240840	1952767266
2006	661000	964765	68,5	248664	1262427049
2007	530000	815300	65	207289	1589547748
2008	800791	1069889	74,8	244630	1178101490
2009	500000	775956	64,4	213141	1378691431
2010	600000	855718	70,1	281333	1783567587
2011	430000	743000	57,9	229628	1819725208
2012	660000	885000	74,6	310963	1750439804
2013	549000	825000	66,5	267642	1981441719
2014	450000	660773	62,4	192150	2314253067
2015	646000	867647	68	240137	2827316418

Source: Ministry of Food, Agriculture and Animal Husbandry, Ministry of Customs, Export Unions, Fiskobirlik, Hazelnut Stock Exchange, TUIK, INC (International Hazelnut Council).

Italy, USA, Azerbaijan, Georgia, and Spain have important shares in hazelnut production as well as Turkey in the world. The mild (temperate) climate of these countries ensures the cultivation of hazelnuts. The amounts of production in these countries are given in Table 1.

As it is seen in Table 2, the areas where hazelnut is grown are inclined to increase in the future. This may be explained both with the increase in hazelnut production and with the improvements in the industry based on hazelnut such as chocolate industry. In addition, the export of hazelnuts by Turkey and the related revenues show a general increase. The economy that is based on hazelnut has a constant inclination to increase.

4.3. Hazelnut - Climate Relation in Düzce and its Vicinity

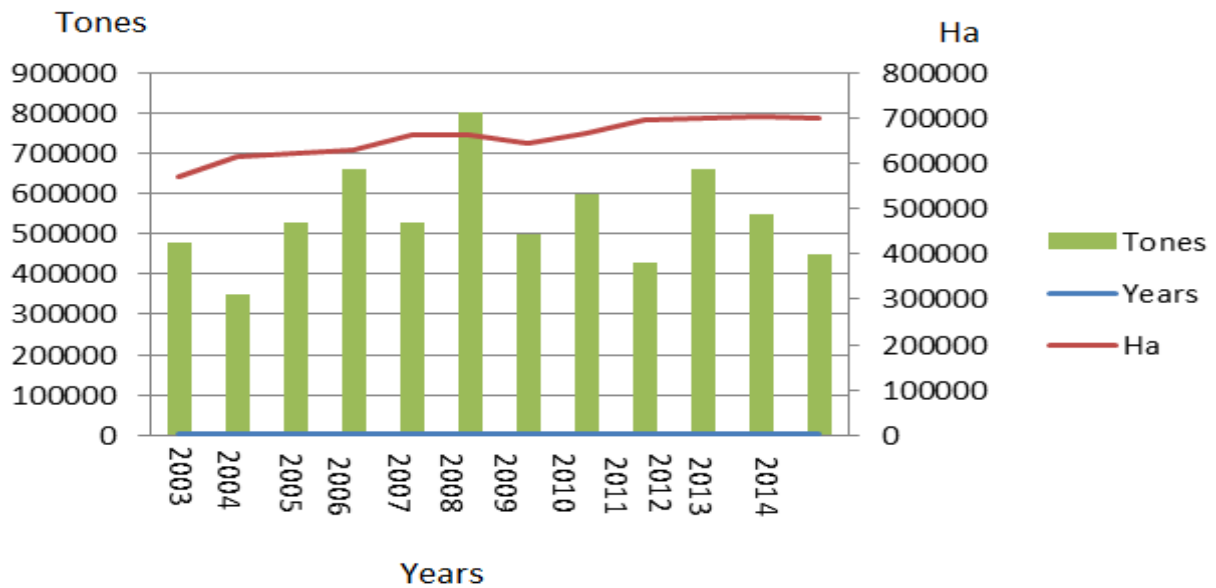
The temperature and precipitation values in and around Ordu and Giresun where hazelnut is grown with monoculture method are at adequate levels. For this reason, it is possible to claim that the ecological demands of hazelnut have been obtained at optimum values in Ordu and Giresun. In addition to these, Ordu, Giresun, Samsun, Sakarya and Düzce where hazelnut production is at the highest rates have similar values in terms of their temperature regimes. The average temperature in winter in these cities is around 5-8°C, in spring around 12-14°C, in summer around 21-24°C and in autumn around 16-18°C.

The annual precipitation amounts in Ordu and Giresun are higher than the annual precipitation values of Düzce (Düzce; 822mm, Ordu;1035mm and Giresun; 1266 mm). However, among these cities, Düzce is the hazelnut production center which has the lowest winter temperatures. The average temperature in Düzce in December is 5,8°C; in January 3,8°C; and in February 5,2°C. The average winter temperature value in the other cities is at and over 7°C. Summer temperature values of Düzce show similarities to the ones of the other cities. In terms of temperature values, Düzce is actually in the limit values when compared with the other cities. The temperature values below the current ones might produce negative influences. A possible temperature and precipitation change in Düzce may influence agriculture and therefore the hazelnut production (Sözen, 2016). When the past 56 years' process when climatic records were kept at a regular basis is examined in Düzce, it is observed that the average temperature values and precipitation values have changed according to the Düzce Meteorology station data. While

the temperature values increased, the precipitation amount had the inclination to decrease. This situation is shown in Tables 5-6 and Graphics 2-3 below. Similar increases in the temperature values were also determined in minimum and maximum temperature averages. According to these data, Düzce is inclined to become a warmer and drier city in the future years.

The increase in the temperature may shorten the ripening period of hazelnut, and thus, bring the harvest time forth. However, if the precipitation decrease becomes significant, and if the temperature values increase, the optimum values that are demanded by the hazelnut may be lost, which will result in disrupted yield and quality values. In addition, the increase in winter average temperatures might bring the blooming period of the hazelnut trees forth. The blooming period of the hazelnut tree may swift to early March or late February. This situation will increase the risk of the trees to be affected by frost and might damage the blooms. In interviews made with the Provincial Agriculture Management officials, it was learnt that the period in which the hazelnut tree received the highest damage was the years when winter temperatures were over the average values. In case the annual average values continue to increase, the blooming period may occur earlier. This situation may cause that the production is influenced more by the frost events in February and March.

The frost events observed in hazelnut trees gave rise to the Agricultural Insurance system in Düzce and its surroundings, and the farmers insured their products. In 2013 and 2014, both the Provincial Agriculture Management and insurance company officials investigated the fields for frost damage. It was understood that there was 15% loss in the product rates in 2013, and 30% in 2014. The year 2008 was the most productive year in terms of the yield in hazelnut production. When Table 4 is examined it is observed that the hazelnut production decreased at an important level in 2013 and 2014 in Düzce.



Graphic-1. Turkey's Hazelnut production Amount and Cultivation Areas in Years

Source: TUIK (2016)

As it is observed in Graphic 1, the hazelnut production in Turkey differs between years. The yield changes occur between years mostly due to temperature values. Especially unexpected frost influences the production in a negative way, and causes that the production values decrease. It is also observed in Graphic 1 that the hazelnut planting areas show a regular increase. However, it is also clear that the amount of the hazelnut show variations in years. It is also clear in Table 4 that the production rates differ in cities through years. This situation stems from the characteristics of the hazelnut tree as well as from unexpected frost.

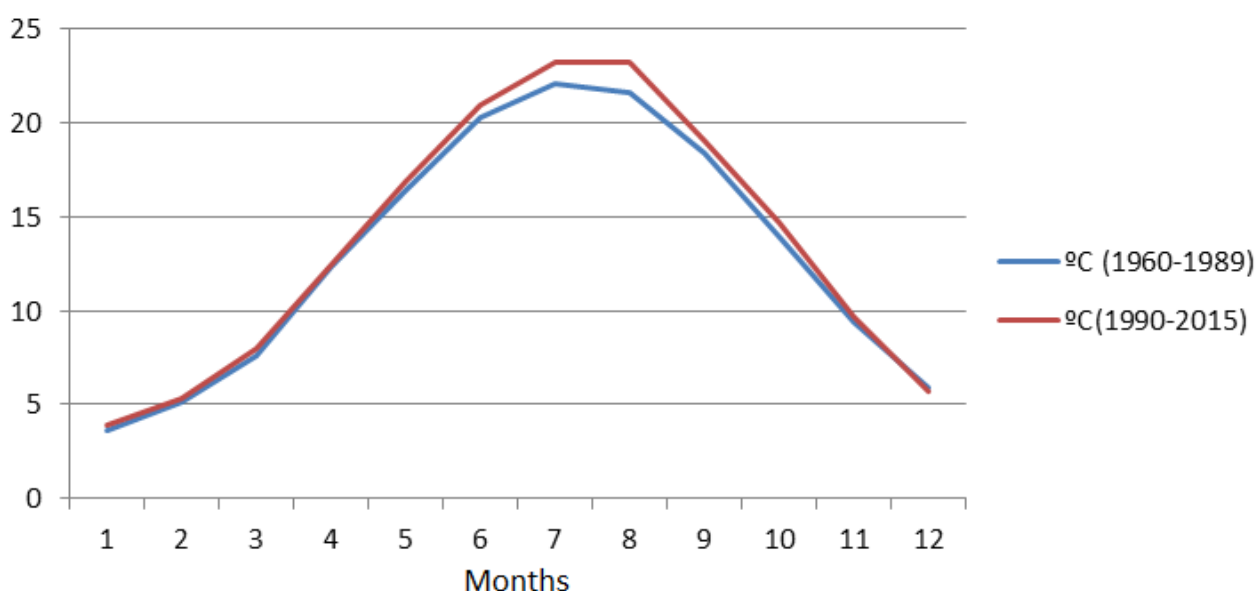
Table-4. Turkey's Hazelnut production according to Cities (tons)

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Ordu	188060	140300	210583	91758	206605	99881	145353	178357	88874
Giresun	86723	64131	139764	76273	51567	67603	101532	81942	25237
Sakarya	113988	88295	115262	84012	94520	77500	118057	64500	84865
Samsun	79412	37714	115706	71656	82055	78500	88392	69392	65011
Düzce	78493	71213	90972	72689	67428	69500	81278	48295	56306

Source: TUIK

There are hazelnut cultivation activities in 34 cities in Turkey (Güngördü, 2012) and the Law 2844 enacted on Planning Hazelnut Production and Determining Planting Areas changed the hazelnut production areas many times, and eventually, the licensed hazelnut production areas were limited to 16 cities by the Ministerial Decree with the number 2014/7253. The city of Düzce, which is the study area, is also among these 16 cities. The purpose of this limitation is to protect the quality of the hazelnut, and regulate the amount of production.

The annual precipitation amount in Ordu, Giresun, Samsun, Sakarya and Düzce, which are prominent cities in hazelnut production, are as follows; Samsun: 706 mm; Düzce: 822 mm; Sakarya: 834 mm; Ordu:1035 mm; and Giresun: 1266 mm. These amounts are adequate for hazelnut production. In these centers, the precipitation regime is regular. There is precipitation at a regular basis in every season in every month in these cities. However, a possible increase in temperature and decrease in precipitation will influence the hazelnut production in Düzce. As of 1960, the meteorological records were kept at a regular basis, and when these records are examined it is observed that the temperatures have increased at a certain amount and the precipitation has decreased a little in the past 26 years (Sözen, 2016). When the data of Düzce meteorology station are examined (Graphic 2-Table 5) it is observed that the increase in the temperature in Düzce supports the idea that Düzce will become a hotter city in the future. In addition to this, when Graphic 3 and Table 6 are examined it is observed that annual precipitation amount has decreased in Düzce. Since Düzce is at the lowest optimum limit values demanded by hazelnut, the decreases especially in precipitation might affect hazelnut production in a negative way in the future. In addition, the increases in the temperatures might bring the ripening and the harvest times of the hazelnut to earlier times.



Graphic-2. Comparison of Temperature Changes in Düzce between 1960-1989 and 1990-2015 (Sözen, 2016)

Source: The General Directorate of Meteorology (<https://www.mgm.gov.tr>)

Table-5. Average Temperature Change in Düzce between 1960-1989 and 1990-2015 according to months and seasons (Sözen, 2016)

Months	12	1	2	3	4	5	6	7	8	9	10	11	Annual average temp. (C°)
1960-1989 temperature averages (C°)	5,86	3,61	5,18	7,6	12,3	16,41	20,24	22,04	21,06	18,4	13,9	9,44	13,0
1990-2015 temperature averages (C°)	5,75	3,94	5,32	8,0	12,38	16,86	20,89	23,02	23,16	19,06	14,73	9,7	13,56
Monthly temperature difference (C°)	-0,11	0,33	0,14	0,4	0,08	0,45	0,65	0,98	2,1	1,02	0,83	0,26	0,56
Seasonal temperature difference averages (C°)		+0,12			+0,31				+1,24			+0,70	

(Source: The General Directorate of Meteorology (<https://www.mgm.gov.tr>))



Graphic-3. Precipitation in Düzce for 1960-1989 and 1990-2015 periods in Months (Sözen, 2016)

Source: The General Directorate of Meteorology (<https://www.mgm.gov.tr>)

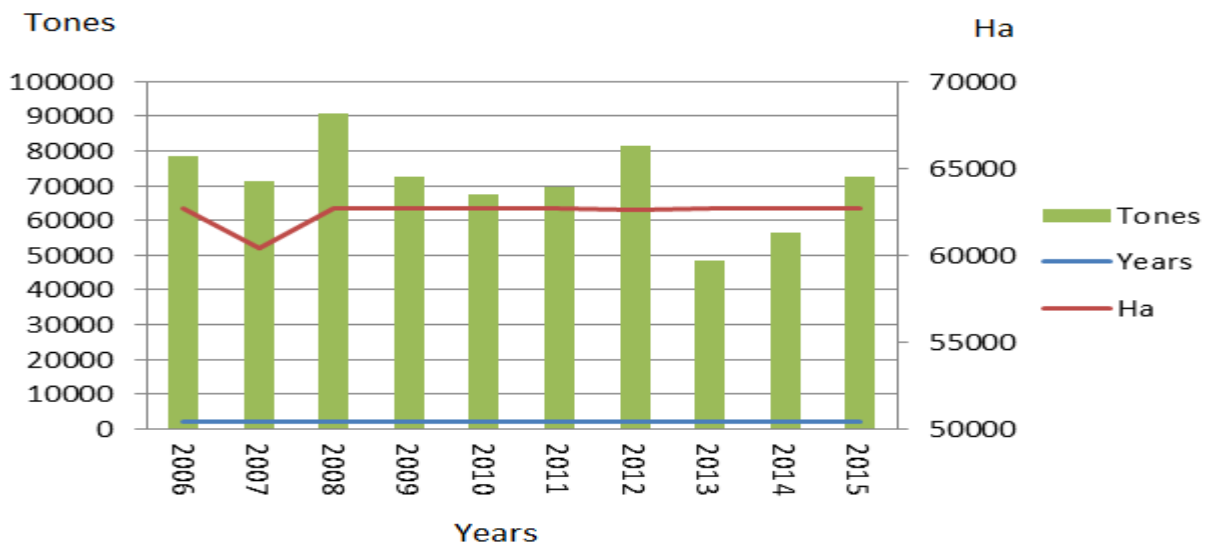
Table-6. Average precipitation change in Düzce in months and seasons for 1960-1989 and 1990-2015 periods (Sözen, 2016).

Months	12	1	2	3	4	5	6	7	8	9	10	11	Annual average precipitation (mm)
1960-1987 precipitation averages (mm)	112,95	92	69,14	70,58	57,23	65,4	53,85	47,81	56,58	46,06	77,73	89,81	69,9
1988-2014 precipitation averages (mm)	91,77	88,88	71,07	76,52	62,63	54,04	64,58	37,85	45,19	57,61	87,76	70,72	67,38
Monthly precipitation difference (mm)	-21,18	-3,12	1,93	5,94	5,4	-11,36	10,54	-9,96	-11,39	11,55	10,03	19,09	
Seasonal precipitation difference averages (mm)		-7,45			0			-3,60					13,55

Source: The General Directorate of Meteorology (<https://www.mgm.gov.tr>)

It is observed that there were no changes in the general distribution of the precipitation regime between 1960-1989 and 1990-2015. The highest precipitation was in winter and the lowest precipitation was in summer season. This situation in precipitation regime shows a difference from the Black Sea Region.

Between 1960-1989 and 1990-2015, the average precipitation in December, January and February decreased to -7,45 mm; however, there were no changes in the precipitation in these periods in spring months. In summer months, there was an increase at a rate of -3,60mm, and in autumn months there was an increase at a rate of +13,55mm. In this context, it is possible to claim for the precipitation regime that there was an increase at the average values only in the autumn, and there were no changes in spring; and there were slight decreases in average values in the precipitation in winter and summer. When the total precipitation average values for the 1960-1989 and 1990-2015 are compared, it is observed that the total average precipitation amount for 1960-1989 period was 69,9 mm; and the total average precipitation for 1990-2015 period was 67,38 mm. There was a decrease between the precipitation averages of these years in terms of monthly average values at a rate of 2,52mm, and in annual total values at a rate of 30,24mm. This decrease in the precipitation amount may be considered as being important. This situation may influence the hazelnut production in Düzce in a negative way.



Graphic-4. Hazelnut Production amounts and planting areas in Düzce in Years

Source: TUIK / <http://www.tuik.gov.tr>

When **Graphic 4** is examined it is observed that the hazelnut planting areas in Düzce have not changed a lot in the past decade; however, the production amounts differed at a great level in years. This situation stems from the characteristics of the hazelnut tree, which occur in the form of high yield in one year and lower yield in the other year and frost.

5. RESULT AND RECOMMENDATIONS

- Turkey is a country where hazelnut production and the hazelnut plant areas are at the highest level. In addition to this, the hazelnut grown in Turkey has an extreme quality. The climatic conditions are influential in this. Hazelnut is a selective plant in terms of climate.
- Hazelnut is extremely important in the economy of Turkey. The hazelnut export rates in Turkey are the highest levels in the world. The export to the countries whose chocolate industry is developed has a high rate. The demand and the need to the hazelnut are increasing with the increasing population all over the world. The changes in the supply-demand balance influence hazelnut prices and revenues that depend on the export of hazelnut in Turkey.

- Unexpected frost influences the hazelnut production in Turkey in a negative way. Since the hazelnut tree blooms earlier in years when winter temperatures are a little higher, the trees are damaged more by the frosts during winters. This situation causes that the production amount varies between years. In addition to these, the increases in the average temperatures in Düzce in recent years have increased the blooming period of the hazelnut trees, and now, this period occurs at an earlier time when compared with the previous years; which increases the risk of frost. The increases in summer temperatures will cause that the harvest is made earlier. On the other hand, the scarcity in precipitation will give rise to the loss of the proper conditions for hazelnut trees.
- Düzce ranks among the five cities in Turkey in terms of hazelnut production amounts. The climatic conditions are influential in this.
- Possible temperature and precipitation changes in the future may influence the hazelnut production amounts in Düzce and the harvest time.
- Early warning system for frost must be established to prevent the changes in hazelnut production in years, which occur due to frost during winter months. For this purpose, production areas must be followed with more care, and farmers must be trained to become more conscious.
- Current meteorology station has an elevation of 150 meters and is located incorrectly in terms of monitoring frost. Since Düzce is an important hazelnut production area, the number of meteorology stations must be increased and frost must be monitored more seriously.

Funding: This study received no specific financial support.

Competing Interests: The authors declare that they have no competing interests.

Contributors/Acknowledgement: Both authors contributed equally to the conception and design of the study.

REFERENCES

- Açkurt, F., 1996. Evaluation of nutrition in terms of nutrition and health. Tirebolu I. Fındık Festivali (6-7 Eylül 1996), Bildiriler, Tirebolu Belediyesi Kültür Yay. No: 2, İstanbul.
- Arseven, A.D., 2001. Field research methods (Principles Techniques Examples). Ankara: Gündüz Eğitim Yayıncılık.
- Bozoğlu, M., 2003. The possibilities of establishing the Turkish Hazelnut stock exchange and the fact of the hamburg stock exchange. Fındık Borsası Paneli, OMU Ziraat Fak. 8 Ekim 2003, Trabzon.
- Çalışkan, M., M. Atlı, H.C. Bilim, K. Sarpkaya and N. Kalkancı, 2012. The level of adoption and impact assessment of innovations and research results in pistachio enterprises. Gaziantep: Antepfıstığı Araştırma İstasyonu Müdürlüğü, Proje Sonuç Raporu.
- Doğanay, H., 2012. New developments in Turkish Hazelnut cultivation. Erzurum: Doğu Coğrafya Dergisi, 17 (27): 1-22.
- Güngördü, E., 2012. Geographical place planning and development relation. Ankara: Nobel Yayıncılık.
- Mamıkoğlu, N.G., 2011. Trees and bushes of Turkey. İstanbul: Doğu Grubu İletişim Yayıncılık.
- Özcüre, G., 2006. Fiskobirlik continues to suffer from late-night grievances despite sourcing. Ankara: Kuzey Noktası.
- Özcüre, G., 2012. Seeking solutions to the economic and social problems of fiskobirlik and hazelnut producers in the context of European Union agriculture policy compliance. Kent Akademisi. Kent Kültürü ve Yönetimi-Elektronik Dergi.
- Sıray, E., 2013. Hazelnut production and trade status. Eğitim Notları, Giresun: Fındık Araştırma İstasyonu Müdürlüğü.
- Sözen, E., 2016. The assessment of Düzce's temperature and precipitation averages after 1960 in terms of climate changes. INES, Side-Antalya. pp: 3629-3636.
- TMO, 2010. Hazelnut Sector Report.

BIBLIOGRAPHY

<http://www.fiskobirlik.org.tr/findigin-kullanim-alanlari/>, [accessed 25/10/2016].

<http://www.ftg.org.tr/tr/turk-findigi-turkiyede-findik.html/>, [accessed 28/10/2016].

<http://www.tzob.org.tr/Bas%C4%B1n>, [accessed 28/10/2016].

http://www.zmo.org.tr/genel/bizden_detay.php?kod=24516&tipi=17&sube=0, [accessed 27/10/2016].

<http://www.findikhracati.com/findik/findik-s%D0%B5ktor-raporu.html> [accessed 27/09/2016].

<http://www.tmo.gov.tr/Upload/Document/raporlar/findiksektor.pdf>. Accessed Tarihi: 09.09.2011

<http://www.ordutb.org.tr/pdf/FINDIK%20IHRACATI%20/> Accessed: 28.01.2015.pdf

<http://www.tuik.gov.tr/> / accessed: 15.10.2016

<http://www.esriturkey.com.tr/> / acces:19.10.2016

<https://www.mgm.gov.tr/> / acces: 29.10.2016

www.viewfinderpanoramas.org/ / acces: 20.10.2016

Views and opinions expressed in this article are the views and opinions of the author(s), International Journal of Sustainable Agricultural Research shall not be responsible or answerable for any loss, damage or liability etc. caused in relation to/arising out of the use of the content.