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Araştırma Makalesi (Research Article)

Climate Change and Effect on Yield Components of Opium Poppy

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Abstract

This paper was prepared from the poppy production data of Turkish Ministry of Food, Agriculture and Livestock, and climate data of Turkish State Meteorological Service. In this paper, it was stated how is affected the agricultural production by climate change. In accordance with this purpose, it was used the last five years production data of opium poppy and monthly weather temperature, precipitation and relative humidity data in the provinces producing opium poppy.

Keywords: Climate change, poppy production, Turkey, yield components

İklim Değişikliği ve Haşhaşın Verim Bileşenleri Üzerine Etkisi

Öz

Bu makale Gıda, Tarım ve Hayvancılık Bakanlığı'nın haşhaş üretim verileri ile Meteoroloji İşleri Genel Müdürlüğünün iklim verilerinden yararlanılarak hazırlanmıştır. Makalede, tarımsal üretimin iklim değişikliğinden nasıl etkilendiği vurgulanmıştır. Bu amaçla, haşhaşın son beş yıllık üretim verileri ve haşhaş üretilen illerdeki aylık sıcaklık, yağış ve nisbi nem değerleri kullanılmıştır.

Anahtar Kelimeler: İklim değişikliği, haşhaş üretimi, Türkiye, verim öğeleri

Introduction

Poppy (*Papaver somniferum* L.), belonging Papaveraceae family, has been used for many purposes. The main parts of the plant used are alkaloid containing capsules and oil containing seeds. Throughout the history, poppy was used for medicinal purposes and as narcotic drug (Gümüşçü et al. 2008).

Different land races, cultivars, varieties and chemical types were developed so far and they adapted to the various usage purposes, climates and regions through selections and other breeding methods. Because of these achievements, poppy growing areas of the world have ranged from Bombay (India) to Moscow (Russia) in the northern hemisphere and to Tasmania (Australia) in the southern hemisphere. Major poppy growing countries were Turkey, India, China, Australia, Spain and France. Turkey is accepted as a traditionally poppy growing country by the United Nations (Gümüşçü et al. 2008).

Poppy has been traditionally cultivated in Anatolia since 3000 B.C. Poppy cultivation, production and trade were free until 1933 in Turkey. In 1933, controlled poppy cultivation and production was launched and later on, in 1938 with the establishment of Turkish Grain Board (TMO) monopoly authority of narcotic drugs was given to TMO. Poppy cultivation was based on obtaining opium gum and poppy seed until 1971. After the poppy capsules were lanced, the world's best quality opium gum with highest morphine concentration was purchased by TMO from the farmers and exported for medicinal purposes after being processed. The opium production by lancing the poppy capsules was banned in 1974 and production of unlanced poppy capsule which is a safer method was started (Anonymous 2013).

Climate change is one of the biggest issues confronting humanity in the 21st century. This will give rise to changes in weather patterns,

and an increase in the frequency and severity of extreme events. Given the complexity and global nature of the climate system, cooperative activities within international and interdisciplinary programs are indispensable for monitoring and predicting climate change (Şensoy et al. 2013).

Precipitation was generally increased on the rural areas at high altitudes of the northern hemisphere, especially in cold season. On the contrary, it was observed a rapid decreasing on precipitation where subtropical and tropical zones from Africa to Indonesia. These alterations were observed on rivers, lakes and soil humidity, too (Türkeş et al. 2000). The rapid decreasing on precipitation at subtropical zone has begun to effect East Mediterranean Basin and Turkey after 1970's. The important decreasing of the precipitation and drought came into winter season clearly (Türkeş et al. 2000).

Climate change can effect negatively agriculture, sylviculture and water sources at semi-arid and semi humid regions of Turkey which are under desertification threat (central, southeast Anatolia, Aegean and Mediterranean regions). In the last decades, it was determined some results related to that drought, air pollution and acid rains were the reasons for block tree deaths and harmful insect invasions in the forests of Turkey (Anonymous 1999).

Investigations of the ontogenetic variation of secondary metabolites in plants have been made over several years, e.g. alkaloid changes during fruit development in *Papaver somniferum* L. (Miriam and Pfeifer 1959) and diurnal variations of alkaloids have been reported for *P. somniferum* (Heidenreich and Pfeifer 1962). Diurnal fluctuations in the concentration of the major alkaloids morphine, codeine and thebaine in the latex from immature fruits of *P. somniferum* was first reported in 1964 (Fairbairn and Wassel 1964).

The possible small amount change on the temperature and precipitation will affect negatively agriculture and livestock in Turkey. Product and income loss, leaving non-fertile land, restriction or drying of grassland, decreasing of livestock etc. will prompt to move from rural areas to cities. The industries dependent on agriculture such as sugar, flour, leather, milk and yarn etc. will also negatively affect climate change (Kara et al. 2010).

Material and Method

All materials were formed by collected data from governmental institutions. The lustrum (five years period) data related to the poppy growing areas, amount of production and yield of capsule and seed were obtained from Turkish Ministry of Food, Agriculture and Livestock, and Turkish Grain Boards. The lustrum data related to the monthly and annual temperature, precipitation and relative humidity in poppy growing areas (stations) were obtained from Turkish State Meteorological Service.

Four poppy producing provinces of Turkey were selected for this paper and the data of both climate and agricultural were represented in tables according to these four provinces data.

Results and Discussions

Four provinces, which permitted to produce opium poppy by the government, were selected among totally 13 poppy producing provinces. Firstly, the data of area sown, production and yield of poppy were represented in table 1. All these characters were displayed by both capsule and seed, separately.

There are 13 provinces where permitted by government to sow poppy in Turkey. It was exemplified only four provinces both agricultural and climate data among these provinces. The climate data of these four provinces were represented in table 2, 3, 4 and 5 at the end of this text.

As seen in table 1, a distinct decrease of both capsule and seed production and yield of poppy was observed at selected provinces, in year 2012. According to the climate data tables below, the temperatures on January and February in 2012 were measured very low at all locations which were sown poppy, compared with long term period mean temperatures. This temperatures affected negatively the poppy seedlings sown at autumn. Therefore, like in whole Turkey, all of the crops which were sown at autumn affected negatively by low temperatures in winter 2012.

Poppy areas are altered year by year in terms of cost policy, alternative more profitable products, climate and farmers habit. In some years, the farmers cannot sell their products (especially capsule) by desired costs. Also, poppy plant is sensitive to frost and winter

Table 1. The last five years data of area sown, production and yield of poppy by selected provinces*
Çizelge 1. Seçilmiş illerin son beş yılda haşhaş ekim alanları, üretim miktarı ve verim değerleri

Provinces	Years	Area sown (ha)	Production (ton)		Yield (kg/ha)	
		Capsule + Seed	Capsule	Seed	Capsule	Seed
Burdur	2009	2869,2	1965	2163	680	750
	2010	4773,9	3023	3326	630	700
	2011	4542,2	3692	4062	810	890
	2012	752,0	290	319	390	420
	2013	2272,2	1347	1347	590	590
Tokat	2009	215,7	179	196	830	910
	2010	276,5	187	206	680	750
	2011	270,5	169	187	620	690
	2012	47,2	12	13	250	280
	2013	83,3	90	90	1080	1080
Çorum	2009	1152,6	803	883	70	77
	2010	1412,2	686	754	49	53
	2011	1162,0	851	935	73	80
	2012	385,3	36	40	9	10
	2013	780,8	293	293	38	38
Amasya	2009	2487,8	1919	2111	77	85
	2010	2627,9	1780	1958	68	75
	2011	2212,0	1783	1960	81	89
	2012	1088,7	156	171	14	16
	2013	1429,2	769	769	54	54

*From Ministry of Food, Agriculture and Livestock, Statistical Data and Turkish Grain Boards
**Gıda Tarım ve Hayvancılık Bakanlığı verileri ve Toprak Mahsulleri Ofisi Verileri*

conditions or sometimes tolerant. Very cold winter and freezing days affect negatively poppy seedlings development in spring.

Numbers of summer days have been increasing all over Turkey especially northern parts have greatest trends (Şensoy et al. 2013).

The poppy is sown both in autumn and in spring. The seedlings should have at least 4-5 leaves and strong root system before winter. Therefore, the temperatures and precipitation should be enough between September and December. If there is not enough precipitation, then the poppy fields should irrigate. In spring, the rainfall in March, April and May months is very important for healthy and strong seedlings development.

As it was seen table 2 for Amasya province, especially since November of 2011 till April of 2012 the temperature was decreased compared with long term period and two years ago. In May and following months towards to 2013, temperatures are increased. The precipitation in the last four months of 2011 was very low compared with long term period and the other years. This condition affected the production of poppy in next years, like other field crops in Turkey.

In Burdur, the temperatures of the last three months of 2011 and the first two months of 2012 were decreased compared with long term period and other years. Precipitation in first two months of 2011 and the last five months of 2011 was decreased compared with long term period and two years ago. Especially, precipitation in April of 2012 affected negatively the production of poppy in this year.

In Çorum, February observations of 2011 could not be done by meteorological service. The temperatures in five months of 2011 and the last three months of 2011 were decreased compared with long term period and other years. The temperatures in the first three months of 2012 and the rainfall in April and May of 2012 and the last two months of 2011 were decreased. These conditions affected negatively especially poppy production in 2012.

In Tokat, the temperatures in the first three months of 2012 and since august till December of 2011 were decreased compared with long term period and the other years. The precipitation in the last four months of 2011 and in april of 2012 were decreased distinctly. Especially, low April rainfall affected negatively poppy production at non-irrigated areas. Then precipitation since February till May of 2013 were decreased, too. May and June observations of 2013 could not be done.

Table 2.The climate data of long term period and the last five years on Amasya province

Çizelge 2. Amasya ili için uzun yıllar ortalaması ve son beş yılın iklim verileri

Amasya		Jan.	Feb.	March	April	May	June	July	August	Sept.	October	Novem.	Dec.
Long term period (1954 - 2013)*	Temperature (°C)	2,6	4,4	8,4	13,5	17,9	21,6	24,1	23,9	20,0	14,6	8,6	4,6
	Precipitation (kg/m^2)	49,1	38,4	46,7	57,2	50,9	36,4	14,7	9,2	20,5	36,0	45,4	55,8
2009	Temperature (°C)	3,8	7,0	8,2	12,0	17,0	22,9	24,3	22,5	19,0	17,8	8,9	7,4
	Precipitation (kg/m^2)	91,8	105,1	82,2	56,8	55,1	30,0	26,6	1,0	41,8	19,8	76,2	94,8
2010	Temperature (°C)	5,8	9,6	9,3	13,3	19,5	23,4	26,4	27,9	22,7	14,1	10,5	7,3
	Precipitation (kg/m^2)	71,5	43,4	55,0	73,8	51,4	68,5	8,1	0	8,4	133,1	11,3	142,6
2011	Temperature (°C)	3,8	5,2	7,9	11,7	16,8	21,4	25,9	23,6	20,4	14,0	4,7	4,8
	Precipitation (kg/m^2)	48,0	13,7	59,7	32,7	104,9	19,3	41,1	25,0	6,4	27,7	7,3	39,9
2012	Temperature (°C)	1,7	0,8	5,3	16,9	19,6	23,4	25,4	24,5	21,7	17,7	10,9	6,3
	Precipitation (kg/m^2)	67,7	68,5	43,0	29,9	58,7	34,0	33,6	4,7	7,7	38,6	76,3	91,0
2013	Temperature (°C)	5,3	8,2	10,7	14,8	21,1	23,0	24,3	19,9	13,1	9,6	5,6	8,2
	Precipitation (kg/m^2)	53,3	46,1	55,7	44,2	41,4	31,0	0,6	0	22,3	20,3	25,7	0

* Data of The Turkish State Meteorological Service (* Meteoroloji İşleri Genel Müdürlüğü verileri)

Table 3. The climate data of long term period and the last five years on Burdur province

Çizelge 3. Burdur ili için uzun yıllar ortalaması ve son beş yılın iklim verileri

Burdur		Jan.	Feb.	March	April	May	June	July	August	Sept.	October	Novem.	Dec.
Long term period (1954 - 2013)*	Temperature (°C)	2,6	3,7	7,0	11,6	16,5	21,3	24,7	24,5	19,8	14,3	8,6	4,3
	Precipitation (kg/m^2)	53,9	42,4	43,8	47,0	41,7	25,4	12,5	7,2	14,5	33,4	37,7	60,2
2009	Temperature (°C)	4,2	4,8	6,3	12,3	16,8	23,3	25,5	25,3	19,5	16,5	8,6	6,5
	Precipitation (kg/m^2)	72,8	28,6	28,6	70,6	64,8	7,0	26,0	4,1	19,6	12,7	40,7	144,2
2010	Temperature (°C)	5,0	6,7	9,5	13,3	18,4	20,6	26,6	28,5	22,4	13,6	12,4	7,4
	Precipitation (kg/m^2)	63,9	84,8	26,2	48,3	8,8	57,1	12,8	0	18,8	62,4	17,0	72,2
2011	Temperature (°C)	3,7	4,6	7,4	11,3	15,1	21,0	26,4	25,7	21,3	12,4	5,2	3,5
	Precipitation (kg/m^2)	44,6	36,6	62,8	110,4	96,0	52,2	0	1,4	11,6	31,0	0,2	19,4
2012	Temperature (°C)	0,2	1,5	7,0	13,4	16,1	24,7	27,6	24,7	22,5	16,1	10,5	5,3
	Precipitation (kg/m^2)	93,4	55,7	0	21,6	68,0	4,2	5,2	2,4	0	22,6	19,2	49,6
2013	Temperature (°C)	4,0	6,1	8,5	13,1	19,5	23,1	25,4	26,0	20,2	11,8	10,2	1,9
	Precipitation (kg/m^2)	23,6	45,2	23,8	52,9	38,2	13,4	12,6	3,4	0,2	55,4	60,8	17,0

* Data of The Turkish State Meteorological Service (* Meteoroloji İşleri Genel Müdürlüğü verileri)

Table 4.The climate data of long term period and the last five years on Çorum province

Çizelge 4. Çorum ili için uzun yıllar ortalaması ve son beş yılın iklim verileri

Çorum		Jan.	Feb.	March	April	May	June	July	August	Sept.	October	Novem.	Dec.
Long term period (1954 - 2013)*	Temperature (°C)	-0,3	0,9	5,1	10,5	14,9	18,5	21,2	21,0	17,0	11,8	5,9	1,8
	Precipitation (kg/m^2)	39,1	30,3	37,5	51,2	59,1	51,7	19,7	13,9	22,4	28,3	34,4	45,8
2009	Temperature (°C)	0,9	4,0	4,8	9,6	13,8	20,2	21,8	20,5	16,5	15,0	6,0	4,7
	Precipitation (kg/m^2)	67,6	72,5	34,5	110,2	59,6	73,2	58,0	1,0	12,8	18,7	72,3	53,4
2010	Temperature (°C)	2,8	6,0	7,0	10,5	16,4	20,4	24,1	25,7	20,2	10,9	7,7	4,2
	Precipitation (kg/m^2)	44,2	26,0	32,2	56,8	36,3	94,5	18,3	0	3,0	105,2	27,8	70,6
2011	Temperature (°C)	0,9	-	4,3	8,7	13,8	18,2	23,0	20,8	17,5	10,0	1,7	1,4
	Precipitation (kg/m^2)	30,5	-	39,6	36,9	60,0	64,5	10,9	7,0	50,2	31,6	5,4	37,3
2012	Temperature (°C)	-1,5	-4,3	1,8	13,1	16,1	20,3	22,5	21,4	18,8	14,1	7,7	2,9
	Precipitation (kg/m^2)	75,2	55,5	33,3	28,8	114,8	46,3	47,1	0,2	8,8	23,7	66,7	76,7
2013	Temperature (°C)	1,7	4,1	6,9	11,5	17,6	20,0	21,5	21,6	16,5	9,7	6,5	-2,4
	Precipitation (kg/m^2)	51,6	27,3	36,7	33,4	15,6	22,9	1,0	7,0	15,7	11,8	17,8	2,1

* Data of The Turkish State Meteorological Service (* Meteoroloji İşleri Genel Müdürlüğü verileri)

Table 5. The climate data of long term period and the last five years on Tokat province

Çizelge 5. Tokat ili için uzun yıllar ortalaması ve son beş yılın iklim verileri

Burdur		Jan.	Feb.	March	April	May	June	July	August	Sept.	October	Novem.	Dec.
Long term period (1954 - 2013)*	Temperature (°C)	2,6	3,7	7,0	11,6	16,5	21,3	24,7	24,5	19,8	14,3	8,6	4,3
	Precipitation (kg/m^2)	53,9	42,4	43,8	47,0	41,7	25,4	12,5	7,2	14,5	33,4	37,7	60,2
2009	Temperature (°C)	4,2	4,8	6,3	12,3	16,8	23,3	25,5	25,3	19,5	16,5	8,6	6,5
	Precipitation (kg/m^2)	72,8	28,6	28,6	70,6	64,8	7,0	26,0	4,1	19,6	12,7	40,7	144,2
2010	Temperature (°C)	5,0	6,7	9,5	13,3	18,4	20,6	26,6	28,5	22,4	13,6	12,4	7,4
	Precipitation (kg/m^2)	63,9	84,8	26,2	48,3	8,8	57,1	12,8	0	18,8	62,4	17,0	72,2
2011	Temperature (°C)	3,7	4,6	7,4	11,3	15,1	21,0	26,4	25,7	21,3	12,4	5,2	3,5
	Precipitation (kg/m^2)	44,6	36,6	62,8	110,4	96,0	52,2	0	1,4	11,6	31,0	0,2	19,4
2012	Temperature (°C)	0,2	1,5	7,0	13,4	16,1	24,7	27,6	24,7	22,5	16,1	10,5	5,3
	Precipitation (kg/m^2)	93,4	55,7	0	21,6	68,0	4,2	5,2	2,4	0	22,6	19,2	49,6
2013	Temperature (°C)	4,0	6,1	8,5	13,1	19,5	23,1	25,4	26,0	20,2	11,8	10,2	1,9
	Precipitation (kg/m^2)	23,6	45,2	23,8	52,9	38,2	13,4	12,6	3,4	0,2	55,4	60,8	17,0

* Data of The Turkish State Meteorological Service (* Meteoroloji İşleri Genel Müdürlüğü verileri)

In poppy cultivation, for autumn type poppy cultivars, the temperatures under 0ºC in winter months without snow layer affected negatively, even destructive. The damage can rise 100 % in some years. The year 2012 was such a year.

The number of warm days has been increasing all over Turkey. Growing Season Length has increasing in Thrace, central Anatolia and Eastern Anatolia while decreasing in coastal regions. Warmer temperatures promote increases in plant growth in mid-northern latitudes (Şensoy et al. 2013).

The number of cool days has been decreasing in most of the locations. Numbers of frost days have been increasing mainly in central Anatolia. Erzurum, Uzunköprü, Çorum, Sivrihisar, Balıkesir, Isparta, Burdur and Diyarbakır show statistically increasing trend (Şensoy et al. 2013).

Annual total precipitation amount is increasing in northern parts of the country while decreasing in Southeastern Anatolia, Mediterranean and Aegean Regions (Şensoy et al. 2013).

Itenov et al. (1999) studied diurnal fluctuations of alkaloids in the latex of poppy cultivar Parmo. They determined that the simultaneous variations in latex water content and the fresh weight concentration of major alkaloids show pronounced reverse phase fluctuations with high daytime levels of alkaloids coinciding with low latex water levels. During day time (9.00 to 20.00 h) the level of alkaloids is 5.9% ± 0.67 and during night time (21.00 to 9.00 h) 4.7% ± 0.39. The shift from day time to night time level takes two hours as does the shift in the morning. The diurnal fluctuations of latex water content attain a night time level of 73.7 ± 1.2 between 22.00 and 8.00 h and a day time average of 66.7% ± 2.6 with a minimum of 62% at 13.00 h.

Chung (1987) studied an irrigation trial on the growth and yield components of poppy in Tasmania. According to this study, he determined that irrigation increased total dry matter production. In his study, irrigation increased total morphine yield by 5-20 kg/ha compared with no irrigation. Also, the author stated that, for maximum yield, one irrigation of 50 mm should be applied at the hook stage, at 50% flowering, at the end of flowering and 2 weeks after the end of flowering. Farmers who cease irrigation at 50 % flowering can expect yield increases of 4-13 kg/ha if they apply two further irrigations thereafter.

Conclusions

As a conclusion, it could be say that the strategical importance having crop poppy is affected extremely weather conditions such as very low temperatures and precipitation. When rainfall is very high amount relatively normal weather conditions at flowering stage, the pollination and then capsule developing is negatively affected and then alkaloid accumulation in capsule, also seeds forming less than the normal.

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