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IMPORTANCE OF GEOTHERMAL WATER USING FOR GREENHOUSE HEATING IN TURKEY

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ABSTRACT

Total greenhouse area is about 49310.6 ha in Turkey. This area is one of the most important countries in greenhouse agriculture all over the world. However, the level of yield and quality in greenhouse crops is not enough. The mean reason of these must not been kept at the desired level of the climate of greenhouse in general. The biggest deficiency in the greenhouses ecology is the deficiency in heat value. Heating costs in greenhouse are generally very high in Turkey that has almost 50-80% in total production costs of greenhouses. Therefore, most farmers have used anti-frost greenhouses in vegetable crop production. Under cold climate conditions, the tolerance level of vegetables has decreased the biotic and abiotic stress factors, so yield and quality of crops reduce. To improve the yield and quality, higher fertilizers, pesticides and plant growth regulators have to be used by farmers.

By heating the greenhouses with geothermal water, friendship of environment, both yield and quality of the crops are improved while also residual problems of crops associated from all chemical applications reduce. The geothermal water supply is very rich in Turkey (more than 3000 water supplies) and one of the most economical sources in heating the greenhouses.

In this paper, therefore, the geothermal water potential of Turkey and possibly of its uses and effect of heating the greenhouses by geothermal water sources on yield and quality of vegetable crops were researched. In addition, the importance of geothermal water for suitable crops human health and sustainable environment were studied.

Key Words: *Geothermal energy, Greenhouse heating, improvement of crop yield, vegetable production.*

TÜRKİYE'DE SERA ISITMASINDA KULLANILAN JEOTERMAL SUYUN ÖNEMİ

ÖZET

Türkiye'de toplam sera alanı 49310,6 ha'dır. Bu alan ile bütün dünyada sera tarımında önemli gelişmiş ülkelerden biridir. Ancak, sera üretimindeki verim ve kalite yeterli değildir. Bunun ana nedeni genellikle sera ikliminin istenen düzeyde tutulamamasıdır. Sera ekolojisindeki en büyük eksiklik ısıtmanın yeterli olmamasıdır. Türkiye'de genellikle seralarda ısıtma maliyetleri çok yüksek olup toplam üretim maliyetlerinin %50-80'ni ısıtma oluşturmaktadır. Bu yüzden pek çok çiftçi sebze yetiştirirken anti-frost seracılık (dondan koruma seracılığı) yapmaktadır. Dondan koruma seracılığında sebzelerin abiotik ve biotic stress faktörlerine dayanımı azalmakta, verim ve kalite düşmektedir. Verim ve kaliteyi artırmak için, seralarda çiftçiler tarafından daha fazla gübre, pesisit ve bitki büyüme düzenleyici kullanılmaktadır.

Seraların jeotermal akışkanlarla ısıtılmasıyla, çevreye dost üretim yapılmakta, kimyasal uygulamalarında kaynaklanan kalıntı sorunları azalmakta ve verim ve kalite artmaktadır. Türkiye'de jeotermal su rezervleri çok yüksektir (3000'den fazla) ve sera ısıtmasında en ekonomik kaynaklardan biridir.

Bu nedenle bu çalışmada Türkiye'nin jeotermal su potansiyeli, sera ısıtmasında kullanılabilirliği ve jeotermal enerji ile ısıtılan seralarda sebze üretiminde verim ve kaliteye etkileri araştırılmıştır. İlave olarak insan sağlığına uygun üretim ve sürdürülebilir çevre için jeotermal suyun önemi üzerinde durulmuştur.

Anahtar Kelimeler: *Jeotermal enerji, sera ısıtması, verim, kalite, sebze üretimi.*

INTRODUCTION

Greenhouses provide an enclosed growing environment that can be controlled along all year. This allows intensive culture with annual yields many times higher than field production. Greenhouse production is a highly intensive enterprise requiring substantial labor and capital input. Because of this, growers should be carefully consider all of the factors necessary for better crop yields, higher labor productivity, energy efficiency and successful enterprise. Greenhouse enables overcoming climatic diversity and use of the sun's free energy. However, the structure selected and the practice in production not only depends on the location and the climate but also economics, politics and social structures of that location in a particular country (Kacıra *et al.* 2004).

Climatic conditions are much favorable for the complex industry producing vegetable, fruits, flowers and nursery crops in Turkey. Turkey is the second country in the world after United States in term of its ecological richness, making Turkey paradise for horticultural productions. The country is capable of producing 80 different types of fresh fruit and vegetables out of 40 products in the world and out of the 80 types of fresh produce, 50 kinds are exported (Kacıra *et al.* 2004).

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Turkey is one of major greenhouse production countries not only the Mediterranean region but also in the world. Total greenhouse area is about 49310.6 ha in Turkey (Anonymous 2008). Greenhouse production in Turkey began 1940's in glasshouses built in Antalya Province which is still the centre of such production due to the very favorable climatic conditions for protected cultivation (Sevgican 1999). Generally, heating costs in the greenhouse are very high that has almost 60-80% of total production costs. Therefore, greenhouse production is carried out by taking advantage of favorable climate while keeping the operational cost at a minimum level. Thus, majority of the greenhouses are heated for frost prevention except for indoor plant production. In recent years, thermal screen utilization has been becoming popular to reduce the heat losses.

Turkey is also the 7 th richest country in the world as geothermal potential (Satman *et al.* 2007). Therefore, the geothermal water potential of Turkey and possibly of its uses and effect of heating the greenhouses by geothermal water sources on yield and quality of vegetable crops were researched. In addition, the importance of geothermal water for suitable crops, human health and sustainable environment were studied (Paksoy *et al.* 2008).

PROTECTED CULTIVATION IN TURKEY

Protected cultivation began in glasshouses built in Antalya city in the 1940's in Turkey. After the advent in plastic industry, protected cultivation area rapidly increased and now total area has reached to 49310.6 ha plastic tunnel that accounts of 45.07% of the total area, while the 55% are greenhouses. The plastic films and glass covered areas are 84.63 and 15.37%, respectively. Most greenhouses and tunnels are located on the Mediterranean coast region due to the favorable climatic conditions. Crop production is realized mainly in unheated greenhouses. Vegetables, ornamental plants and fruits are grown in 95, 4 and 1 % of the total greenhouse area, respectively (Sevgican 1999; Kacıra *et al.* 2004).

Turkey has seven geographical regions: the Marmara, Aegean, Mediterranean, Central Anatolia, Black Sea, East Anatolia and Southeastern Anatolia regions. The most important region within the country for protected cultivation is the Mediterranean region, covering almost 86.57% of total production with plastic and glass covered greenhouses (Tablo 1). This climate zone allows unheated greenhouse production most of the time due to abundant solar radiation during the seasons. The greenhouses are usually heated only for frost prevention. The average mostly air temperature range between 9.2 and 28.2 ºC while average monthly relative humidity ranges between 56 and 69% (Anonymous 2008).

In Turkey, greenhouse production is carried out by taking advantage of the favorable climate while keeping the operational cost at a minimum level. Thus, the majority of the greenhouses are heated for frost prevention except for indoor plant production greenhouses. Thermal screen utilization is also becoming popular to reduce the heat loses. air heaters are mostly used due to their higher efficiency in low cost and maintenance. Moreover, the number of greenhouses is increasing in regions where geothermal water resources are available. There are almost 120.0 ha greenhouse heating with geothermal source in Turkey and projections for 2013 year (Tablo 2) (Dağıstan 2008).

Tablo 1. Protected cultivation areas in regions of Turkey (ha) (Anomymous 2007).

	Greenhouse		Tunnel		
Regions	**Glass**	**Plastic**	**Low**	**Height**	**Total**
Mediterranean	6886.1	15971.6	14616.7	5215.3	**42689.7**
Aegean	687.3	2666.3	396.2	467.3	**4214.1**
Marmara	1.2	272.4	7.9	306.4	587.9
Black Sea	1.4	556.1	745.1	409.4	1712.0
Central Anatolia	0	16.1	0.9	17.4	34.4
Southeastern Anatolia	3.3	22.7	2.2	5.5	53.7
East Anatolia	0	2.5	6.9	9.4	18.8
Total	**7579.3**	**19504.7**	**15795.9**	**6430.7**	**49310.6**

However, heating for only frost prevention decrease the yield and quality of crops in the greenhouse. For increasing the yield and quality, greenhouses should be necessary heated. Also, geothermal hot water is one of the heating resources and friendship of environment. In addition, geothermal water is cheaper than most other heating resources and is very important in total greenhouse production costs.

GEOTHERMAL POTENTIAL OF TURKEY

Turkey is poor in fossil fuel resources but rich in renewable resources such as geothermal, solar, hydraulics, wind, and biomass. The wide spread hydrothermal occurrences due to tectonic activities and some young volcanism indicate significant existence of geothermal resources in Turkey. Nearly 1500 thermal and mineral water springs and more than 170 geothermal fields with a temperature range up to 242 ºC have been discovered in Turkey which is located on Mediterranean (Satman *et al.* 2007).

The geothermal resources in Turkey have mostly moderate and low-temperature. Some are distributed mostly at the central and western parts of Turkey,

some at the central and eastern Anatolia volcanic regions, whereas high temperature geothermal resources capable of supporting direct use projects and power generation are discovered primarily in the graven structures of Western Anatolia (Tablo 3) (Satman *et al*. 2007).

Tablo 2. Present geothermal greenhouse areas in Turkey and predictions for 2013 year (Dağıstan 2008).

Locations	Area (ha)	Projections for 2013 (ha)
İzmir-Dikili	60.0	100.0
Denizli-Yenicekent	0.5	10.0
Denizli-Sarayköy	2.0	40.0
Manisa-Salihli	20.0	40.0
Manisa-Urganlı	2.0	7.0
Kütahya-Simav	20.0	35.0
Aydın-Gümüşköy	6.0	10.0
Afyon-Sandıklı	1.0	20.0
Afyon Merkez		50.0
Nevşehir-Kozaklı	0.45	2.0
Urfa	4.0	8.0
İzmir-Balçova	4.4	10.0
Kırşehir-Mahmutlu		20.0
İzmir-Aliağa-Samurlu		20.0
Manisa-Kula		10.0
Balıkesir-Balya		5.0
Denizli-Gölemezli		15.0
TOTAL	120.35	402.0

PROBLEMS IN GEOTHERMAL UTILIZATION

The wastewater and $CaCO_3$ scaling are the most important technical problems encountered during exploration. The other problem is the non-existence of the proper and understandable geothermal energy procedures and laws in Turkey.

Wastewater problem: It is created due to chemical pollutant in the produced fluid at geothermal fields. Major chemical pollutants can be due to high salinity and high boron concentration. In addition to this, As Cl, NH_4 and some other ions can be stated as other pollutants. Especially, these pollutants are harmful for agriculture, human and environment (Akıllı and Ersöz 2002).

Scaling and Corrosion: This is resulted from decreasing pressure and temperature of discharged fluids. Content of CO_3 in fluids is the main effect on $CaCO_3$ scaling. Calcite deposit is very serious in geothermal fields like Kızıldere with high CO_2 content. In order to solve this serious problem, inhibitors, pressure control and exchanger system are used. Corrosion is being overcome by using epoxy pipe at some fields (Akıllı and Ersöz 2002).

Tablo 3. Capacity of geothermal energy for direct heat (For $T_{res} > 60$ ºC) (Anomymous 1996).

Locations	Temperature (ºC)	Flow Rate (kg/s)	Capacity (MW_t) for T_{outlet}=60ºC
Germencik	220	765	503.8
Salavaklı	157	454	181.1
Kızıldere	217	250	162
Ömer-Gecek	94	673	95.7
Simav	109	476	96.1
Seferihisar	144	264	91.2
Dikili	120	250	61.7
Tuzla	160	120	49.4
Balçova	117	369	88.3
Kula-Emir	135	140	43.2
Kozaklı	91.2	247	31.8
Diyadin	72.3	560.5	28.3
Salihli	104	150	27.4
Kuzuluk	80.9	271	23.4
Sandıklı	67.6	496	15.6
Hisarköy	96.7	103	15.6
Gölemezli	70	340	14
Yılmazköy-İmamköy	142	40	13.5
Aliağa	96	80	11.9
Gediz	83.3	119	11.4
Hisaralan	72.3	176	8.9
Tekkehamam	138.7	26.6	8.6
Kızılcahamam	80.1	91.5	7.6
Erciş-zilan	86.7	66	7.3
Gönen	80	83	6.9
Kavaklıdere	215	6.5	4.2
Yenice	65	164	3.4
Köprübaşı	70.7	67	2.9
Banaz	66	114	2.8
Caferbeyli	155	6.5	2.5
Other			16.3
TOTAL			**1637**

CONCLUSIONS

Geothermal energy is a renewable resource, which exploitation and utilization can save a great deal of fossil fuel and avoid environmental pollution, both economical and environmental benefits are obvious. In recent years, geothermal energy have been utilizing widespread for greenhouse heating. Improving the utilization efficiency of geothermal energy and peak load regulating are effective ways to the geothermal resource utilized perfectly. To increase the crop yield and quality in greenhouses, ecological heating resources like geothermal water should be widely used in areas where these water potential are plenty. Recently studies have been mostly dominated by reducing the production costs in all sectors. Heating by geothermal water is very cheap in greenhouses heating in Turkey.

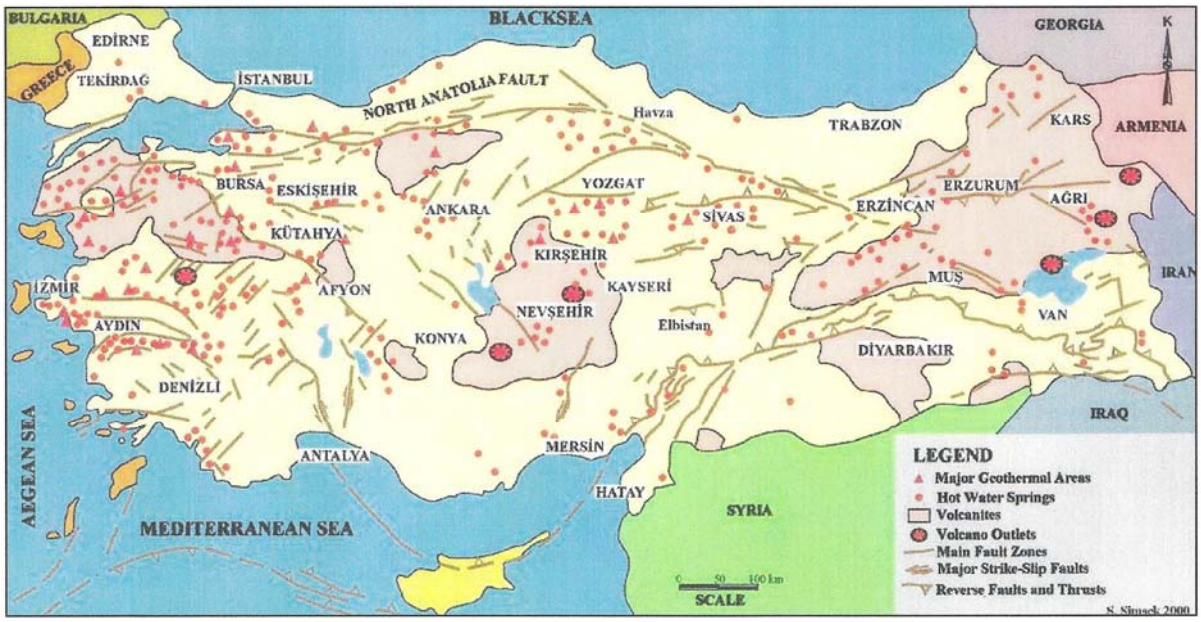

Figure 1. General tectonic and volcanic features of Turkey (Akıllı and Ersöz 2002).

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