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GREENHOUSE HEATING METHODS AND COMPARISON WITH THOSE WHICH ARE USED IN ANTALYA REGION

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SUMMARY

There are many heating methods used in greenhouse production designed in order to obtain more yield in terms of quality and quantity. Heat is dissipated by 3 processes, which are convection, conduction and radiation to maintain a desired inside air temperature. From the main heat sources, basically geothermal, reject or waste and solar heat is carried into greenhouse by water or air.

Turkey has a large potential of greenhouse production area. The vast majority of greenhouses are concentrated in Akdeniz, Ege and Marmara Regions, respectively. When compared to the others, Akdeniz Region has the largest greenhouse population due to its sufficient climate for plant growth even in the coldest months. This speciality forces the farmers to increase the covered production areas.

According to 1989 data. Turkey has a 8533 ha area of greenhouses and portion of Antalya is 5119 ha, which covers about 60 % of total. Tomato has the largest production area (that is 48 % in glasshouses, 43 % in plastichouses) amongst the other crops cultivated under high structures.

From this research it has been observed that greenhouses are heated only for frost protection because of high fuel expenses. Generally stoves are used and wood, gas and heavy oil supply the required amount of heat. The gas stoves can be pointed out to spread for they are simple in use and have low cost when compared to the others, mentioned above.

Recently, some applications of energy saving have started in the region. These contaion use of polyethylene thermal screens, fogging inside and covering on the screens with smoke.

Further research should be carried out on using passive solar energy systems that could be economic for heating in this region.

INTRODUCTION

One of the most important operation cost of greenhouses is heating expenses, particularly when fossil fuels are used. This cost may cover about 60 to 70 % of the total production costs, depending

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on region, plant and type of production (Popovski, 1987). To increase the efficiency of heating systems will reduce the production costs.

In greenhouse production techniques, to control the air temperature is the most important stage. Most of the plants need different temperature regimes during their growing seasons.

Temperature needs of some of plants are given in Table 1.

Table 1. Optimum temperatures required by some plants during their growing season (Alibaş, 1988)

Tomato	16-19
Cucumber	18-30
Aubergine	15-35
Pepper	15.5-21.1
Melon	15
Watermelon	12-15

Outside air temperature is too low to grow for most of the plants in the important period of the year when optimum values are considered. For this reason an efficient heating system is required and this must control the temperatures correctly and minimise fuel consumption.

GREENHOUSE HEATING METHODS

As mentioned before, many heating methods are applied in practice. In modern systems inside air temperature is maintained by hot water or warm air, but in conventional ones this is supplied by stoves.

Planning of a greenhouse heating system depends on heat demand of structure in the coldest periods of year. The desired heat is calculated by multiplying total or overall heat comsumption factor by needed inside-outside temperature difference and surface area of greenhouse. According to the type of heat transfer, systems are grouped into three;

- Convection, which generally takes place in piped central heating systems.
- Conduction, which is usually used underfloor and benches and
- Radiation is a new method and in stage of experiment (Bailey, 1988).

In all of these three heating systems, energy sources applied are as follows;

- Fossil fuels,
- Geothermal,
- Reject or waste and
- Şolar (Nicolaus, 1988).

Heating Systems With Hot Water

Hot water and steam are used as flue in heat distribution circuit. However, in Turkey steam is not used for its high operation cost.

Hot water systems generally consists of steel pipes which are commonly 32, 38 and 50 mm in diameter. These systems can be classified as follows considering water out and in to boiler;

- Low pressure (LPHW); 85/75, 90/70, 95/70 and
- Mid and High pressure (MPHW and HPHW); 125/95

If finned pipes are used in heating, a heat emission of 4 to 7 times higher than flat pipes at the same conditions can be reached (Mastalerz, 1979; Balls, 1985; Gosselin and Trudel, 1989). Two examples of this system for floor and under floor are shown in Figure 1. In the second figure, plastic pipes are generally used and their depths from the surface of floor change from 250 to 500 mm and distance from each other, from 300 to 600 mm.

Heating Systems With Warm Air

In this type of heating system, hot water or steam is passed through heat exchanger and air is send onto it by fan to take the heat of flue over. The most preferred method used of this kind of heating is that where polyethylene plastic pipes are used to distribute the heat. Widely, PE pipes are connected to the unit heaters and

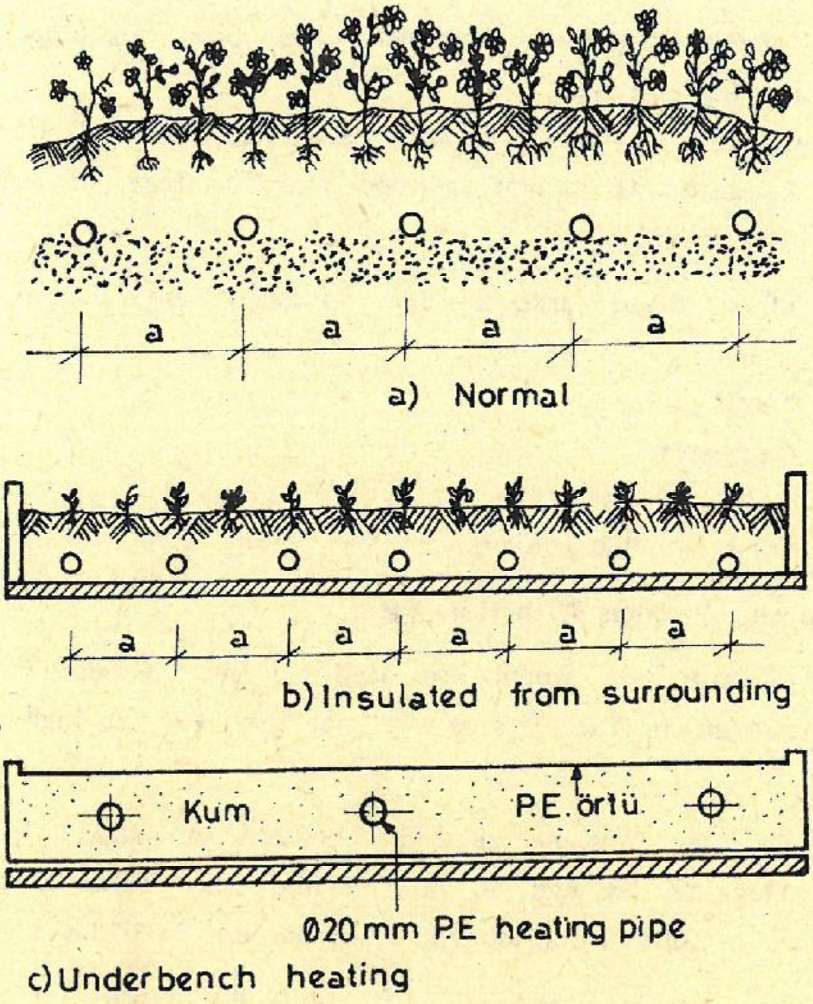

Figure 1. Floor and underfloor heating

longtidunal of greenhouse. Spaces between ducts change from 0.5 to 1 m and 5 to 8 cm in diameter. Systems with PE duct pipes can mix air uniformly and supply an uniform vertical and horizontal temperature distribution. It can also be used for winter ventilation (Figure 2).

Greenhouse Heating With Geothermal Energy

This type of heating is so important in the areas where this energy is available and sufficiently usable. In the case of using this kind of energy source, operation costs of greenhouse decrease because a potential source is converted into an active one. In practice, geothermal energy sources are classified by considering temperature limits of them (Icerman and Cotter, 1984);

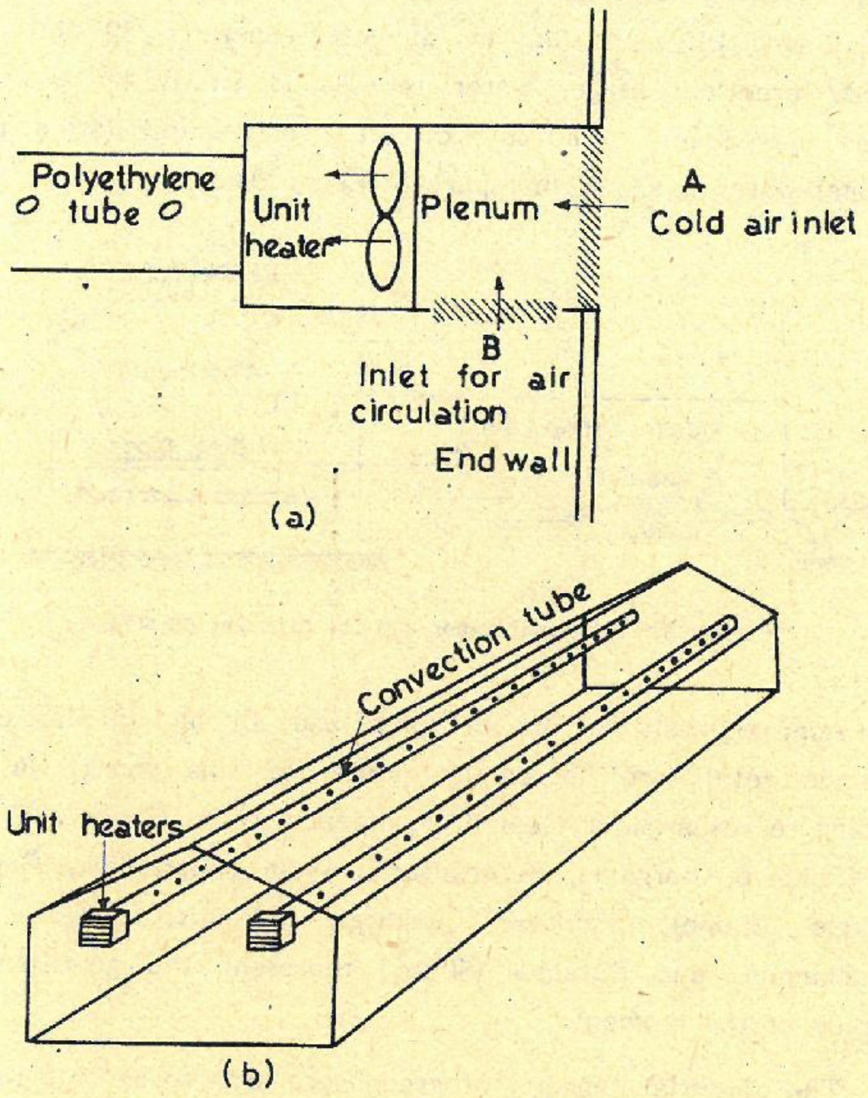

Figure 2. Warm air - PE duct pipes

- 150 C -for generation of electricity,
- 100 C -for trade, industrial and agricultural applications.

In defining the sufficiency of geothermal source, properties of it below are investigated:

- Temperature of the source,
- Depth,
- Output or flow rate,
- Water quality and
- Production duration and capacity.

In heating applications; underfloor pipes, floor pipe plates, steel pipes and PE pipes (big in diameter-generally 10 cm) can be seen. For practical usage, water is cleaned firstly by a separator and then passed into a heating circuit. General circulation flow of geothermal water is shown in Figure 3 (Eker, 1986).

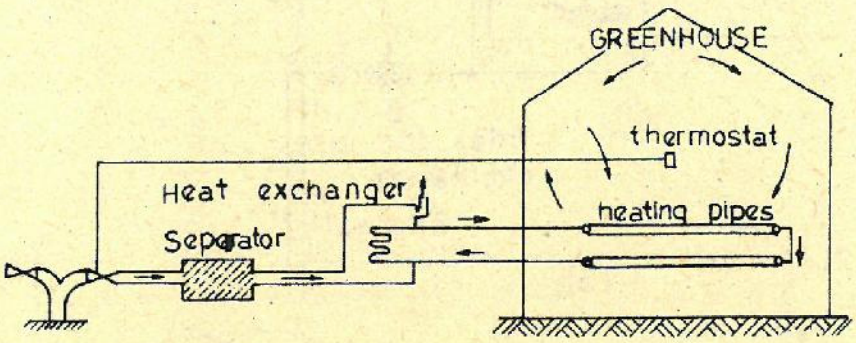

Figure 3. Geothermal water and its circulation scheme

Approximately 5.1 ha of glass and 4.1 ha of plastic houses (i.e.9.6 ha total) are heated by means of this energy in Turkey. According to researchers; Denizli (Kızıldere), Afyon (Ömer and Gecek), İzmir (Balçova, Bergama, Seferihisar), Aydın (Germencik, Ömerbeyli), Çanakkale (Ezine), Balıkesir (Sındırgı, Edremit, Gönen), Ankara (Kızılcahamam) and Kütahya (Simav) represent the geothermal map of Turkey at the moment.

The potential capacity of greenhouse area to be able to heated by this energy is about 15000 ha (Harzadin, 1986).

Greenhouse Heating With Reject Heat

Reject or waste warm water and chimney gases that come out in the end of some processes in thermic power plants or factories are left in the environment or at mosphere. Use of these energies in greenhouses can be seen in Figure 4 (Başçetinçelik, 1988; Walker et al., 1981).

The system illustrated in Figure 4-B is a special application of reject heat heating called space heating. In this type, all heat requirement can be supplied by 27 C temperature reject water (Walker, 1984).

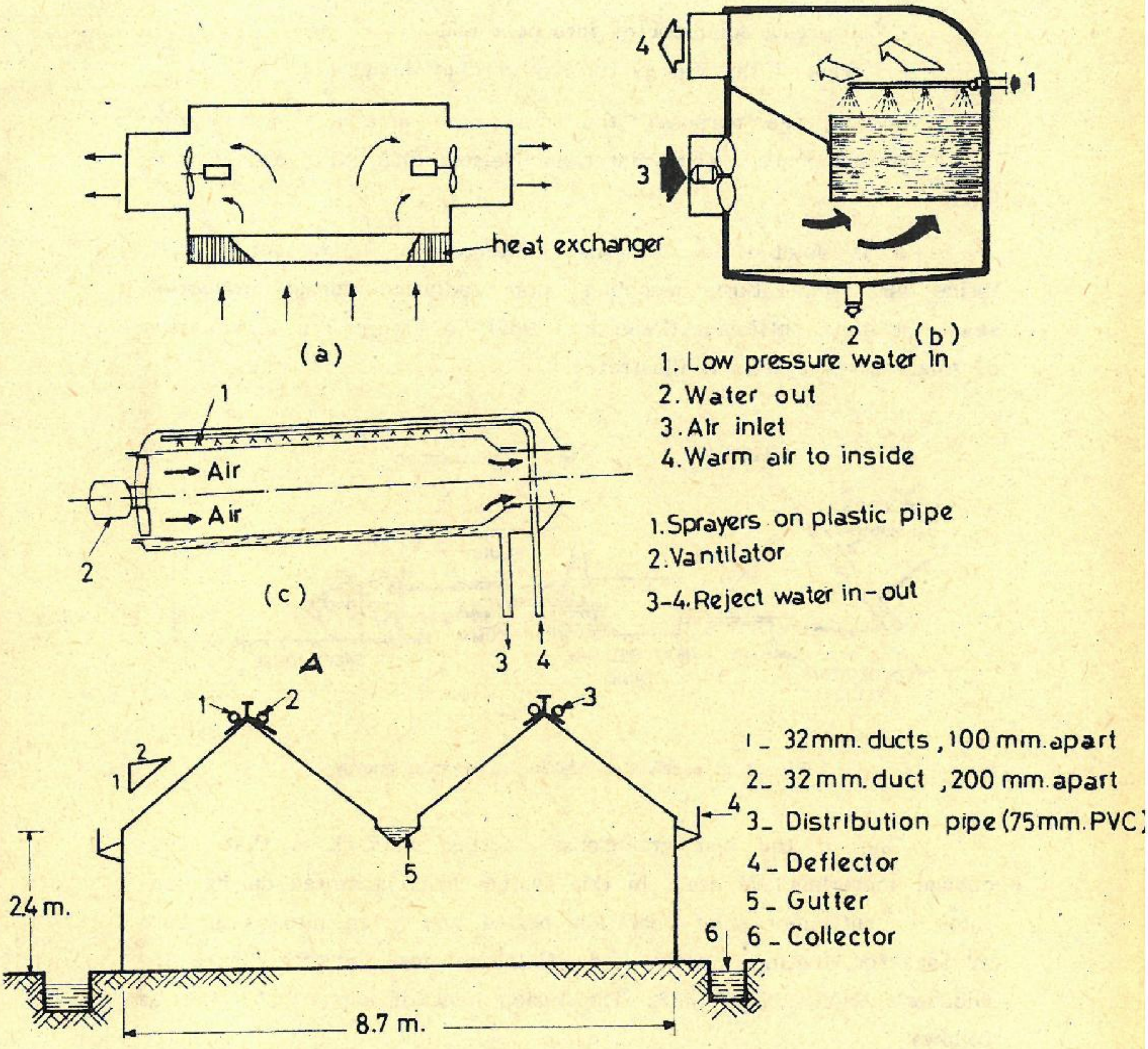

Figure 4. Greenhouse heating with reject heat

Greenhouse Heating With Solar Energy

Nowadays, because costs of fossil fuels are increasing, some alternative energy sources, like solar and the others mentioned before, must be searched.

Necessary techniques to profit from solar energy can be ordered as below;

- Converting solar energy into heat and
- Storing of this energy for day or night heating.

For storage purposes, the most used materials are; water, rock, soil and phase change materials (Nelson, 1985; Kılıç and Öztürk, 1983).

It is pointed out that in Mediterranean Region for a 14-C inside air temperature, incoming solar radiation during production season is quite sufficient (Zabeltitz, 1987). In Figure 5 a combination of solar energy system is illustrated.

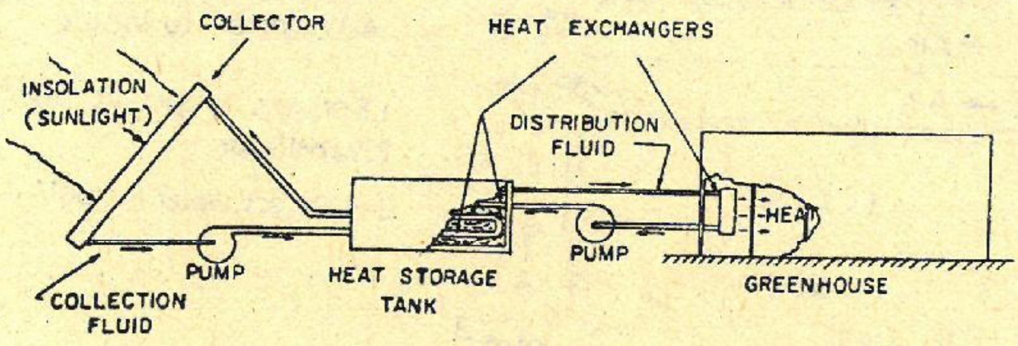

Figure 5. Greenhouse heating with solar energy

One of the last greenhouse heating methods is that phase change materials are used. In this system heat is stored during sunshine or sufficient solar radiation period and given into greenhouse by fans for heating. Widely used PCMs are; Ice, Paraffin Waxes and Glauber's Salt (Abhat, 1982). The fusion heat of some PCMs are as follows;

- Paraffin 116:147 kJ/Kg
- Glauber's Salt:255 kJ/Kg
- Calcium Salt:172 kJ/Kg (Abhat, 1982; Wyman, 1979).

In practice generally the last two ones which have melting points of 32.4 and 29.7, respectively are considered (Baille and Boulard, 1987; Levav and Zamir, 1987; Nishina and Takakura, 1984).

MATERIAL AND METHOD

Material

When the greenhouse map of Turkey is glanced at, the largest area seen is along the Mediterranean coast. Why this is so was explained in the sections before.

In this region, Antalya has the largest area when compared to the others. While mostly vegetable production takes place in greenhouses in Antalya, in other regions like Ege and Marmara it is replaced by flowers and pot plants. In Table 2 greenhouse production areas of some centres are exhibited.

Table 2. Greenhouse production areas (1989)

Centres	Glasshouse (ha)	Plastichouse (ha)	Total (ha)
Hatay	0.1	76.6	76.7
Adana	1.7	15.6	17.3
İçel	106.8	1887.1	1993.9
Antalya	1317.6	3801.8	5119.4
Muğla	1050	859.2	964.2
İzmir	29.3	182.8	212.1
Kocaeli	11.7	66.6	78.3
Turkey's Total	1583	6950.1	8533.1

Source: Antalya Branch of MAFF

As mentioned before, Antalya has a 83 % portion of glasshouses and 55 % of plastichouses of total of Turkey. Wind velocity which effects the heat losses from greenhouse is about 3 ms^{-1} and minimum temperatures which are limiting factors for plant growth change from 4.3 to 6.2. Incoming solar radiation even during the coldest months is sufficient enough and this sufficiency is approximately the same for the other centres in this region. During the growing season, insulation differs from 627 to 1480 $j/cm^{-2}h^{-1}$ and period of solarization also differs from 4.7 to 10.38 h.

In mentioned region, tomato is cultivated in 48 % of glasshouses and 43 % of plastichouses. These values are 34 % and 20 % respectively for cucumber.

Method

In this research, by finding out the heating and frost protection methods used in the region, comparison with other modern greenhouse heating methods and also to find out advisable method were purposed. During this research different types of greenhouses were investigated. This research was conducted in Alanya, Serik, Merkez, Kumluca and Kale where cover the largest areas in Antalya Region. Figure 6 shows the general view of Kale's greenhouse areas.

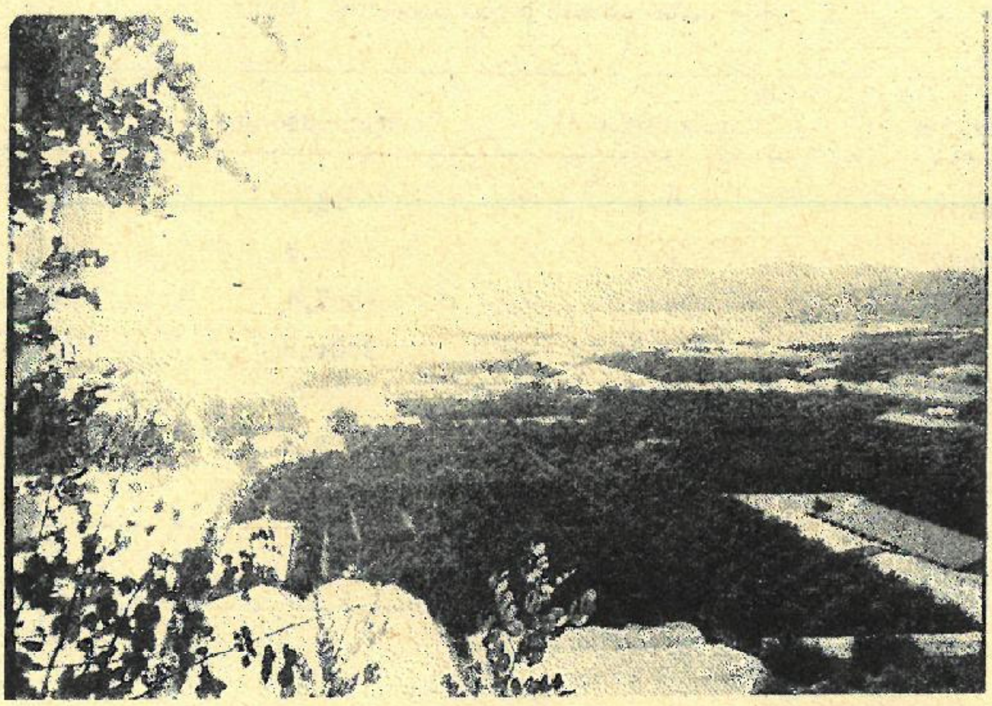

Figure 6. General view of Kale's greenhouse areas

RESULT AND DISCUSSION

Results

During this research about 200 of greenhouses were investigated one by one to define the heating methods and the numbers of heating units. Methods used are as follows:

Heating Applications With Wood And Heavy Oil Stoves

About 90 % of the investigated greenhouses is heated by means of stoves. The lifetime of these stoves is 2 to 3 years and they are made from iron plates. There are 3 to 4 outlets for pipes on the stoves. The numbers of stoves per 600 m^2 greenhouse area are 3 to 6. Figure 7 shows general view of a greenhouse heated with wood stoves.

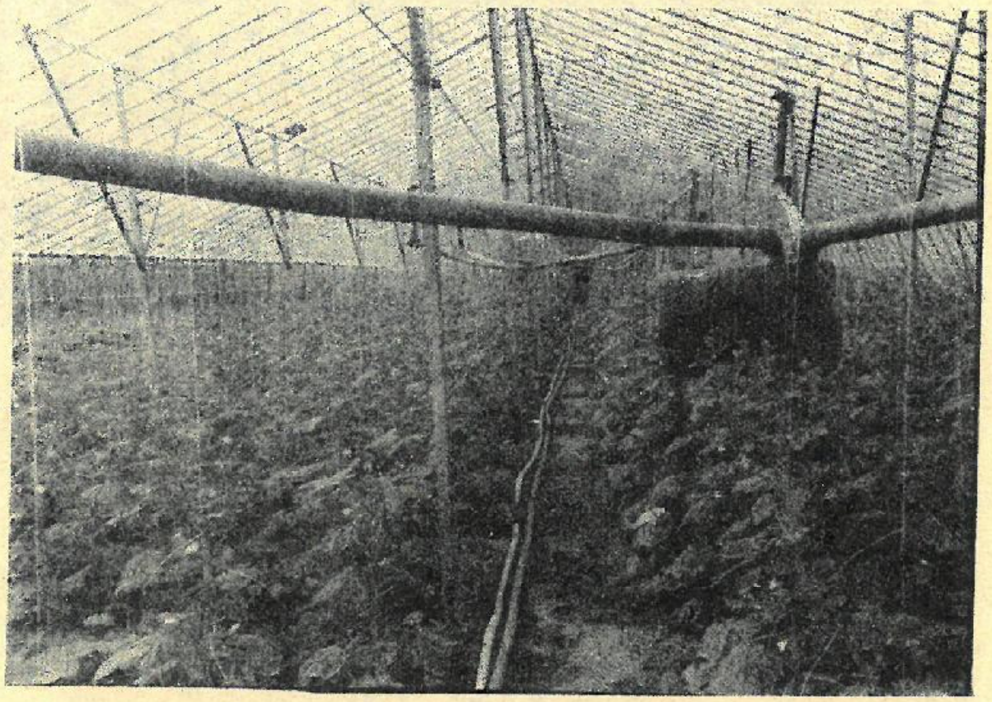

Figure 7. General view of a greenhouse heated by stoves

Furthermore, the stoves having small dimensions are also used and numbers of these stoves change from 9 to 10 per 600 m^2 greenhouse area. Another type of the stoves is that so called oven type stoves which are on the floor and their walls are made from tail. They have 3 or 4 outlets of chimney and can store some amount of heat. Their numbers per 600 m^2 greenhouse area are usually 4. Figure 8 indicates this kind of heating.

Heavy oil stoves are also in use in the region and the numbers of them range 5 to 6 per 600 m^2 greenhouse area (Figure 9).

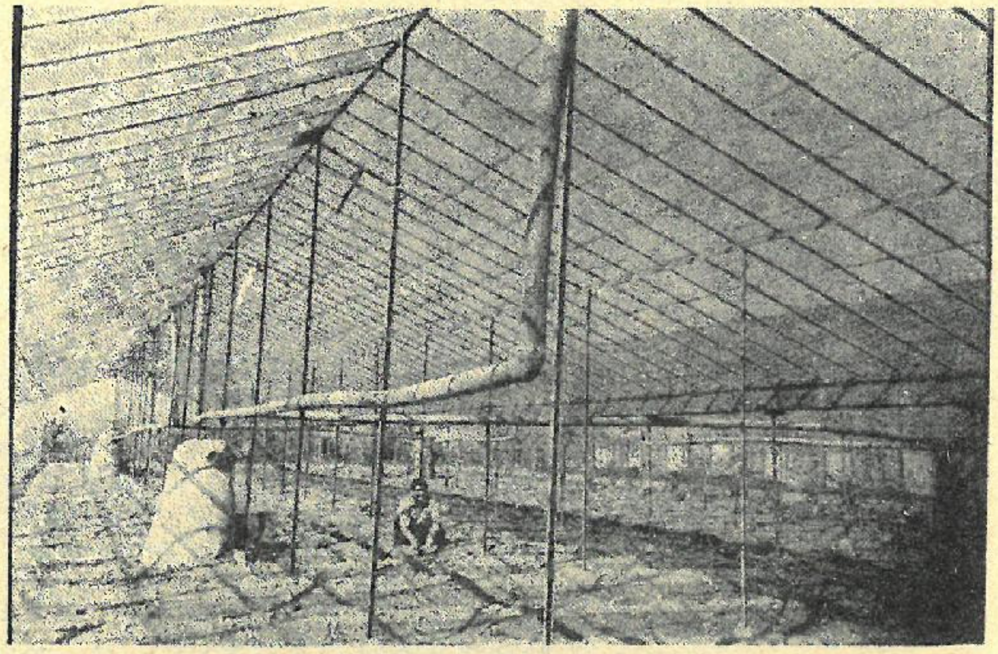

Figure 8. Greenhouse heating by oven type stoves

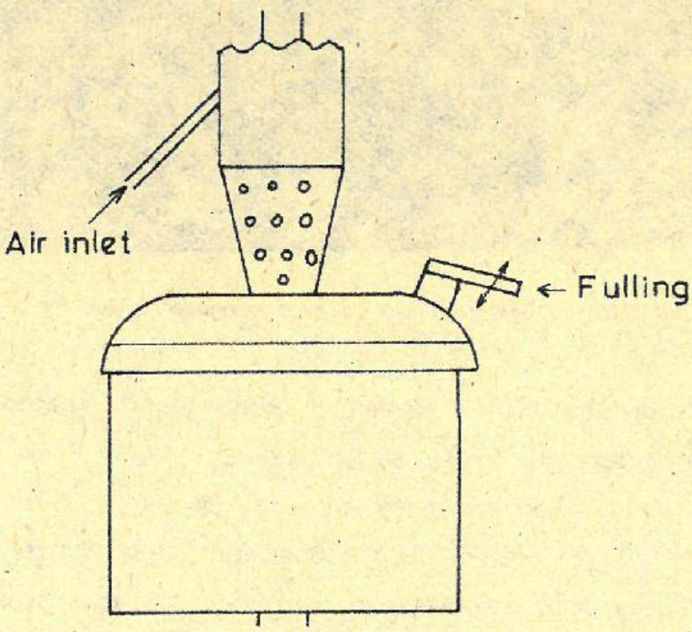

Figure 9. Heavy oil stoves

Greenhouse Heating With Liquidified Petroleum Gas (LPG) Stoves

Approximately 1 ha area in Kumluca and 2 ha area in Kale are heated by system above. Radiants are commonly used with the LPG tubes of 12 kg.

The stoves are usually used with the industrial type (i.e.45 Kg) LPG tubes. Every tube of 12 Kg has one radiant in application and three stoves are used with the LPG tubes of 45 Kg (Figure 10).

Figure 10. LPG tubes inside the greenhouse

Some greenhouses are heated by hot water pipes of flat steel and finned pipes of polyethylene. But investment and operation costs of these systems are very high for farmers having low income. At the moment some frost protection applications have also started to be used increasingly. These are simply:

- Use of thermal screens,
- Smoking on the thermal screens,
- Fogging inside of greenhouse and
- Distribution of the well-water on the greenhouse roof (Figure 11).

Heating Expenses Per Heating Element

The largest production expenses are those which are because of heating and frost protection. Heavy oil stoves have the largest expenses per heating element when compared to the others. Because fuels used in these stoves have not any certain collection area and a price, which may be very expensive some times. The LPG stoves have the lowest expenses per heating element (i.E.about 160 000 TL/per stove or radiant). So, it can be claimed that use of these stoves will spread in Antalya in one to two years.

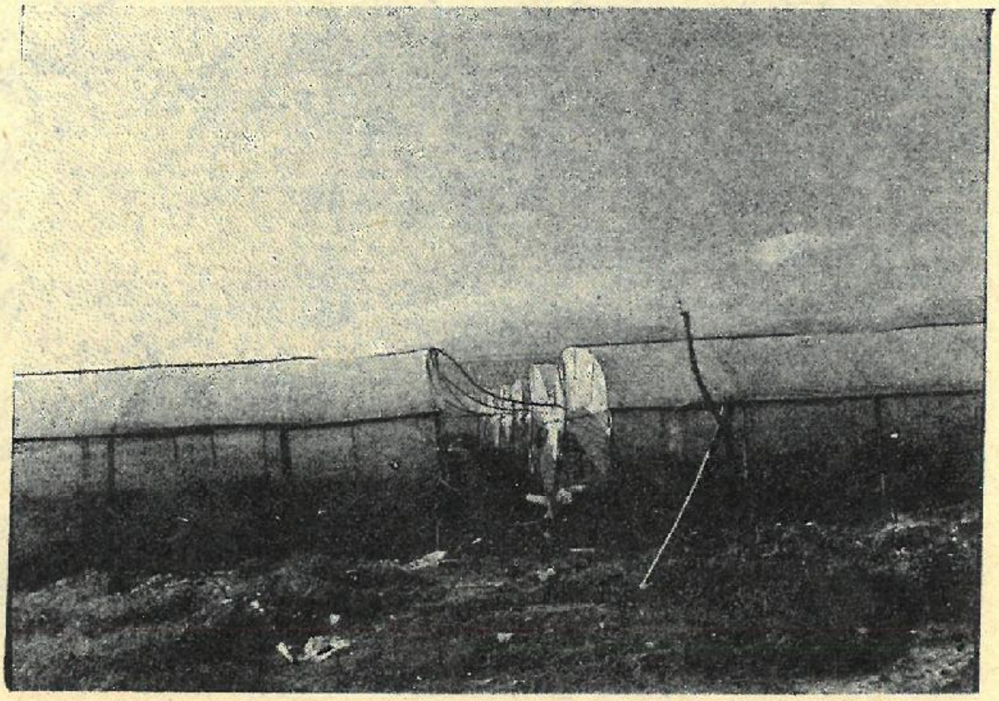

Figure 11. Polyethylene duct pipes for frost protection

DISCUSSION

It was found out in the end of research that the modern heating methods (i.e.inside air temperature is controlled very good by using them) are not used in greenhouses in the region. Heating applications are in use if frost protection is the only objective and as a result of this quality and quantity decrease when compared to the yield that can be obtained by using a heating system working properly. The problems related to the heating methods and elements used in this region's greenhouses can be ordered as below;

- It is difficult to burn the wood in the stoves and to supply it.
- The distribution uniformity of the pipes is not good,
- Extra tubes are needed in LPG appliations, just in case,

- All the greenhouses have not any automatic control systems either for temperature control or to warn the farmers about inside air temperature,
- The distances between the stoves are not equal to each other,
- Applications of thermal screens are insufficient and ineffective,
- Although incoming solar radiation and sunshine period are very attractive for both heating and frost protection, no farmers have any solar energy system for the purposes above.

Lastly, researches must be carried on using solar energy in heating of greenhouses in the region.

ÖZET

SERALARDA KULLANILAN ISITMA SİSTEMLERİ VE ANTALYA SERALARININ BU YÖNDEN KARŞILAŞTIRILMASI

Bu araştırmada "Seralarda Kullanılan Isıtma Sistemleri ve Bu Sistemlerin Antalya Bölgesi Seralarında Kullanılanlar ile Karşılaştırılması" amaçlanmıştır. Modern ısıtma sistemleri genel olarak sıcak sulu, sıcak havalı, jeotermal enerjili, atık ısı enerjili ve güneş enerjili olmak üzere 5 gruba ayrılabilir. Yörede yürütülen araştırmada normal üretici seralarında bu yöntemlerden herhangi birisinin kullanılmadığı görülmüştür. Bunun nedeni de bu tip ısıtma sistemlerinin ilk yatırım masraflarının yüksek olmasıdır. Alternatif olarak, üreticiler odun ve ağır yağ sobaları ve bütan gaz sobaları kullanmaktadırlar. Bu sobalar sadece don tehlikesi olduğu zamanlarda yakılmaktadır. Bütan gaz sobalarının, birim ısıtma elemanı başına giderlerinin az olması nedeni ile kullanımının artacağını söylemek mümkündür. Yörede, güneş enerjisi kış yetiştirme döneminde son derece elverişli olmasına rağmen, herhangi bir uygulaması yoktur. Dondan koruma ve enerji koruma yöntemleri ise henüz başlangıç aşamasındadır.

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