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Investigation of the Greenhouses in Istanbul in Terms of Structural Properties

Hacer Şakar Kolay[1], Can Burak Şişman[2]
[1]Sarıyer Village Directorate of Food, Agriculture and Livestock, Ferahevler/Sarıyer
[2]Namık Kemal University, Faculty of Agriculture, Department of Biosystem Engineering, Tekirdağ
([1]hacerskolay@gmail.com, [2]cbsisman@nku.edu.tr)

Abstract- In this study, we aimed to determine the current structural conditions, problems, characteristics of the ventilation and heating systems of the greenhouse systems in Sariyer and Pendik districts of Istanbul province, then to develop an appropriate greenhouse project to local ecological conditions. Gümüşdere neighborhood in Sarıyer district and Göçbeyli and Emirli neighborhoods in Pendik district have been selected as a research area, which covers 50.8 % of Istanbul's greenhouse cultivation. We carried out a survey to determine the size and type of farms, and greenhouse materials. Examined greenhouses are selected by the random sampling method. The current condition and set up construction, types and features of plastic greenhouses and high tunnels are examined by making measurements, sketches, observations and taking photographs. Of all surveyed greenhouse systems, 7.8 % (totally 10) are single greenhouses, 38.3 % (totally 49) are block greenhouses, and 53.9 % (totally 69) are high tunnels. It is determined that 100% of the surveyed plastic greenhouses and high tunnels are constructed without any project. 79.7% of growers have made a local contractor established plastic greenhouses and high tunnels. Iron is used as the main carrier material in 71.9% of the greenhouses. There is no steel used in greenhouses because it is mostly used in glass greenhouses. In the examined region, there are almost no glass greenhouses. As a result, we aimed to raise technical standards of plastic covered greenhouses and high tunnels to that of the Turkish Standards Institute (TSE). To enlighten local growers, we aim to make a usable technical project suitable for the research area using AutoCAD software

Keywords- *Plastic Greenhouse, High Tunnel, Cover Material, Construction*

I. INTRODUCTION

Greenhouses are movable structures that enable growing cultivated plants economically during periods when climatic conditions are not suitable for plant growing in the open ground and can provide developmental factors necessary for plant production [1].

Since greenhouse cultivation in our country has developed depending on ecology, greenhouse activities have concentrated especially on our southern coasts. However, greenhouse cultivation began to increase rapidly with the use of plastics as a greenhouse cover and the elimination of transportation problems to big cities in the 1960s. Nowadays, greenhouse cultivation is performed in the Aegean, Marmara, and Black Sea Regions, and especially in the Mediterranean Region [2] [3]. The total greenhouse area where production is performed in our country is 649 118 da. 58.5% of the greenhouse areas are glass and plastic greenhouses. The remaining part consists of plastic tunnels [4]. When greenhouses are assessed in terms of the enterprise structure and size, they are observed to be family enterprises with small areas. The average size of greenhouses varies between 1000 and 3000 m2 [5]. Of the products grown in our greenhouses, 97% consist of vegetable species, 2% consist of cut flowers and indoor plants, and 1% consists of fruit species [4].

There is a total of 71895,2 ha agricultural land in Istanbul province (Table 1). Grain and field crops are grown in 65598,6 ha, vegetables are grown in 3410 ha, fruits and spice plants are grown in 2663,4 ha, and ornamental plants are grown in 52,7 ha of this area, and 170,5 ha area is left fallow. In Istanbul, the greenhouse agriculture area is 155,3 ha, and of this area, 1,1 ha consist of glass greenhouses, 34,6 ha consist of plastic greenhouses, 116,4 ha consist of high tunnels, and 3,1 ha consist of low tunnels [4].

TABLE I. AGRICULTURAL PRODUCTS IN RESEARCH AREA

Products	Area (ha)
Grain and Field Crops	65598,6
Fallow Area	170,5
Vegetables	3410
Fruits and spice plants	2663,4
Ornamental plants	52,7
Total	71895,3

In this study, it is aimed to examine the greenhouses and high tunnels in Sarıyer and Pendik districts, where greenhouse cultivation is concentrated in Istanbul province, and to identify the problems faced by enterprises and to suggest solutions for these problems.

II. MATERIAL AND METHOD

In the light of the information obtained from Istanbul Provincial Directorate of Food, Agriculture and Livestock, the research material consists of the surveys conducted with enterprise owners of greenhouses and high tunnels in Gümüşdere neighborhood of Sarıyer district and Göçbeyli and Emirli neighborhoods of Pendik district, where greenhouse cultivation has been concentrated in the province (50.8%). The study was carried out in a total of 128 greenhouses and high tunnels, 59 of which were in Sarıyer district and 69 of which were in Pendik district, and in the selection of these enterprises, the random sampling method was used to represent the region [6]. Sarıyer district constitutes 57.2% of the plastic greenhouse of Istanbul province and Pendik district constitutes 50.7% of the high tunnels of Istanbul province.

The climate of Istanbul exhibits a feature of transition between the Black Sea climate and the Mediterranean climate. The long-term average climatic data of the province are presented in Table 2. [7]

TABLE II. CLIMATE DATA FOR ISTANBUL DISTIRCT (1950-2014) [7].

Mounth	Av. Temp. (° C)	Av. Max. Temp. (° C)	Av. Min. Temp. (° C)	Max. Temp. (° C)	Min. Temp. (° C)	Av. Monthly Precipitation (kg/ m^2)	Av. Rainy Day
Jan	5,6	8,5	3,2	22	-11	105,3	17,5
Feb	5,7	9	3,1	23,2	-8,4	77,3	15,2
Mar	7	10,8	4,2	29,3	-5,8	71,8	13,8
Apr	11,1	15,4	7,7	33,6	-1,4	44,9	10,4
May	15,7	20	12,1	34,5	3	34,1	8,1
June	20,4	24,5	16,5	40	8,5	34	6
July	22,8	26,5	19,5	41,5	12	31,6	4,2
Aug	23	26,7	20	39,6	12,3	39,8	4,9
Sep.	19,7	23,6	16,8	36,6	7,1	57,9	7,3
Oct	15,6	19,1	13	34	0,6	87,7	11,2
Nov	11,4	14,7	8,9	26,5	-2,2	101,3	13,3
Des.	8	10,8	5,5	25,8	-7	122,6	17,3
Anually Av.	13,8	17,5	10,9	32,21	0,64	67,35	10,76

The study was carried out in two stages, namely field studies and desk studies. In field studies, the greenhouses and high tunnels, which constitute the research material, were determined by visiting, and their current conditions and technical characteristics were determined by measurements, observations, photographing, and surveys conducted with growers. After having completed the field studies, desk studies were started, and the data obtained in the field and survey results were converted into charts, graphs, and plans. In the light of the obtained data, problems were determined, and solution suggestions were made.

III. URESULT AND DISCUSSION

The sizes and built shapes of the 128 greenhouses that make up the research material are presented in Tables 3 and 4. Approximately 69% of the greenhouses examined have a size smaller than 500 m2 and are medium-sized, and all of them are covered with plastic.

The technical characteristics obtained as a result of the measurements and examinations performed in the greenhouses and surveys conducted with growers are presented in Table 5.

TABLE III. SIZE OF THE INVESITAGATED GREENHAUSES (M^2)

Greenhouse area (m^2)	Number	Percentage(%)
100-300	53	41,4
300-500	35	27,3
500-700	6	4,7
700-900	6	4,7
900-1100	6	4,7
1100-1300	6	4,7
1300-1500	6	4,7
>1500-	10	7,8
Toplam	128	100

Plastic greenhouses constitute 46.1%, and high tunnels constitute 53.9% of the enterprises studied. The most used material in the roof system and columns as a bearing element was iron (71.9%), and the use of iron and wood (21.1%) together was observed to be ranked as the second. It was determined that the condition of the land was taken into consideration in the direction of greenhouses and high tunnels and 82.8% of the enterprises were placed in the East-West direction. In our country, it is recommended to position the long walls of greenhouses in the East-West direction in order to make the best use of the sun rays in winter [8] [9].

TABLE IV. BUILT SHAPES OF THE INVESTIGATED GREENHAUSES

Type	Cover						Total	
	Single greenhouse		Block greenhouse		High Tunel			
	Number	%	Number	%	Number	%	Number	%
Glass	-	-	-	-	-	-	0	0
Plastic	10	7,8	49	38,3	69	53,9	128	100

TABLE V. TECHNICAL CHARACTERISTICS OF THE GREENHOUSES (%)

Type of the greenhouse	High tunel		53,9
	Plastic greenhouse		46,1
Construction material	Iron		71,9
	Wood		0,8
	Iron+wood		21,1
	Iron+ galvaniz		2,3
	Galvaniz		3,9
Direction	E – W		82,8
	N – S		17,2
Construction Shape	Arch with water pipe		75
	Arch with circle profile		3,1
	Wood		0,8
	Iron+wood		21,1
Protection type against corrosion	Antirust		76,6
	Used galvanized profiles		3,9
	Oil paint		19,4
Joining type of metal elements	Screw		13,2
	Welding		60,2
	Mixed (welding+screw)		26,6
Cover material	PE UV		57
	PE UV+IR+Antifog		13,3
	PE		29,7
The shape of fix the cover material to the construction	Nail		21,1
	Clips		33,6
	Latches		45.3
Aeration	Roof ventilation		5,5
	Side wall ventilation		35,1
	Door ventilation		59,4
Irrigation system	Drip		100
Heating system	Stove		0,8
	Fan		0,8
	Radiator		0,8
Prevention against heat loss	Yes	Second cover	2,4
	No		97,6
Shanding	Yes	Lime and mud	46,1
	No		53,9

In the region, single greenhouse lengths vary between 30 and 50 m, 26-60 m in block greenhouses, and 30-50m in high tunnels. Filiz (2001)[10] stated that the long lengths of greenhouses would prevent the greenhouse from being heated homogeneously and that the natural airflow entering through open doors could cause damage to plants by reaching a high speed. The researcher also stated that shorter lengths of greenhouses would lead to the fact that agricultural works could not be performed easily and it would cause productivity to decrease. Therefore, the researcher recommended that the greenhouse length should be between 30 and 60 m. The greenhouses and high tunnels examined in Sarıyer and Pendik districts are among the stated values in terms of length.

In 99.2% of the enterprises, the arc roof was preferred, and this is due to the fact that they were generally constructed by people with insufficient technical knowledge according to the greenhouses and high tunnels, which had been previously built without a project.

Of the greenhouses examined in the study, the sidewall height is less than 2m in 17%, between 2-2.5m in 76%, and over 2.5m in the remaining 7%. The sidewall height in greenhouses is requested to be at least 2.6 m [8] (Yüksel, 2000). Therefore, the sidewall heights of the greenhouses in the region are insufficient in 93% of the enterprises. The height of all the high tunnels examined is over 2m.

According to Yüksel (2000) [8], the optimal roof width that can be applied in greenhouse enterprises should be between 9-12m in glass-covered greenhouses and between 6-9m in plastic-covered greenhouses. There is no glass-covered greenhouse in the research area because the initial investment cost is high, and enterprises are usually small family businesses. The widths of plastic-covered single greenhouses vary between 7-8 m, and the widths of block greenhouses vary between 16-56 m. The high tunnel width is 8 m. According to the data obtained, it was determined that the roof widths of the greenhouses in the research area are within the specified limits.

It was observed that of the enterprises, 4% used galvanized profiles, 76.6% used antirust preservatives, and the remaining 19.5% used oil paints in the protection of skeletal materials against corrosion.

In the joining types of metal elements, welding ranks first by 60%, mixed (welding + screw) ranks second by 26.6%, and bolt ranks third by 13.2% (Figure 1). Welded connection is mostly preferred by producers due to its robustness. However, it is necessary to clean the burrs formed on joints well in order to avoid damages to the cover, especially in plastic-covered greenhouses [8] (Yüksel, 2000).

Figure 1. Joining type of metal elements (screw, welding)

Plastic cover, which is the most used cover material in greenhouses in our country due to its cheapness [11] (Tüzel and Eltez, 1997), was used in all of the enterprises in the research area. It was determined that of the greenhouses and high tunnels examined, 57% used UV-reinforced polyethylene, 29.7% used polyethylene (normal), and 13.3% used UV+IR+Antifog-reinforced polyethylene cover material. The minimum physical life of the cover material in all enterprises is 3 years. It was determined that 45% of the enterprises in the research area used latches, 34% used clips, and the remaining 21% used nails to fix the cover material to the construction.

Natural ventilation is performed in all of the greenhouses and high tunnels where the study was carried out. Ventilation is usually performed by opening the cover material on the side wall. 6% of the greenhouses have roof ventilation windows (Figure 2). The ratio of the roof window area to the greenhouse floor area of these greenhouses is 5.64%. While it is desired that roof ventilation is as large as 20% of the greenhouse floor area for good greenhouse ventilation, this ratio varies between 1 and 4% in greenhouses in our country [5] [12] (Sevgican, 1999; Gezer et al., 2009). In the light of the obtained data, it can be said that although the roof ventilation window areas in the greenhouses in the region are above the country's average, they are very inadequate.

Figure 2. Ventilation on wall and roof in the greenhouses

It was determined that the drip irrigation system was used in all of the greenhouses in the region and 99% of the growers did not have any complaints about drip irrigation.

It was determined that of the 128 greenhouses and high tunnels examined in the study, 3 (approximately 2%) took measures for heat protection, only 1 greenhouse (0.8%) used a solid fuel central heating system, 1 greenhouse (0.8%) used a blast and pipeless greenhouse heating system, and 1 greenhouse (0.8%) used a stove blast heating system. In all three greenhouses, heating is performed for protection from frost instead of effective heating. Blast heating systems are preferred in these greenhouses since ornamental plants are grown here and they are not wanted to be affected by humidity, especially during flowering periods.

IV. CONCLUSION

The results of this study, which was conducted to determine the present conditions of the greenhouses and high tunnels in Sarıyer and Pendik districts that constitute more than half of the greenhouse agricultural areas in Istanbul and to determine

the problems encountered and to suggest solutions for these problems, are summarized below.

It was determined that the size of the enterprises in the research area is generally small and they continue production in the traditional way. It was observed that greenhouses and high tunnels were similar to each other and that the faults were exactly the same in all greenhouses and high tunnels due to the fact that they were constructed without a project and by people with insufficient technical knowledge. Therefore, the desired quality and the efficient product cannot be obtained.

The plastic cover material has been preferred in all of the enterprises in the research area since it is inexpensive and easy to use. However, the use of especially the UV+IR+Antifog-reinforced polyethylene cover should be widespread due to the short physical life, low sunlight permeability, and high heat loss of the plastic cover material. Continuous clips should be used to fasten the plastic cover material to the construction.

In the region, where spring and fall ornamental plants are cultivated in general, heating is performed in very few greenhouses only for the protection from frost. Heating must be performed for the cultivation of high quality and productive ornamental plants.

In natural ventilation systems, ventilation is performed through windows in greenhouse side walls and roofs. For good ventilation, the total window area of the greenhouse must be between 16-25% of the greenhouse floor area. Windows that are effective in ventilation are roof windows. Although 6% of the greenhouses in the research area have roof ventilation windows, their sizes are very inadequate. Moreover, the vast majority of the greenhouses and high tunnels examined do not have side and roof ventilation windows. This determined situation has revealed that effective ventilation cannot be performed in the entire research area. Accordingly, water condensing on the inner surface of the cover material falls on plants and causes various fungal diseases. Furthermore, the condensed water causes wood decay and oxidation of metals in bearing materials.

When the obtained information was evaluated, it was determined that greenhouse cultivation in the research area continued as learned from the father or neighbor and could not adapt to new developments. It is necessary to perform maintenance and repair works by technical staff in greenhouses and high tunnels and to overcome technical inadequacies of greenhouses and high tunnels. Furthermore, growers should be informed about production techniques and the latest technologies to be used in production, and projects suitable for the region should be developed for new enterprises to be established in the future.

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