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The availability of irrigation and fogging systems in crop production under greenhouse conditions by evaluating rain water

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Abstract: Providing sustainable crop production regardless of climate conditions can be realized with production in greenhouse conditions. Greenhouse irrigation and moisture balance are among the systems related to the environmental conditions required for plant development. All the water resources are decreasing day by day due to the indiscriminate practices in agricultural irrigation and the pollution caused by the leakage of waste materials directly into the water resources. For this reason, water saving methods should be used in irrigation and fogging systems to be made in greenhouse conditions. With the method of harvesting rainwater, which is used in today's conditions, a special water collection system is planned in the roof system during the greenhouse design phase, and the accumulated water is transferred to the water collection pool with the help of pipes. The water accumulated in the water collection pool is transferred to the greenhouse irrigation and fogging systems by using pressurized systems when needed. In this study, it is aimed to give information in the context of the literature on the collection and accumulation of rainwater, which is being used recently in modern greenhouses, and the establishment of irrigation - fogging systems. For this purpose, it has been revealed that the information obtained by literature review is compiled and water saving can be achieved in greenhouse cultivation. In the compilation study, it is recommended to support the studies on the technology of harvesting rainwater in greenhouse and to encourage the investments to be made in this field.

Keywords: Greenhouse, Irrigation systems, Fogging systems, Rain waters, Water harvesting, Water storage

Yağmur suyunun değerlendirilmesi ile sera koşullarında tarımsal üretimde sulama ve sisleme sistemlerinin sağlanabilirliği

Özet: İklim koşullarına bağlı olmaksızın sürdürülebilir bitkisel üretimin sağlanması, sera koşullarında üretim ile gerçekleştirilebilmektedir. Sera içi sulama işleminin yapılması ve nem dengesinin sağlanması, bitki gelişimi açısından gerekli çevre koşulları ile ilgili sistemlerin başında gelmektedir. Tarımsal sulamada gelişi güzel şekilde hoyratça yapılan uygulamalar ve atık maddelerin doğrudan su kaynaklarına sızması sonucu oluşan kirlilik nedeniyle, tüm su kaynakları her geçen gün daha da azalmaktadır. Bu nedenle, sera koşullarında yapılacak olan sulama ve sisleme sistemlerinde, su tasarrufu sağlayan yöntemlerin kullanılması gerekmektedir. Günümüz koşullarında kullanılmaya başlanan yağmur sularının hasadı yöntemiyle, sera tasarlama aşamasında çatı sisteminde özel su toplama sistemi planlanmakta olup, biriktirilen su borular yardımıyla su toplama havuzuna aktarılmaktadır. Su toplama havuzunda biriktirilen su, ihtiyaç duyulduğunda basınçlı sistemlerden yararlanılarak sera içi sulama ve sisleme sistemlerine aktarılmaktadır. Bu çalışmada, günümüzde modern seralarda yeni kullanılmaya başlanan yağmur sularının toplanması ve biriktirilmesi ile sulama - sisleme sistemlerinin oluşturulması ile ilgili literatür kapsamında bilgi verilmesi amaçlanmıştır. Bu amaçla, literatür taraması ile elde edilen bilgiler derlenerek seracılıkta su tasarrufunun sağlanabileceği ortaya konulmuştur. Yapılan derleme çalışmasında seracılıkta yağmur sularının hasadı teknolojisi ile ilgili çalışmaların desteklenmesi ve bu alanda yapılacak yatırımların teşvik edilmesinin gerekliliği tavsiye edilmektedir.

Anahtar Kelimeler: Sera**,** Sulama sistemleri, Sisleme sistemleri, Yağmur suları, Su hasadı, Su depolama

1. Introduction

Greenhouse, cultivation started at the beginning of the 19th century in Northern European countries, and II. It has developed in the world after the World War. Starting greenhouse operations in the province of Antalya Turkey in the 1940s, is today in the Mediterranean and Aegean regions heavily (Kervankıran, 2011; Çerçioğlu ve Şahin, 2016).

Creating a suitable climate for the growth and development of plants in greenhouses, It is achieved by controlling variables such as temperature, relative humidity, solar radiation. In classical type greenhouses, the climate, sun outside the greenhouse, temperature, humidity, rain. It changes constantly. This change occurs according to the energy-mass balance in the greenhouse. Other one ın a sense, some of the energy coming on the greenhouse is stored, some of it is given outside. If the leaf temperature is high, it is caused by the excess energy stored in the plant. Excess energy accumulation, by activation of ventilation or cooling systems. It is tried to be resolved to a certain extent (Wee 2010).

Irrigation is generally defined as the water required for plant development but cannot be met naturally, to the soil without causing environmental problems. In order to maintain the aesthetic beauty of the landscape areas, most of these areas apply irrigation similar to natural precipitation to keep them alive. If this is not done, most of the parks and green areas around us can be lost. With the effective and continuous use of our water resources, it is hoped that the maintenance and irrigation of these systems and the expansion of the landscape areas (Smith 1997).

Between 1950 and 1990, while the world population doubled, the amount of water used increased 6 times. It is estimated that the annual water amount of 7300 m³ per capita in 1995 will decrease to 4800 m yılında in 2025. A rapid decline is observed due to annual renewable fresh water per capita, rapid population growth in the country, urbanization and industrialization events and increased water consumption on a personal basis. According to these developments, while the amount of water per capita in our country was 1950 m³ in 1990, this figure will decrease to 1500 m³ in 2000, and it is estimated that our population will be around 100 million in 2030, and that water consumption per capita will be around 1000 m³ / year (Anonymous 1998). . Thus the left and sufficient water resources for the future generations to Turkey should be used very well preserved.

In our country, it is aimed to obtain more products in greenhouse than the unit area. For this reason, the number of plants grown in the unit area and the biomass weights obtained are high. Depending on the product variety and climate characteristics of our agricultural areas, large amounts of organic waste are generated and generally there is no systematic evaluation of these wastes. Sonmez et al. (2002) in a study conducted in Antalya-Kumluca, it is stated that approximately 57 500 tons of plant waste annually from tomato greenhouses, and 330 625 tons of plant waste in Antalya province are discarded randomly and destroyed by burning.

Figure 1. Modern greenhouse with air conditioning control

The aim of this study is to meet the water source needed in the greenhouses from the climate conditions in irrigation and fogging systems, which is one of the most important production ways in order to increase the agricultural products in the face of the population increase in the the world. In this way, the nutritional needs of the growing population will be met on the one hand, and water supply will be provided to be used in agricultural production without damaging the decreasing water resources with each passing day.

2.Material and Method

One of the variables required to provide optimum conditions for crop production in the greenhouse is the provision of irrigation and fogging systems. For the greenhouse, irrigation systems should be provided to provide fogging for the moisture balance and the water needed by plant products. The study material was composed of national and international studies on irrigation and fogging systems in greenhouses and the availability of rainwater harvesting of these systems. In the light of the information collected from these studies, the path to be followed in the research has been determined.

3.Results

Within the scope of the research, the findings related to the automated irrigation and fogging systems to be provided in the greenhouse and rainwater harvesting methods are tried to be explained under the following sub-titles.

3.1. Fogging Systems

Fogging System is the system used to cool the environment in a short time and to provide the moisture needed by the plant in the greenhouse. One of the systems installed in the greenhouses to provide the moisture that the plant needs and to reduce the greenhouse indoor temperature is the fogging method.

Fogging method is one of the systems established to provide the moisture required by the plant in the greenhouses and to decrease the indoor temperature of the greenhouse. In the fogging system, heat is absorbed from the ambient air by the evaporation of water sprayed with high pressure, and the absorbed heat is transported outside the greenhouse by air. The fogging heads are placed at the top of the greenhouse at 1m intervals and at a height of about 1m from the plant height. Fogging is applied by running the heads every 5 minutes for 5 or 10 seconds. The fogging system is preferred in places with low humidity and high temperature because the system increases the humidity together with cooling (Sarıkoç 2007).

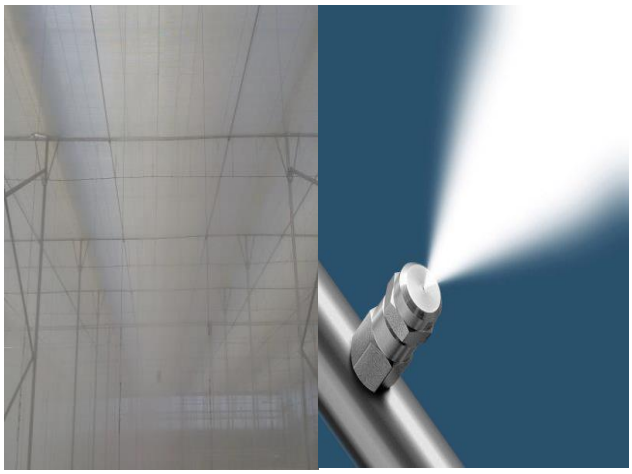

Fig.2. Greenhouse fogging systems

3.2.Irrıgatıon Systems

Irrigation of water, which is necessary for plant development but cannot be provided by precipitation, through artificial means is called irrigation, and the way this water is given to the soil in the plant root zone is called irrigation method. Pressurized irrigation methods that can be used in greenhouse conditions; sprinkler irrigation method, drip irrigation method, bubbler irrigation method and micro sprinkler irrigation methods (Sarıkoç 2007).

3.2.1. Sprinkler Irrigation Method

In this method, irrigation water is transported in closed pipes under pressure to mechanical sprayers and applied to the soil in a manner similar to natural precipitation. Almost all plants can be watered with this method if the paddy is kept separate. In sprinkling method, starting capital and operating costs are higher than surface irrigation methods. In this method, water application can be as low as 0.25 cm / hour. Thus, it can be applied without causing water loss and erosion in over inclined, uneven areas and soils with low depth, and it can be applied efficiently in soils with high permeability or low water holding capacity (Ertuğrul and Apan 1979).

Fig.3. Greenhouse sprinkler systems

Sprinkler irrigation method; It is one of the most suitable irrigation methods that can be used for irrigation of plants with low usable water holding capacity, high water intake rate, lightly structured soils, especially high economic value and sensitive to moisture deficiency in the soil (Demirel 2005).

3.2.2.Drip Irrigation Method

With drip irrigation, evaporation from the dry soil surface, surface runoff and deep leakage are prevented, water saving is increased and irrigation efficiency increases. Since the irrigation water requirement is also less for the unit area, a larger area can be irrigated with the water source at hand. Thus, it is possible to use the water optimally where the water supply is limited (Kanber et al. 1994).

Fertilizer saving is also provided since the necessary fertilizer for plants can be given to the plant root area with irrigation water in the desired time and amount. Weed development decreases as water will not reach between the rows in which drip irrigation is applied in row plantings. Herbicides to be given by irrigation water are effective against weeds that can develop in wet areas (Haroğlu 2000). The structure of the drip irrigation system to be used in greenhouses is shown below (Anonim 2019).

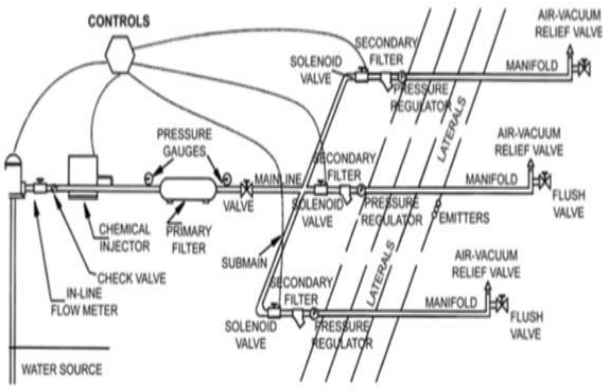

Fig.4. Structure of drip irrigation system

3.2.3. Micro Sprinkler Irrigation Method

This sprinkler irrigation method using small sprinkler heads is called "Micro sprinkler irrigation method". System elements are the same as drip irrigation system elements. The only difference is that small sprinkler heads are used instead of drippers. In other words, this method is a form of irrigation where drip irrigation system and small sprinkler heads are used, but irrigation is done by sprinkler irrigation method. In this method, a lateral pipeline is laid during each tree and a sprinkler head is placed under each tree along the lateral (Güngör et al. 1995).

3.2.4. Bubbler Irrigation Method

Bubbler irrigation method is mostly suitable for irrigation of trees, shrubs and orchards and not for grass and other field crops. The basis of the system consists of the lateral pipe that conducts water with low pressure and transparent polyethylene water distribution pipes with a diameter of 10-12 mm (Sarıkoç 2007).

Fig.5. Bubbler irrigation method

4. Discussion

In cooling with fogging method, in the greenhouse greenhouse from a sufficient height from the plants placed on pipes passed along made with spray nozzles. It the primary purpose of the method; greenhouse air Although it is moisturizing, the plants for cooling and even irrigation functions is used (Öztürk ve Başçetinçelik, 2002).

Low and low in the cooling system by fogging. There are two methods, high pressure. The low pressure of these is 300-400 kPa pressure between 50-100 µm and medium produces bulky drop diameters. High pressure ın systems, it works between 3.5-7.0 MPa pressure and they produce drop diameters of 2-60 µm. High pressure systems low pressure finer droplets than systems they produce faster evaporation and cooling rate increases (Li ve Willits, 2008).

Rain water can be collected and treated and reused. Instead of rainwater, it can be evaluated in different ways depending on the amount and type of use. Examples include barrels used for storing rainwater, rain gardens, wet and dry ponds. It is possible to collect and store water flowing from roofs in large facilities, to be used as water for ice skating rinks, garden irrigation and industry, and to be used as reservoir water in toilets. In addition, storing rainwater helps to reduce the risk of floods and floods by reducing the amount of water mixed into the network during periods of heavy rainfall (Silkin, 2014).

The idea of rainwater collection actually appears as a method used since ancient times. The cisterns used to prevent water shortage in drought periods were used to collect rainwater. Today, rainwater is obtained by using cistern systems, especially in arid regions where agriculture is common (Şahin & Manioğlu, 2011).

Fig.6. Water storage cistern

Advanced rainwater collection system; collection surface consists of horizontal and vertical grooves, filters, pump, rainwater tank and distributor systems. According to the need of use in buildings, the quality of water is divided into two as drinking and utility water (water not of drinking water quality). Although the water collected from the roofs is used as some utility water, it can be purified and brought to the level of drinking water (Şahin and Manioğlu 2011).

The use of rainwater on a global scale is increasing day by day. Rain water is stored in many cities of Japan, especially in Tokyo. Rain waters are collected in the region of the Fiji Islands and used when needed. From a numerical perspective, there are rainwater use systems in approximately 25,000 homes in the USA (Alparslan et al., 2008).

Rain water is collected from roofs or from the surface using two different techniques and drinking water, irrigation and cleaning etc. It can be used for purposes. The collected water is also leaked underground for purposes such as preventing ground collapse and feeding groundwater resources. Today, collecting and using rainwater has become one of the alternative water sources due to reasons such as the consumption of fresh water resources and pollution (Alparslan et al., 2008).

Fig.7 Rainfall Collection System

5. Conclusion

Globally, natural water resources are decreasing day by day. Meeting the growing population's water needs with available resources will be in danger in the near future. In this regard, measures to save money should be taken in all areas of water use. In agricultural production, where water consumption is the most intense, all developments in this regard should be followed closely.

The main purpose of irrigation is to provide the water lost through transpiration and evaporation from the soil for healthy agricultural production. In this regard, the most important condition that should be provided in agricultural production under greenhouse conditions is to meet the plant water consumption.

In greenhouse conditions, the water requirement of the plants should be met with minimum water consumption. Likewise, in-greenhouse humidification is of great importance in terms of agricultural production. Planning the irrigation and fogging systems that should be provided in greenhouse conditions in the most economical way is a great necessity in terms of decreasing water resources every day.

Within the scope of national and international researches, the study was conducted on storing rainwater in modern greenhouses and using irrigation and fogging systems for the greenhouse. As a result of the study, it was concluded that it is possible to transfer the water collected by the rainwater harvesting system to be designed in the roof system of the greenhouses to the water tank to be projected underground. In this way, the water required in agricultural production for the greenhouse can be obtained naturally. Vegetable production will be done without damaging the existing water resources, and the desired amount of product can be provided at any time, regardless of climate conditions.

Conflict of interest disclosure:
There is no conflict of interest.

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