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# Use of Tensiometer for Optimal Water Management in Tomato Cultivation

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***Abstract:*** *For optimal water management in tomato cultivation an experiment was conducted in a randomized complete blocks design with three replications in research farm of Jiroft in Kerman. In this experiment four suction levels ($I_1$=35, $I_2$=45, $I_3$=55 and $I_4$=65 centibar) were compared. The results showed that the used water in total course of growth with mentioned suction levels was respectively 6550, 5470, 4510 and 3490 cubic meters per hectare. Performance obtained from studied treatments also showed that irrigated treatment with suction level of 45 centibar has the highest performance (44.21 tons per hectare) and suction levels of 35, 55 and 65 centibar respectively have the performance of 37.44, 44.22 and 27.62 tons per hectare.*
**Key words:** *Tensiometer, Tomato, Jiroft*

## 1. INTRODUCTION

Lack of water for human life especially in arid and semi-arid regions and in developing countries has emerged as a real threat. Population growth and also rising standards of living have increased water use and since the amount of used water in agriculture is significant, saving water used in this section is possible and effective as a way to overcome the lack of water problem. Most parts of Iran is in arid and semi-arid regions and this has caused that water be the most important restrictive factor in increasing agricultural productions (Dehghan et al., 2010).

Considering the value of water in agriculture and restriction of this vital resource and because of the alternate droughts in the country, saving and efficient use of available water seems to be essential. On the other hand water restriction in irrigated agriculture is the main negative and inhibitor factor (Karimi et al., 2010). The kind of appropriate irrigation for each plant is different and time of irrigation has the greatest impact on quality and quantity of product performance, because some courses of plants growth are more susceptible to lack of water by delay in irrigation. In water restriction situations, the amount of water in root zone is less than when irrigation takes place entirely (Wang et al., 2007). The purpose of irrigation is providing suitable moisture conditions or in other words it is maintaining optimal moisture conditions in growth region in a manner that plant growth is not restricted. Most of the crops growth and root activity is restricted to the unsaturated soil because the root of most plants does not grow in saturated soil conditions where ventilation is restricted. In this sense we can say that plant growth is not related to components of pressure potential. If the salt concentration in growth medium is negligible, component of osmotic water potential in the soil will have little impact on plant growth and the absorption of water by the plant, so in root zone in soil the whole water potential equals the matric potential (Asadi & Homayounfar, 2011). The most important compounds of tomato are about 90% water and the rest are protein, fat, various sugars such as glucose and fructose, vitamin A, vitamin C, vitamin K, essential amino acids, minerals such as phosphorus, iron, sodium and cobalt. Recently, the existence of iodine in tomato is also reported. Due to the mentioned combinations, we can realize its unique properties. Because of this from 1980 to 1990 about 6000 research papers have been published about the analysis and identification of valuable materials in this plant. Although it is obvious that research on tomato still has continued and much of the materials and its constituent elements have not been discovered, today's research suggests the existence of a set of elements and materials in this plant which are very valuable for humans and very few people know about it and therefore are not aware of its value (Arab Poor, 2014).

## 2. TENSIOMETER:

Water is stored in the soil with different forces and to remove or displace it must overcome these forces. Due to the gravity position of water, the adhesion of water to the soil and water chemical properties, each of these forces has its own potential and water potential in soil is more preferred than potential of soil moisture.
Matric potential measurement is done by tensiometer. Available tensiometers include mercury tensiometer, stationary and mobile metal tensiometer and electronic tensiometer. Due to the measurement problems mercury tensiometers are not used, and metal tensiometers are used more. Tensiometer is a simple tube filled with water which ends a cap in top and ends a ceramic cap in bottom. Different parts of a tensiometer are (Asadi & Homayoonfar, 2011):

## 3. MATERIALS AND METHODS:

### 3.1. Location of the Study Area

Jiroft is located 240 kilometers southeast of Kerman. The region's climate is semi-warm and semi-humid, with 650 meters above sea level. It has longitude of 56 to 95 degrees and latitude of 28 to 29 degrees. The area of this city is 18438 square kilometers which makes up 11 percent of Kerman area. Meteorological Department statistics of Kerman show that this region has arid and semi-temperate climate and its average annual rainfall is around 150 mm per year. Minimum and maximum average annual temperature in this region is respectively -14 and +40°C. Winds in this area are dry monsoon winds and their direction is from the southwest to the northeast. Rainfall in this area usually begins in October and continues until May in next year. According to the recorded statistics in Meteorological Department of Kerman, the most rainfall is from January to April and most precipitation is as rain (Nameless, 2014).

### 3.2. Condition and Characteristics of Soil and Water:

Before doing the research, the farm soil and the used well water were sampled in depth of 0-30 cm. Then the samples were sent to the laboratory of soil and water in Jiroft research institute of agriculture and natural resources. Soil texture was determined using hydrometer approach and soil bulk density was identified using paraffin method. The moisture content at field capacity and the wilting point were determined using pressure plates. In addition, by preparation of saturation mud from soil samples, soil pH was measured by pH meter and electrical conductivity of soil was also measured by salinity meter device. Measuring ions of phosphorus, potash and nitrogen have been respectively determined using spectrophotometer, flame photometry and crude methods. The results of analysis of soil texture and soil physical and chemical key elements are presented in the table below.

**Table 3.1. Soil texture in research location**

| Soil depth (cm) | Clay (percent) | Silt (percent) | Sand (percent) | Texture | Apparent specific weight (grams per cubic centimeter) | Soil moisture percent at field capacity | Soil moisture percent at wilting point |
|---|---|---|---|---|---|---|---|
| 0-30 | 35 | 49 | 16 | Clay loam | 1.38 | 32 | 7 |

### 3.3. Characteristics of Pilot Project:

For optimal water management in tomato cultivation in Jiroft using tensiometer, an experiment was conducted in an area of 380 square meters (20×19) in a randomized complete blocks design with three

replications. Treatments included four suction levels ($I_1$=35, $I_2$=45, $I_3$=55 and $I_4$=65 centibar). In this experiment, wide of each plot was 4 meters and its length was 6 meters. The distance between planting rows was 100 cm and the distance between bushes was 40 cm. Moreover, to carry out measurements and for ease of commuting between treatments, the distance between primary and secondary treatments was considered a meter. It should be noted that the used irrigation systems was surface drip irrigation.
The used greenhouse was 3.5 meters in height and 5.5 meters in width. It was equipped with a sunroof, heating and cooling system and 4.5% UV coat of polyethylene. For providing the required heat, gasoline torch heating device was used. Heat distribution system was in the middle of greenhouse and under the roof and released heat from top to the bottom. So that during the growth period, the daytime temperature was between 30 and 45°C, the night temperature was between 22 and 28°C and relative humidity was between 35 to 65 percent.

### 3.4. Water Supply for Plants:

In this study, to determine the time of irrigation metal tensiometers were placed in three depths of 10, 40 and 70 cm and in 15 cm distance from hydrating tubes. The tensiometer which was placed in depth of 10 cm, was used for reading at an early stage of growth. Tensiometers placed in depths of 40 and 70 cm were used for readings in the middle and final stages of growth.
In this study when the vacuum gauge of tensiometer shows the intended suction level, irrigation was done. To determine the volume of irrigation, the soil moisture curve obtained from pressure plates were used. To do that first volumetric moisture proportional to the interested potential points was earned and then soil moisture in suction level of 35, 45, 55 and 65 centibar was brought up to field capacity to achieve irrigation depth (relation 1-3). It should be noted that the irrigation volume was calculated by multiplying the depth of irrigation by the area of plot.

$W = (\Theta_{FC}-\Theta_{I})\ MA.d$ (1-3)

In this relation W is irrigation requirement (mm), d is root depth (mm), $\Theta_{FC}$ is soil moisture content at field capacity (decimal), $\Theta_{I}$ is volumetric moisture in potential points (decimal) and MAD is discharge limit of soil moisture which according to reports is 0.45 for tomato plant (Razmi & Ghaemi, 2011). It should be noted that because irrigation system was drip irrigation and tested plots were under control, thus irrigation efficiency was assumed 95%. Also, because there was no information about the depth of tomato roots in the study area, so the root zone of plants in various stages of growth was achieved using sampling. The root zone at an early, development, middle, and final stage was varied, respectively ranged from 5 to 13, 10 to 25, 20 to 45 and 40 to 85 cm.

### 3.5. Data Analyses:

Data analysis was performed using statistical software MSTAT-C and Excel software was used for diagramming. The mean comparison was also done by Duncan's test.

### 3.6. Analysis of Variance:

The results of variance analysis related to the effects of suction levels on performance, water use efficiency, fruit weight, fruit diameter and bush height are shown in table 2-3. These results suggest that the effect of suction level on all traits was significant at the level of one percent error.

**Table 2.3. A summary of variance analysis**

| Source of changes | Degree of freedom | Performance | Water use efficiency | Number of fruits per plant | Fruit weight | Bush height |
|---|---|---|---|---|---|---|
| **Repeat** | **2** | 2432.12 | 0.0001 | 7.657 | 0.049 | 61.718 |
| **Potential points** | **2** | 1574.02** | 0.004** | 101.46** | 1.698** | 216.216** |
| **Error** | **4** | 1098.41 | 0.0004 | 1.967 | 0.009 | 2.195 |

### 3.7. The Amount of Used Water:

According to the measurements, the amount of used water in total course of growth in suction levels of 35, 45, 55 and 65 centibar are respectively 6550, 5470, 4510 and 3490 cubic meters per hectare.

### 3.8. Irrigation Period:

Taking into account the different folds of harvest during the tomato course of growth (150 days), irrigation courses in studied treatments were different for root growth and its water use in deep soil. Figure 1-4 shows that the highest number of irrigation repeat in suction levels of 35, 45, 55 and 65 centibar are respectively 2, 3, 4 and 5 days. In other words it can be said that if farmers in the cultivation of greenhouse tomato change irrigation period from 2 days to 3, 4, and 5 days, the used water will reduce respectively 16.5, 31.1 and 46.7 percent.

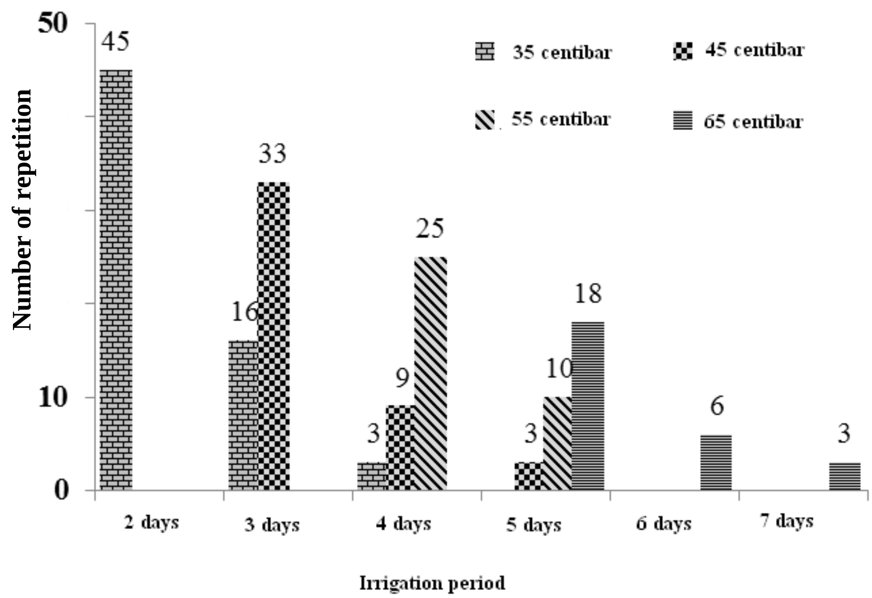


Figure 1.3. Variation in the number of repeated irrigation periods during the growing season

### 3.9. Product Performance:

In this study, as specified in table 2-3, the effect of different levels of suction on product performance is meaningful. Therefore, figure 2-3 shows the comparison of tomato performance mean under effect of different levels of suction which are obtained by Duncan test at the level of one percent probability. According to this figure, we can say that irrigated treatment with suction level of 45 centibar and performance of 44.21 tons per hectare is placed in the best statistical position while it is just 4.5% different from obtained performance of irrigated treatment with suction level of 55 centibar. This is in situations that this treatment in comparison to irrigated treatment with suction level of 45 centibar has about 17.5% (960 cubic meters per hectare) saving of water.

One of the other obtained results of this study is the comparison of obtained performance with suction level of 65 centibar with other levels of suction. As it is obvious of comparison of product performance mean under effect of different levels of suction (figure 2-3), suction level of 65 centibar with performance of 27.62 tons per hectare is placed in the worst statistical position while it is just 37.5% different from the best treatment in terms of performance (suction level of 45 centibar). It should be noted that the used water in this treatment in comparison to suction level of 45 centibar was less about 36.2% (3060 cubic meters per hectare).

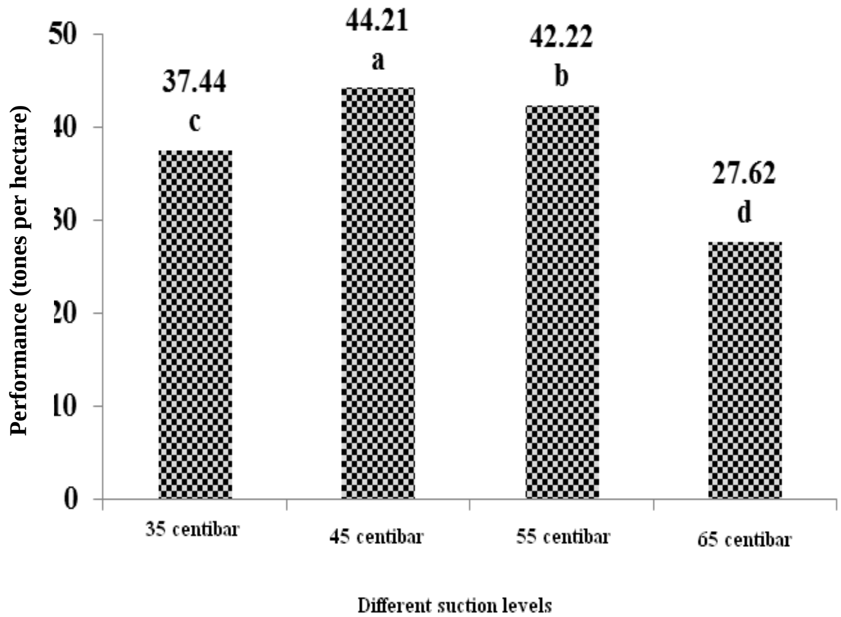


Figure 2.3. Mean comparison of different levels of suction effect on performance

## 4. CONCLUSION:

- The results showed that the used water in total of the tomato course of growth in Jiroft region in Kerman for the suction levels of 35, 45, 55 and 65 centibar is respectively 6550, 5470, 4510 and 3490 cubic meters per hectare.
- According to the measurement of irrigation period can note that the most repetition of irrigation period in suction levels of 35, 45, 55 and 65 centibar is respectively 2, 3, 4 and 5 days.
- The obtained performance of the studied treatments showed that the irrigated treatment with suction level of 45 centibar has the highest performance (44.21 tones per hectare) and irrigated treatment with suction levels of 35, 55 and 65 centibar respectively has the performance of 37.44, 44.22 and 27.62 tones per hectare.
- The results showed that by saving 960 cubic meters of water per hectare between the two treatments of 45 and 55 centibar, water use efficiency increased 13.8 percent.

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