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ProEnvironment

ProEnvironment 6 (2013) 294 - 297

Original Article

Soil Humidity Dynamic on a Tomato Crop Mulched with Different Materials

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Received 10 March 2013; received and revised form 29 March 2013; accepted 7 April 2013
Available online 30 April 2013

Abstract

The history of mulching goes back in time starting 1950; when it was for the first time used organic mulch as a covering material for the soil. Starting 1983 plastic films are for the first time used as mulching material. Although soil mulching with plastic films establishes a better production and an early one, reduces the soil erosion (hidric and air erosion), reduces soil compactation, the number of irrigation cycles, reduces the development of weeds (effect depending of the material color) it has an important issue - integrated recycling system. The aim of the paper consists in observing the soil humidity dynamic of a tomato crop in different stages of development. Different mulching materials where used (unmulched soil - experimental control, straw mulching, polyethylene mulching). The soil humidity dynamic was observed on decades using the moisture and soil temperature meter Aquaterr T300 (used for soil temperature and humidity determination). In order to observe the soil temperature under different mulching materials on decades, where recorded data at 8^{00} AM and 12^{00} AM. Temperature readings where keen on: interior experimental plot temperature, exterior experimental plot temperature, unmulched soil temperature, black plastic film soil temperature, straw mulched soil temperature. Regarding the soil evapotranspiration rate, all the unmulched experimental variants recorded the highest evapotranspiration rate compared with the black plastic films mulched variants where evapotranspiration was significantly reduced.

Keywords: evapotranspiration, mulching material, soil temperature.

1. Introduction

The capacity of an irrigation system to reduce water consumption compared with an conventional irrigation system represents nowadays one of the major concerns of different irrigation systems manufacturers.

Although drip irrigation systems are considered in different horticultural segments the best watering solution, for a perfect water management it is imperative to reduce the water consumption by soil mulching.

Statistical data speak for themselves, considering fresh water reserves of Romania in 2009 (table 1) we can observe a dependency of 80.04 % for this resource.

Although the agricultural sector is placed on the third position as fresh water main consumer (1171 km^3/year), most of the agricultural areas are classical irrigated by water runoff or classical aspersion, resulting improper water management as cited in literature[1, 2].

Its imperative to moderate the water consumption in this sector by implementation of advanced drip irrigation systems related to soil mulching [3, 8, 10].

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Table 1. Fresh water reserves in Romania 2009 (www.fao.org)

Area and population	Year	Value	Reference unit
Total country area	2009	23839	1000 ha
Total cultivated area	2009	9151	1000 ha
Total inhabitants	2009	21537	1000
Inhabitants density	2009	90.34	inhabitants/km^2
Fresh water sources			
Average precipitation amount	2009	637	mm/year
Precipitation volume	2009	151.9	km^3/year
Total amount of fresh water (internal input)	2009	42.3	km^3/year
Total amount of fresh water (external input)	2009	169.6	km^3/year
Dependency rate for fresh water		80.04	%
Fresh water main consumers			
Agricultural sector	2009	1171	km^3/year
City hall	2009	1505	km^3/year
Industry	2009	4200	km^3/year

2. Material and Method

The experiments where conducted in the plastic tunnels afferent to the department of vegetable growing USAMV Cluj-Napoca, with the main goal of improving the tomato technology crops by introducing tree new early tomato hybrids, drip irrigation systems, fertilizer units, mulching materials (black plastic film, straw) and not at least different plant densities [4, 5]. The experiment was conducted between 2006 - 2007 and was composed by the following experimental factors, preented in table 2. From the combination of the tree experimental factors where obtained 18 experimental variants witch where emplaced in tree repetitions (fig. 1).

Table 2. Experimental plot factors (original)

Experimental factor 1 - Tomato hybrid	Cronos F_1 (control) Menhir F_1 Shannon F_1
Experimental factor 2 - Mulching material	unmulched (control) black plastic film straw mulch
Experimental factor 3 - Plant density	70/37 cm (control) 38.500 pl/ha 70/27 cm 51.300 pl/ha

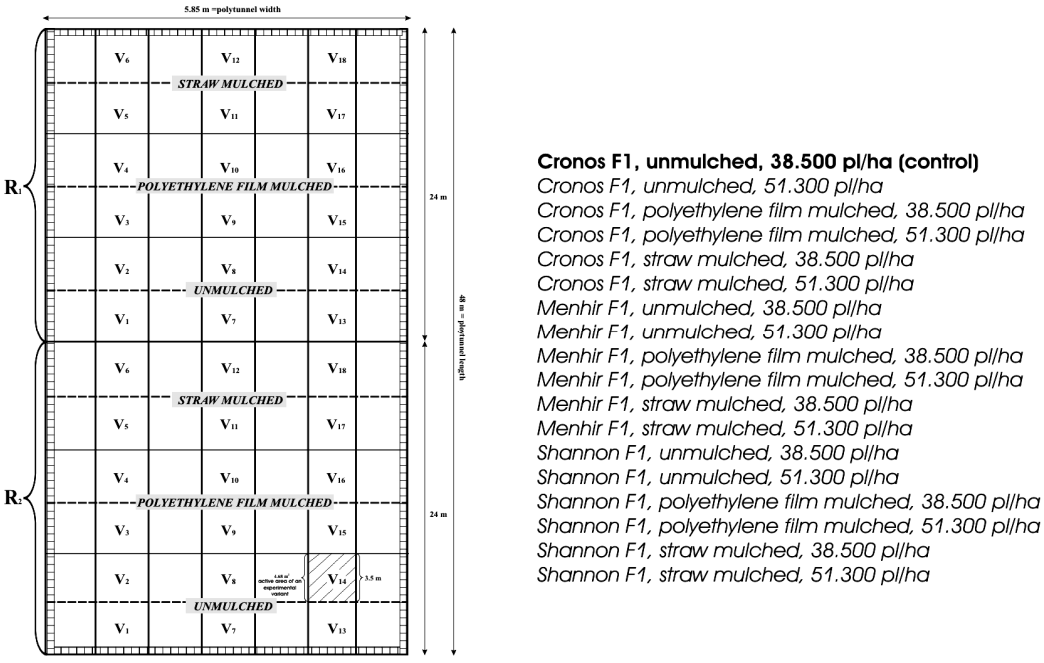
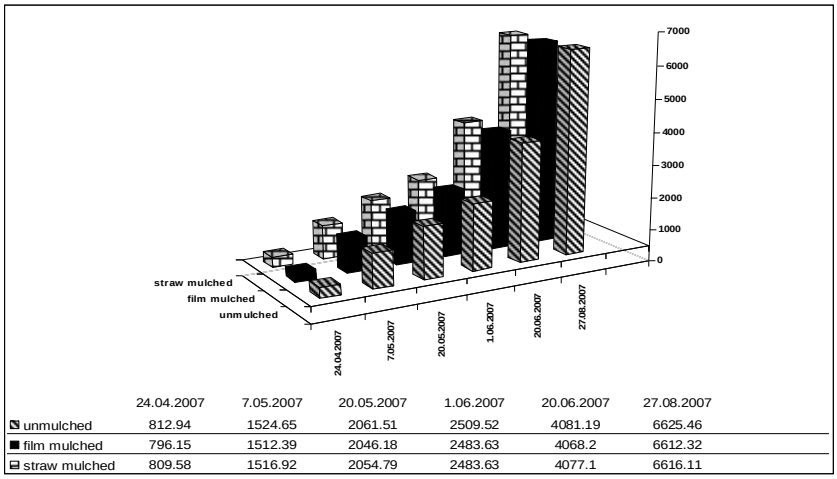


Figure 1. Emplacement scheme of the experimental plot (original)

For a comprehensive understanding of the soil evapotranspiration rate, once with the electromagnetic readings, where prevailed soil probes for deducting the soil water content by gravimetric method. The two deduction methods compensated each other, reducing possible error readings. During evapotranspiration readings, we took into consideration climatic conditions of the polyethylene tunnel by observing temperature readings, above soil, interior and exterior temperature readings of the environment.

3. Results and Discussions

Observed in dynamic, the soil evapotranspiration rate reflects the advantages of soil mulching system (straw or black plastic films) during the experimental years [6, 7, 9]. The experimental variants mulched with black plastic film recorded the highest percent of soil humidity, negatively related with the lowest evapotranspiration rate. This effect is related in fig. 2 and fig. 3.



	24.04.2007	7.05.2007	20.05.2007	1.06.2007	20.06.2007	27.08.2007
unmulched	812.94	1524.65	2061.51	2509.52	4081.19	6625.46
film mulched	796.15	1512.39	2046.18	2483.63	4068.2	6612.32
straw mulched	809.58	1516.92	2054.79	2483.63	4077.1	6616.11

Figure 2. Evapotranspiration dynamic rate between different mulching materials - experimental year 2007 (original)

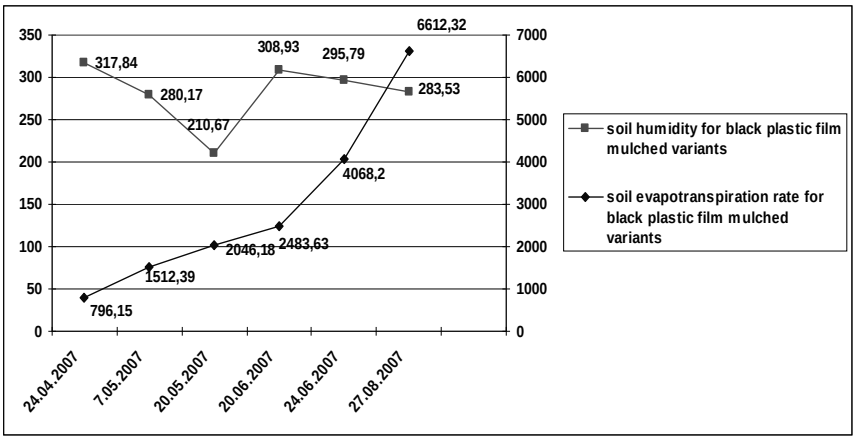


Figure 3. Soil evapotranspiration dynamic rate for the experimental variants mulched with black plastic film (original)

The soil evapotranspiration dynamic rate for the experimental variants mulched with black plastic films has ascendant values, directly related with the state of development and growth of the tomato crop. The evapotranspiration rate ascendant values are influenced by the mathematical formula of evapotranspiration rate that sums irrigation norms to a specific period of time.

The soil temperature recorded highest values for all the black plastic film (fig. 4) mulched variants compared with the unmulched variants, presenting an average value of 1.85ºC. Another aspect that must be mentioned regards the constant and equal temperature of the soil for the straw mulched variants. This aspect can be explained by the permeability for air and humidity of this kind of materials, and their light reflection capacity, that are reducing the soil temperature [11, 12, 13].

4. Conclusions

From the conducted experiments the following conclusions and recommendations can be made: the soil evapotranspiration rate reflects the

benefic advantages of black plastic film mulching system (reducing water evapotranspiration rate, increasing soil temperature for a better plant development); straw mulched experimental variants tend to show irregularities for soil temperature and water constrain capacity, effect related to a week air and water holding capacity, and their light reflection capacity; high temperatures recorded for the black plastic film mulching system can be explained through a better temperature absorption due to their specific color. The effect tends to disappear once with the involution of the heating source (the sun); during night time this kind of materials are cooling down the soil.

As further scientificall approaches we recommend the implementation of new types of mulching materials as biodegradable mulching film and aluminum insertion mulching films. Production extension of new constructive types of polyethylene tunnels, double covered, equipped with artificial fog system, fertirigation system, advanced shading systems, wide and height construction structures.

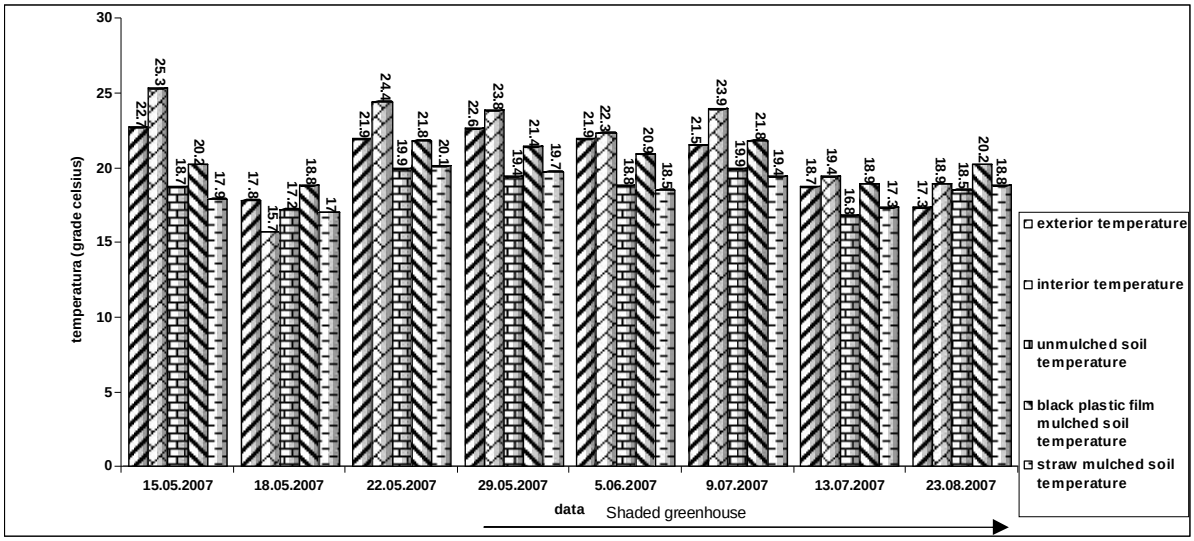


Figure 4. Temperature evolution in the experimental plot, 15.05.2007-23.08.2007, 8^{oo} (^{o}C) (original)

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