State of Israel
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Effect of different types of ground cover on water volume in open field tomato production

Shelly Ganz – National extension specialist for fresh market tomato production, Agricultural Extension Service, Ministry of Agriculture and Rural Development, Israel

Benny Gamliel, Avraham Eliyahu – R&D Lachish, Ministry of Agriculture and Rural Development, Israel

Roni Amir - Greenhouse extension specialist, Agricultural Extension Service, Ministry of Agriculture and Rural Development, Israel

PART 1

Introduction

The growing water shortage in Israel and other countries calls for improved water management.

The severe water shortage in Israel is intensifying for a number of reasons: the country is in a semi-arid region, there are few water sources, the population in Israel is growing and the standard of living is rising. As a result, the water shortage is becoming increasingly tangible every year. Years of drought aggravate the problem.

Implementation of a number of methods is required to solve the problem. These methods are divided into two main categories:

A. Expansion of water resources: flood, recycled and treated water

B. Water saving and reduced consumption

The first method lies in national planning and responsibility. The second method is easier to apply immediately and is simple and available. This method is partially applied in agriculture.

There is evidence that water consumption for agricultural purposes can be reduced by controlled irrigation using tensiometers. Ground cover can also contribute to reduced water consumption by reducing evaporation and retaining soil moisture. Ground cover has an additional advantage in water saving by suppressing growth of weeds that compete with plants for water.

The objective of this work is to examine the effect of ground cover on water saving in a controlled irrigation regime using tensiometers. Two types of ground cover were tested and results were compared to results achieved in an uncovered control plot.

Methods and materials

The trial was carried out at R&D Lachish, under the auspices of the Ministry of Agriculture and Rural Development in Israel.

On April 18, 2008, Shanti variety tomatoes were planted in an open field, using the common agro-technique of single row planting. Plant density was 10,000 plants per hectare, distance between rows was 1.93 m and distance between plants was 0.5 m. Soil was medium-heavy and saturation was 63%.

Three methods were studied:

1. Ground cover with silver/black polyethylene (PE)

2. Rigid ground cover – Tal-Ya
3. Uncovered - control

Each plot was 15.5 m^2. There were four cycles for each type of ground cover in the covered plots and two cycles in the control plot. One 0.5-m wide row was covered for each type of ground cover.

PE ground cover: sheet thickness of 0.4 mm; silver side facing upwards

Tal-Ya rigid ground cover: rigid plastic mold with a unique geometric structure. Each mold is 1 m long and 0.5 m wide, with planting holes every 0.5 m. The molds are attached to each other, creating a continuous ground cover.

Preparation of the soil before planting: plowing, tilling and preparation of rows

Application of fertilizer pellets: 3,000 kg/ha

The pellets are manufactured by Shacham Givat Ada and have the following composition: organic nitrogen – 2%; nitrogen – 3%; phosphorus – 3%; potassium – 2-3%

At the beginning of the growing season, water was applied uniformly to the soil for absorption and germination

Planting preparation

Date	Action
April 15, 2008	Preparation of rows and spreading of fertilizer pellets – 3,000 kg/ha
April 17, 2008	Saturating irrigation of 100 m^3/ha
April 18, 2008	Planting of pepper, eggplant and tomato Technical irrigation of 100 m^3/ha
April 29, 2008	Application of Confidor – 1,000 cc with 30 m^3/ha

Total water for all plots = 230 m^3/ha

During the first three weeks, irrigation was based on the evaporation equivalent for the plot covered by PE and the uncovered plot only. The plot with the Tal-Ya rigid groundcover was not irrigated, in accordance with the manufacturer's recommendation.

After three weeks, irrigation was based on tensiometer measurements. Tensiometers were inserted in each plot at two depths: 20 cm and 40 cm as conventional, monitoring soil water tension to determine irrigation timing and volume. Each plot was irrigated separately in accordance with the tensiometer reading.

Soil temperatures were measured at a depth of 10 cm in each plot. The sensor was inserted at a distance of 10 cm from the plant. Air temperature was also measured 0.5 m above the surface at the trial plot.

A CR10 data collection system with thermocouple sensors was placed on the ground, measuring climatic data every 30 minutes, on average.

Dripline: every 0.3 m
Dripper discharge: 2.3 l/h
Fertilization: compound fertilizer – 5:3:8

Fertilizer is proportional, 2 l per 1 m^3 from the flowering stage. No chemical herbicides were applied in the trial plots. Harvest was once a week. The fruit was sorted, counted and weighed.

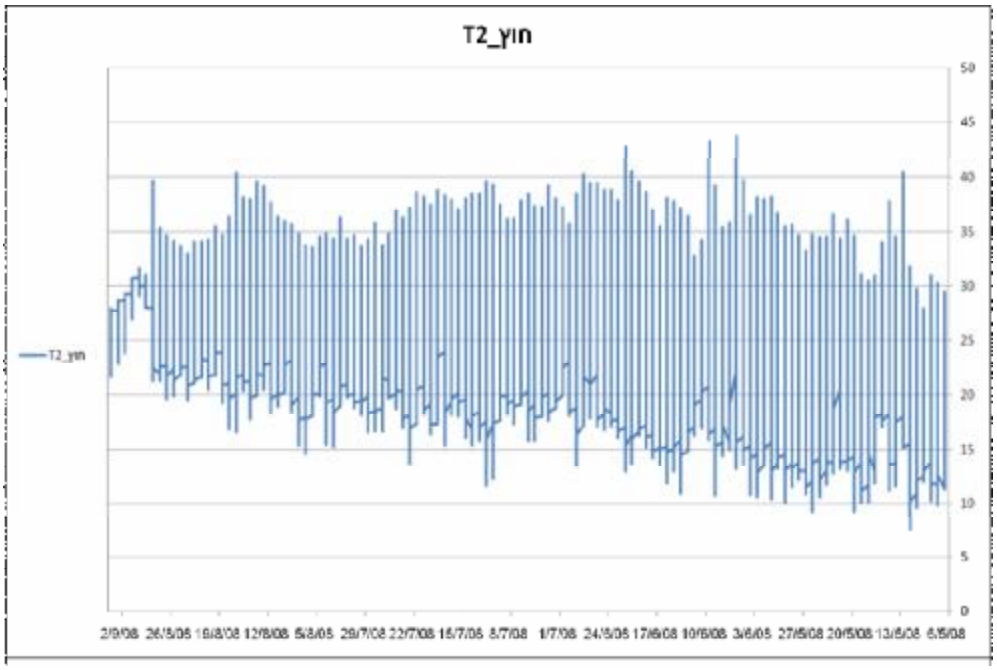
Start of harvest: July 6, 2008, 50 days after planting
End of harvest: end of July

Results

A. Temperature measurements

Measurements were taken from May 6, 2008 to September 30, 2008, which is summer in the Lachish region.

Average air temperature in the area during this season is between 10^{O}C at night and 41^{O}C during the day. Air temperature was generally 20^{O}C at night and 35^{O}C during the day. High temperature is common in the summer. See graph 2.



Graph 2: Air temperature in R&D Lachish 0.5 m above the surface in the trial area

PART 2

Graph 3 describes the initial growing period in May:

Tal-Ya rigid ground cover

Soil temperatures were found to be more moderate with lower amplitude. Temperatures were between 19^{O}C at night and 27^{O}C during the day

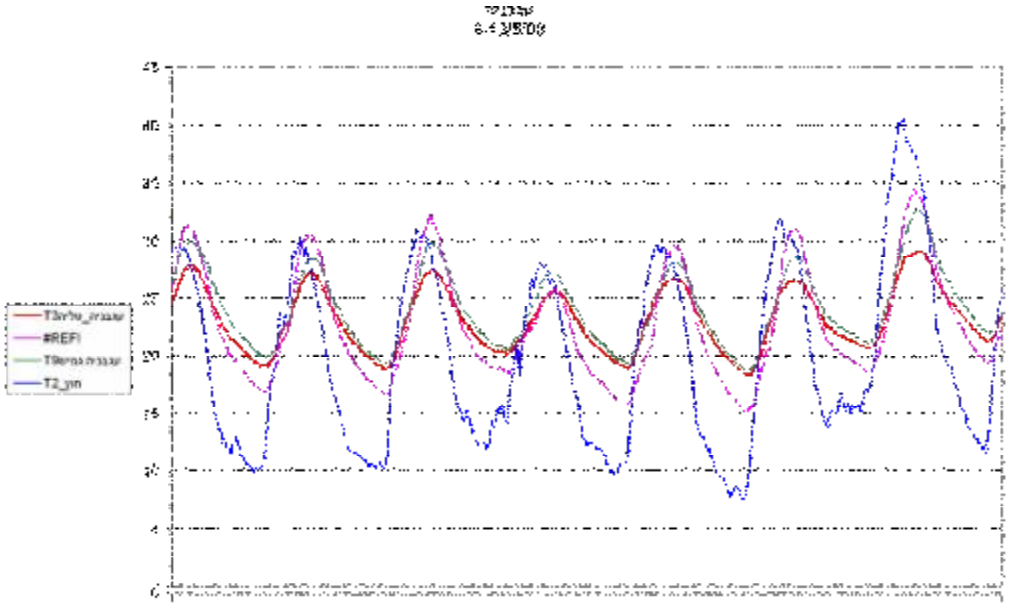
Silver/black PE ground cover

During the day, soil temperature was 1^{O}C higher than soil temperature under Tal-Ya rigid ground cover. The night temperatures were the same.

Uncovered soil

During the day, soil temperature was 3^{O}C higher than the soil temperature under Tal-Ya rigid ground cover. Night temperatures were 3^{O}C lower.

Air temperature was generally 20^{O}C at night and 35^{O}C during the day. This high temperature is common in the summer.. See graph 2.



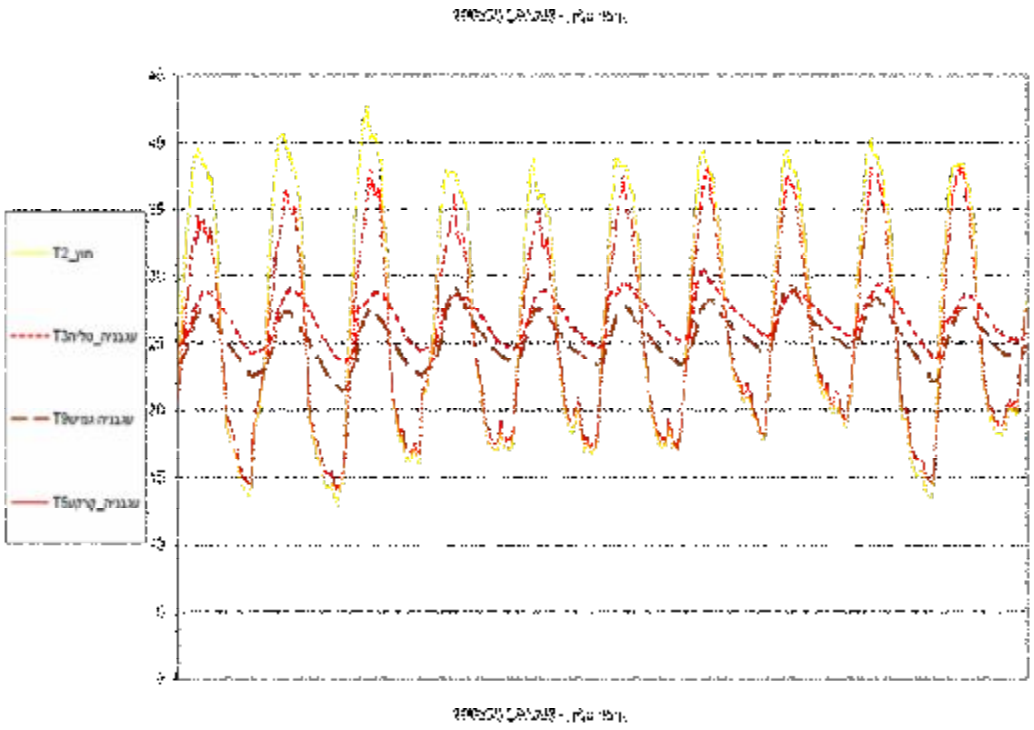
Graph 3: Soil and air temperatures in the different tomato production plots in May.

PART 3

In June, when temperatures rose and the plant developed, an advantage was found in the plots with ground cover compared to production in uncovered soil. See graph 4.

Soil temperature under both types of ground cover was 23^{O}C at night and 28^{O}C during the day.

The temperature of the uncovered soil was higher and fluctuated between 36^{O}C during the day, and lower at night, approximately 18^{O}C.



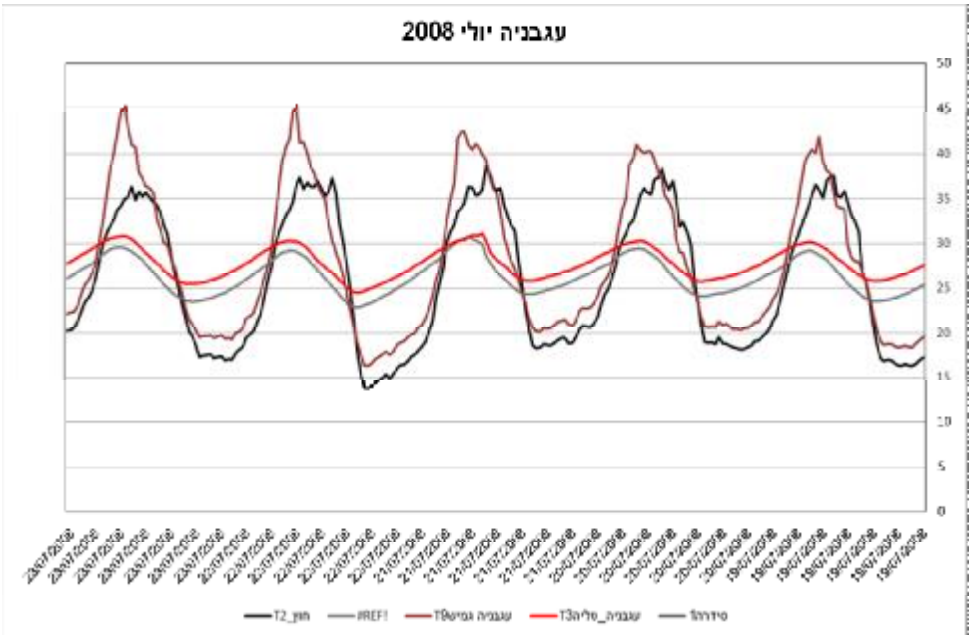
Graph 4: Soil and air temperatures in the different tomato production plots in June.

PART 4

In July, with the rising temperatures and plant development, an advantage was found in the plots with ground cover compared to production in uncovered soil. See graph 5.

Soil temperature under both types of ground cover was 24^{O}C at night and 30^{O}C during the day.

Soil temperature in the uncovered plot was higher, fluctuating between 36^{O}C during the day, and lower at night, averaging 18^{O}C.



Graph 5: Soil and air temperatures in the tomato production plots in July

B. Irrigation and fertilization

Table 1: Irrigation based on tensiometer readings – m^3/ha

		Tal-Ya	PE	Uncovered plot
Treatment	Date			
Irrigation based on evaporation equivalent	April 30 - May 22, 2008	0	63	63
For 21 days at 30 cu/ha/day				
Technical irrigation for application of Amistar	May 14, 2008	0.6	1.4	1.4
Addition of phosphoric acid according to 200 cc/cu	May 18, 2008	2	8	8
Technical irrigation	May 23, 2008	1.3	4	4
Total		3.9	76.4	76.4

Application volume was based on pan evaporation until the tensiometers were installed. In accordance with the manufacturer's recommendation, water was not applied to the Tal-Ya plot, with the exception of technical irrigation as described in the table. At this stage of growth, it can be seen that there was a substantial saving of water of up to 95%.

Table 2: Seasonal application volume based on tensiometer readings calculated in m^3/ha

Tal-Ya	PE	Uncovered soil
3,820	7,480	7,370

Irrigation was applied at a tension of 50 centibar.

It is evident that the plot with the Tal-Ya ground cover consumed the least amount of water. Water consumption was 49% and 48% of the volume used in the plot with PE ground cover and the uncovered control plot, respectively.

Table 3: Seasonal fertilizer applied, calculated at l/ha

Tal-Ya	PE	Uncovered soil
7,640	14,960	14,740

Fertilizer was applied proportionally to the water volume. It is evident that in the plot with Tal-Ya groundcover, fertilizer consumption was about 50% lower than in the plot with PE ground over and the uncovered plot.

C. Yield

Table 4: Weekly distribution of untrellised Shanti tomato yield

Weekly harvest	Tal-Ya		PE		Uncovered	
	General yield kg/ha	Fruit weight Average (g)	General yield kg/ha	Fruit weight Average (g)	General yield kg/ha	Fruit weight Average (g)
1	10,110	116	12,080	120	12,030	119
2	7,090	132	9,610	145	7,470	125
3	24,160	149	22,130	151	13,890	140
4	26,180	135	29,480	138	28,320	132
5	10,270	143	10,850	158	16,720	158
6	3,970	Not examined	5,510	Not examined	5,980	Not examined

There was no difference between the covered plots and uncovered plots.

In the first harvest, the average fruit weight was 116-120 g, which is relatively low.

There were no significant differences in general yield or in fruit weight throughout the growing season in the different plots.

Table 5: General yield of untrellised Shanti tomatoes

Type of ground cover	General yield kg/ha	Fruit weight Average (g)
Tal-Ya	81,770	135
PE	89,660	142
Uncovered soil	84,420	135

The general yield and average fruit weight achieved in the plot covered with Tal-Ya and the uncovered plot are similar.

The general yield and average fruit weight are slightly higher in fruit produced under PE ground cover. It is possible that this difference is not significant.

D. Weeds

Covered plots: The plots were weeded once only. Weeds emerged through the planting holes.

Uncovered ground: The row area was weeded twice. During development, the plant grew over the ground and prevented development of weeds.

Summary

Dew point: There is no dew. At night, the air and cover temperatures are much higher than the dew point temperature in this arid area.

Temperature

Day temperature: Tal-Ya rigid groundcover moderated the soil temperature under the cover. In the first stage of production, in May-June, when foliage was sparse, the advantage was significant and soil temperature was lowered to only 28^{O}C, about 5^{O}C lower than the temperature of the uncovered soil. Later, in August, when foliage was abundant, the differences were reduced. These differences were not expressed in the early harvest.

Night temperature: The soil temperature under the ground cover was higher than the temperature in the uncovered soil. The soil temperature under Tal-Ya ground cover was generally lower than the soil temperature under the PE ground cover, by 0.5^{O}C. There was no dew.

Notwithstanding the differences found in soil temperature measurements, no effect on yield was found in this trial in the summer.

Irrigation regime

There was a difference in water consumption in the two methods of ground cover that were studied. Water consumption in tomato production using the Tal-Ya method was much lower. Water consumption was 48% lower than consumption under PE ground cover and in the uncovered plot.

Fertilizer

Fertilizer was applied proportionally to the water volume. It can be seen that fertilizer use in the Tal-Ya plot was about 50% lower than in the plot under PE ground cover and in the uncovered plot.

Yield

The general yield under Tal-Ya ground cover was not impaired as a result of the use of less water. Minor differences were found in general yield and fruit weight.

Weeds

The groundcover eliminated the need to weed the plots. The plot was weeded once only, through the planting hole. The row area of the uncovered plot was weeded twice.

Discussion

This trial, which was planted in summer, met the strict test of high water consumption. Irrigation was based on soil water tension (SWT). It was found that SWT under PE ground cover was higher than under Tal-Ya ground cover. It appears that soil moisture is better retained under Tal-Ya ground cover. In view of this, the application volume is about 50 percent lower, meaning a 50 percent saving in water.

According to the manufacturer, due to the geometric shape of the Tal-Ya ground cover, which is made up of channels and slopes, dew drains into the planting hole, contributing to the amount of water consumed by the plant.

In this trial, dew did not form on the ground cover. It is likely that the hot dry summer conditions in the Lachish region did not allow formation of dew. In the warm Israeli autumn and winter, climatic conditions are expected to allow formation of dew. If dew is collected, water saving could be even higher.

The ground cover contributed to a lower soil temperature during the day and a higher soil temperature at night. This did not affect the plant and the yield level in summer. However, it can be assumed that it will have a significant contribution in autumn and winter.

Proportional application of fertilizer contributes to significant saving of 50 percent in fertilizers. It is noteworthy that there was no soil analysis for optimum application of fertilizer.

Ground cover prevents development of weeds, with the exception of through the planting hole, eliminating the need for herbicides.