Date palm irrigation with saline water experiment summary

Guy Reshef, Netafim Agronomy unit; Ephraim Tsipilevich, Jordan Valley Agricultural R&D station; Benny Alksalasi, date grower, Kibbutz Gilgal

Objectives

Reassessment of irrigation recommendations for Mejhoul dates under the conditions of the Jordan Valley.

Examine whether irrigation can be optimized by using integral drip irrigation along the length of the row.

Examine the effects of the irrigation method and the water amounts on the root system and salt distribution in the soil.

Abstract

To examine the effects of water quantities and irrigation methods on dates in the Jordan Valley, 2 irrigation methods and two water quantities were tested for 4 seasons between 2015 and 2018: commercial irrigation - 2 sprinklers near the tree, versus 2 laterals of integral drip. Both irrigation methods were tested with 2 water amounts relatively to the recommendations: 100% of the recommended amount compared with 75% of the recommended amount. In addition, the treatment of 75% drip irrigation was examined also according to 75% of the recommendations in an interval determined according to tensiometer readings and a predetermined soil EC threshold (an average of 40 Centibars for the readings at 30 and 60 cm depths). The results show that the treatments did not significantly affect the crop, but the removal of salts was better and the root system was larger and denser with drip irrigation at 100% of the recommendation. Due to a large accumulation of salts and damage to the number of date stalks with drip irrigation according to 75% of the recommendations, we canceled the irrigation treatments at 75% of the recommendation and

instead examined for two more years drip irrigation at 120% and 140% of the recommendation. The results of this experiment show that drip irrigation at 120% of the recommended volume can improve the yield and the size of the fruit under the conditions of saline soil and brackish irrigation water.

Introduction

Dates are the main branch of plantations in the Jordan Valley and its scope in the current season reaches 3,000 ha. According to the accepted irrigation recommendations, water amount for irrigation of a ha of mature dates (starting at the age of 8) is 12000-13000 m3 per season. The accepted stand for planting dates is 9x9 m and in the first years it is acceptable and correct to water the plantation with 2 sprinklers placed near the tree (photo 1). Today it is customary to continue to irrigate mature trees using this method. Exposing the roots of mature trees clearly shows that the roots cover the entire wetted area with varying density, even in places where the electrical conductivity is very high, even though the area wetted by the sprinklers is quite limited.

About 60% of the date plantations are irrigated with brackish water that comes from the Tirzah reservoirs, which supply about 26 million cubic meters per year. The water plant in the Tirzah reservoir is fed by 3 water sources: sewage water that comes from East Jerusalem (Kedron effluents), Jordan river water and flood water. The average electrical conductivity of this water (seasonal average) has been 4.0-6.0 dS/m in recent years. When irrigating with water with such electrical conductivity, borders of salt are formed at the edges of the wetted bulb which can reach 20-30 dS/m. In addition, due to the desire to expand the plantations, date palms are now being planted in marginal areas where the entire area was not flushed before planting. In such areas the level of electrical conductivity of the soil can reach 80-100 dS/m in the soil solution. And the farmers are content with flushing the planting pit only, so that the salt walls at the edges of the pit can reach a conductivity of higher than 100 dS/m.

The irrigation recommendations accepted today for Mejhoul date plantations are: from fruit set to the stage when all the fruit is yellow, irrigation according to a coefficient of 90% of pan evaporation; When all the fruit is yellow, 50% of pan evaporation, until the next season's fruit set. In light of the above, it seems that it should be possible to optimize irrigation, improve salt removal and possibly save water if we switch to integral drip irrigation along the entire row and increase the wetted soil area.

Course of research and working methods

The experiment was carried out in the date plot in Kibbutz Gilgal. Mejhoul variety, planting 2006. Until the experimental treatments were applied in 2014, all plots were watered by 2 micro sprinklers near each tree. A soil survey was carried out on 4 pits: 2 near the tree and 2 in the center between 2 trees. The average EC, salinity components and nutrient levels in the upper soil layers is summarized in Table No. 1.

Treatments

1. Irrigation of 100% of the recommendation using 2 SuperNet™ micro-sprinklers near the tree, each sprinkler 58 liters/hour. 116 liters/hour/tree. Set irrigation frequency.
2. Irrigation of 75% of the recommendation using 2 SuperNet™ micro-sprinklers near the tree, each sprinkler 58 liters/hour. 116 liters/hour/tree. Set irrigation frequency.
3. Irrigation of 100% of the recommendation, 2 laterals of integral drip, Uniram™ drippers every 0.5 m, 3.5 liters per hour per dripper. 126 liters per hour per tree. Set irrigation frequency.
4. Irrigation of 75% of recommendations using 2 laterals of integral drip, Uniram™ drippers every 0.5 m, 3.5 liters per hour per dripper. 126 liters per hour per tree. Set irrigation frequency.
5. Irrigation of 75% of recommendations using 2 laterals of integral drip, Uniram™ drippers every 0.5 m, 3.5 liters per hour per dripper. 126 liters per hour per tree. The irrigation frequency was determined by a threshold value, according to tensiometer readings.

Methods and Materials

Location: 32,00,33N 35,27,37, E. Central Jordan Valley, Israel (Near Kibbutz Gilgal(.

Desert climate:

- Average maximum temperature in August = 41°C.
- Average minimum temperature in January = 9°C.
- Average annual rainfall = 150-180 mm.

Calculated evapotranspiration (average):

Jan =1.7mm	Feb = 2.5mm	March = 4.8mm	April = 5.7mm
May = 8.1mm	June = 9.6mm	July = 10.5mm	Aug = 9.5mm
Sept = 7.6mm	Oct = 5.2mm	Nov = 2.9 mm	Dec = 1.7mm

Soil type: silty clay.

Irrigation water: Recycled sewage water. Salinity: 4.3-5.2 dS/m without added fertilizers.

Variety: Majhoul.

- Planting year: 2006
- Planting distances: 9X9 meters.
- Five treatments x six repetitions. Repetition size = 9 trees (729 square meters). Entire experimental area = 2.2 hectares.
- The amount of irrigation water was determined by multiplying the accepted coefficients (Ministry of Agriculture) with the local evaporation data measured by pan evaporation class A.
- Per treatment, two tensiometer stations, with three tensiometers each, were placed at 30, 60, 90 cm depth.

Image 1: Two micro-sprinklers per tree

Image 2: Two drip laterals per row

Image 3: Aerial photograph of the experiment area

Table 1: An example of the actual annual water quantities used by treatment (31/10/2017 to 1/10/2018)

Treatment No.	Treatment	% of the recommended dose	Actual water quantities (mm)
1	sprinklers	100	1228
2	sprinklers	75	874
3	drip	100	1207
4	drip	75	863
5	drip + tensiometers	75	947

At the end of the fourth season (11.2018), pits measuring 4.5 meters in length, about 2.5 meters deep, were dug along the line and perpendicular to the row, two pits per treatment. At distances of 50 cm by 50 cm, soil samples were taken to characterize the electrical conductivity. A total of 900 samples were taken.

Results

Table 2: Fruit yield (kg per tree), in four harvests

Treatment Year	Sprinklers 100%	Sprinklers 75%	Drip 100%	Drip 75%	Drip + Tens 75%
2015	65.4	82.5	75.9	80.4	65.7
2016	65.6ab	67.5ab	86.1a	59.4b	57.8b
2017	83.1ab	82.8ab	107.5a	78.9b	85ab
2018	89.8	86.8	83.8	62.8	75.6
Average	71.0	70.4	88.3	79.9	76.0
% Difference from sprinklers100%		99	124	113	107

Table 3: Average weight (gram) per fruit, in four harvests

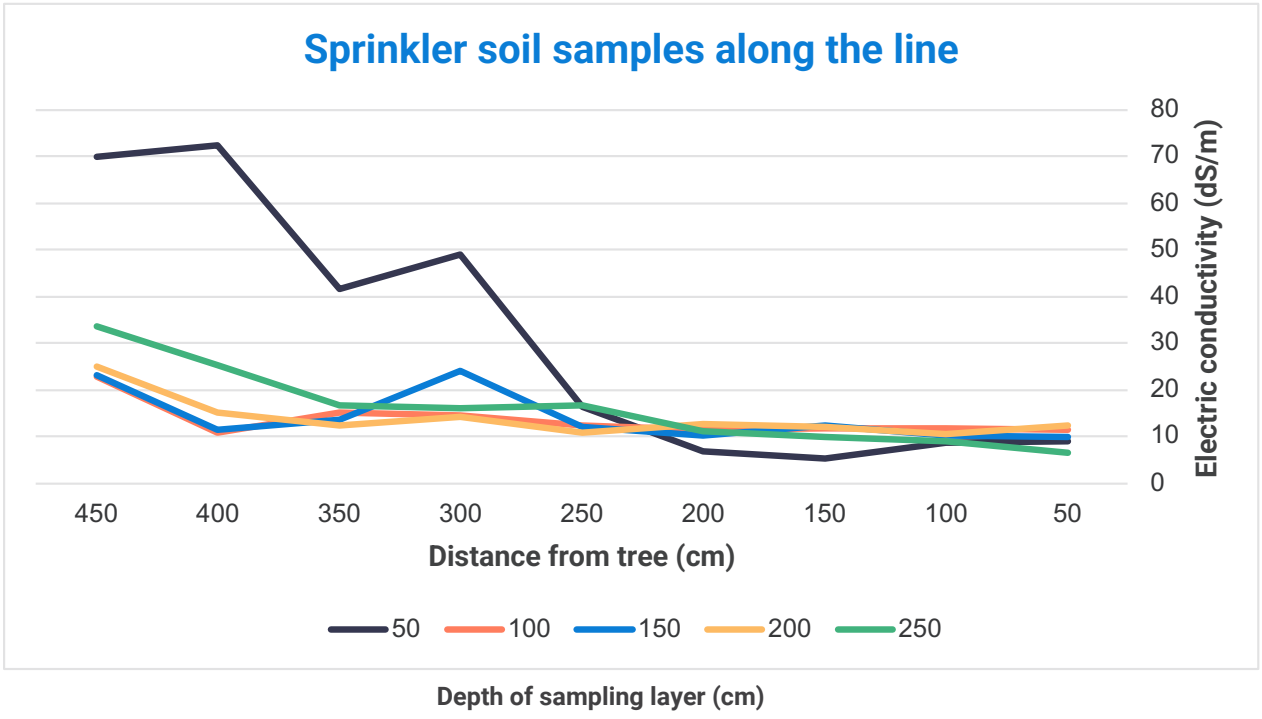
Treatment Year	Sprinklers 100%	Sprinklers 75%	Drip 100%	Drip 75%	Drip + Tens 75%
2015	20.7	20.8	19.8	21.6	19.6
2016	17.3	19.7	17.1	19.3	19.3
2017	17.2	17.7	18.3	17.4	17.8
2018	23.5ab	23.2ab	20.6b	23.2ab	25.2a
Average	19.7	20.4	19	20.4	20.5
% Difference from sprinklers100%		103	96	104	105

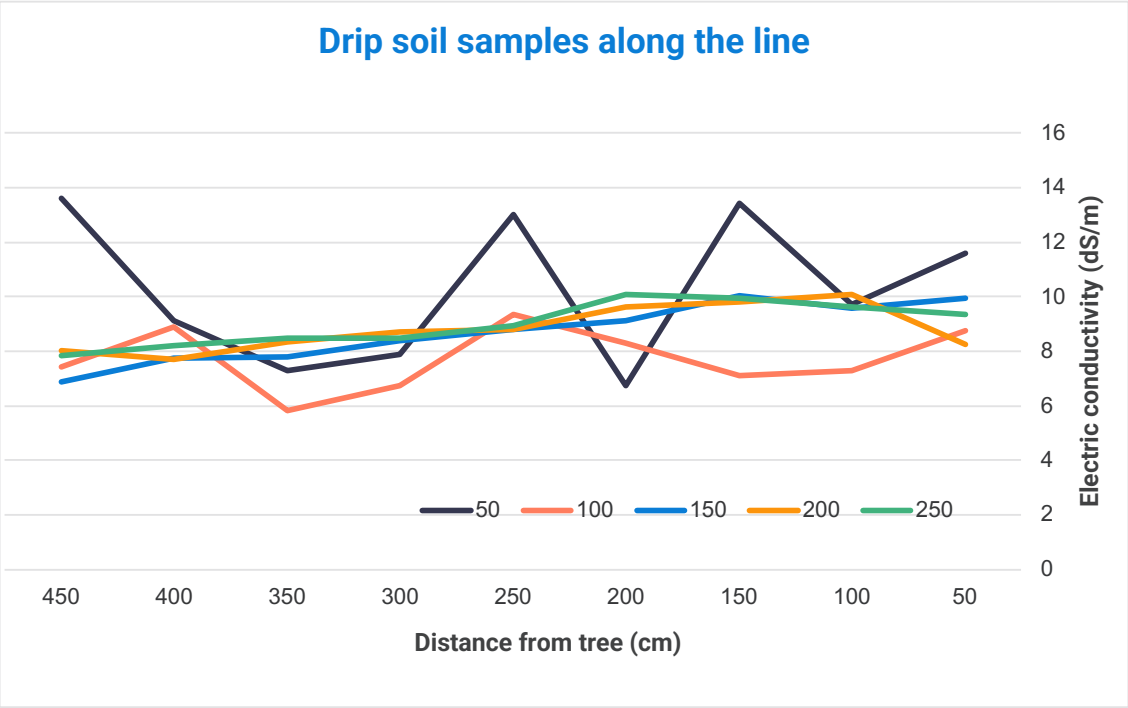
Table 4: Percentage of blistering, in four harvests

Treatment Year	Sprinklers 100%	Sprinklers 75%	Drip 100%	Drip 75%	Drip + Tens 75%
2015	22.8	27	25	23.9	22.4
2016	15.6a	7.7b	13.6ab	13.6ab	11.3ab
2017	10.3	9.7	11.1	11.8	8.1
2018	24.4	27.9	25.2	30.8	23.9
Average	18.3	18.1	18.7	20	16.4
% Difference from sprinklers100%		99	102	110	90

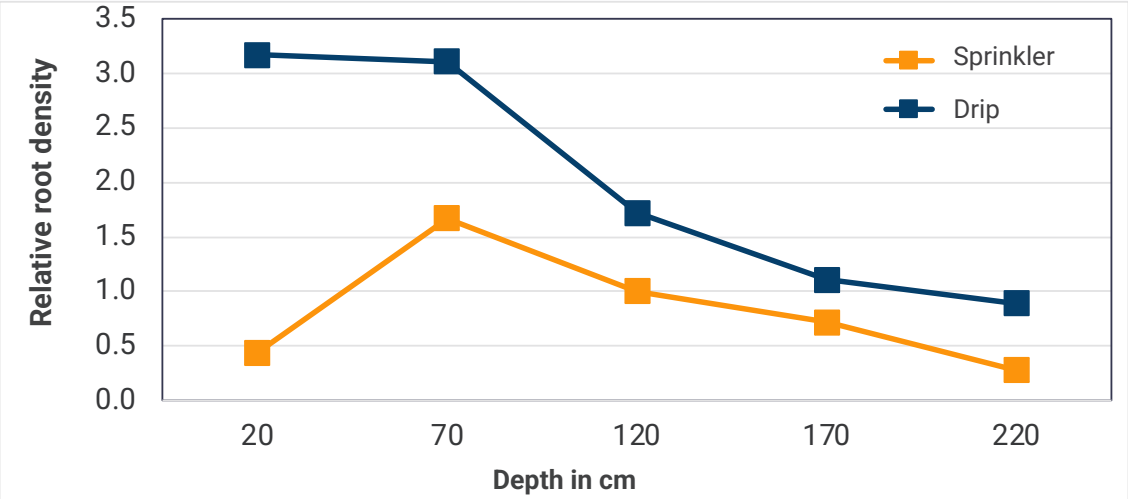
Image 4: The sampling pit with the coordinate grid and the central root layer 30-60 cm deep.

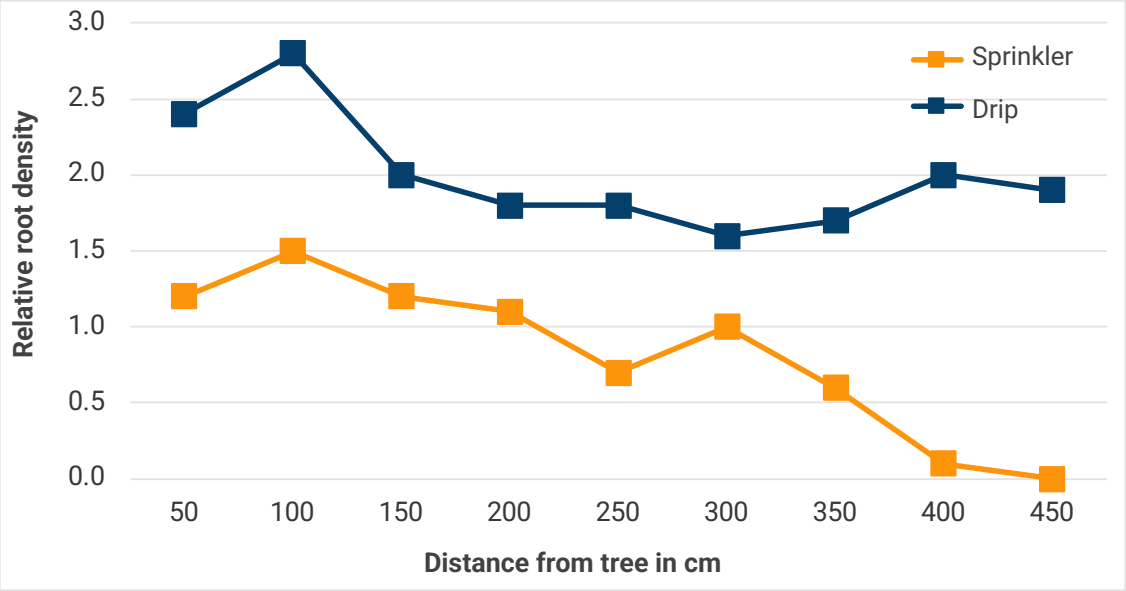
Image 5: The sampling operation





In the graphs above, the continuous salt deposition distributed evenly along the drip line can be seen, while salt deposition by sprinklers is concentrated at a radius of up to 2.5 meters away from the tree.





In the graphs above, the decrease in root density with depth and distance from the trunk can be seen in the 100% irrigation treatment, in both irrigation methods. Root density in the drip treatment is higher, relatively to the sprinkler treatment, up to a depth of 1 meter. Root density in the drip irrigation method, is significantly higher, relative to the sprinkler method, along the drip lateral and away from the trunk.

Conclusions

1. In sprinklers, a decrease in water volume did not damage the crop.
2. In drip irrigation, decrease in water volume, damaged the crop.
3. Deposition of salts to the depths of the soil, was better by drip than by sprinklers, especially in the larger water dose.
4. No commercial advantage was found to determining the irrigation interval according to tensiometer readings.
5. In view of the results, it will be worthwhile to examine an increase in the water dose in drip irrigation. On the other hand, there is room to examine a decrease in water dose in sprinklers.
6. Although the roots of the date tree reach a distance and a depth of several meters, most of the roots are at a depth of 30 to 60 cm.
7. In general, the roots are in the upper soil profile. In sprinklers, the roots are concentrated around the trunk at a radius of up to 1.5 meters. With the drip method, the roots are found along the drip laterals.
8. The wetted area of two continuous drip laterals, is 2.5 to 3 times larger than the wetted area of two sprinklers. As a result, the effective root zone is larger.

Image 6: Typical wetted area of a drip line placed 20 cm deep.

Image 7: Typical wetted radius of sprinklers in similar soil.

Following the results, in the 2019 season, it was decided to increase the irrigation water dose, in both drip treatments with the low water dose (75%), to 120% and 140% of the recommendations. The three additional treatments remained unchanged.

Table 5: The annual amount of water applied in 2019 (by treatments)

Treatment	Irrigation coefficient relative to recommendations	Annual water dose (mm)
Drip	100%	1049
Drip	120%	1235
Drip	140%	1481
Sprinklers	100%	1055
Sprinklers	75%	791

Table 6: Impact of irrigation method and quantities of water on the 2019 crop and quality

Treatment	Yield (Kg/tree)	Blistering (%)	Dry fruit (%)	Average fruit weight (g)
Drip 100%	a120	a13.1	18.4	b18.5
Drip 120%	a110	ab10.7	17.0	a22.2
Drip 140%	a108	ab12.7	19.5	a21.6
Sprinklers 75%	b85	b8.2	18.6	b18.8
Sprinklers 100%	b81	ab10.2	25.8	ab20.8

Discussion

To our surprise, the 75% drip treatments, with the lower yields from the previous seasons, closed the gap with the leading treatment (100% drip) as early as the first season with increased irrigation volumes.

Apparently, the limiting factor for tree development was the salinity in the soil. The increase in water dose improved salt flushing and positively affected the crop.

This experiment is in its seventh season and towards the sixth harvest. We intend to continue for two more seasons in the hope of preserving the emerging trend.