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Agricultural Oasis

First interim report: winter cycle 2010/11

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1. Executive summary

The project has achieved the overall objectives and technical goals for the first winter cycle in a very satisfactory way and with only minor deviations from the description of works.

The pilot desalination unit with nanofiltration membranes has operated without interruption for 24 h/d since project start. It exceeded the expectations regarding permeate flow (6.5 m^3/d) and specific energy consumption (1.37 kWh/m^3). It was consistently operated at the low pressure of 4.3 bar. During this first phase, the desalination unit was operated with grid electricity.

The permeate water produced after blending with a fraction of the feed water (50 L/h) has a moderate electroconductivity of 0.86 dS/m and contains concentrations of the plant micronutrients calcium (45 ppm) and magnesium (23 ppm), which are above the minimum recommended for use of desalinated water in agriculture.

Two varieties of potato (“Mondial” and “Bellini”) were cultivated from November to March on a 1,000 m^2 agricultural plot and irrigated with either desalinated water or, as a control experiment, brackish water (EC = 2.32 dS/m). The average measured yield of potatoes from all experiments exceeded *a priori* expectations (5.35 ton/ha, 6.5% higher than expected).

The analysis of the produce from the plots irrigated with desalinated and brackish water shows no significant differences in terms of total yields and number of tubers produced. Irrigation with desalinated water has however an important advantage in the 25% reduction in irrigation volume compared to brackish water irrigation.

The lack of a detectable positive effect of desalinated water irrigation can be largely attributed to an infestation of *Erwinia carotovora*, which affected plants grown with desalinated water 1.7-2.7 times more severely than those irrigated with brackish water. The analysis of a sample of potato plants of the “Bellini” variety performed before the final harvesting revealed a 25% higher yield and 31% higher number of tubers for the plants irrigated with desalinated water, suggesting that for healthier plants the effect of different irrigation water quality is substantial. This result was however not confirmed by the “Mondial” variety sample.

The brine of the desalination plant (4.73 dS/m) was entirely used to irrigate red beet plants that were cultivated on a 100-m^2 agricultural plot adjacent to the potato fields. Red beet plants grew strong, showing no sign of being affected by the salinity of the irrigation water and yielding 22% higher quantity of produce than expected (6,081 kg/ha vs. 5,000 kg/ha).

2. Progress and achievements during the period

2.1 Pilot desalination unit

The nanofiltration (NF) pilot desalination unit has achieved the objectives for the period and exceeded the expectations for faultless operation, permeate production and energy consumption. The NF pilot has been in operation since the start date of the project for 24 h/d and without any significant interruption due to defective operation. Table 1 shows the flows and pressures measured in the pilot desalination unit between November 2010 and February 2011.

Table 1. Operation parameters of NF desalination unit between November and February

Date	Flows				Pressures		
	Permeate L/h	Recycle L/h	Brine L/h	Blending L/h	Feed bar	Before NF bar	Brine bar
29/11/10	270	900	200	25	2.0	4.2	4.0
2/12/10	280	900	200	25	2.2	4.3	4.0
6/12/10	270	800	200	25	2.0	4.4	4.1
9/12/10	280	900	200	25	2.3	4.2	4.2
12/12/10	260	1000	200	25	2.0	4.3	4.1
16/12/10	260	900	200	25	1.8	4.3	3.9
20/12/10	270	800	200	25	1.8	4.2	4.1
24/12/10	270	800	220	25	1.5	4.3	4.1
27/12/10	270	800	200	25	1.8	4.2	4.0
30/12/10	260	900	220	25	1.6	4.3	4.2
3/1/11	270	900	200	25	1.7	4.2	4.0
5/1/11	270	900	200	25	1.6	4.2	4.0
10/1/11	270	900	220	50	1.7	4.3	4.3
13/1/11	280	1000	220	50	1.8	4.4	4.2
17/1/11	270	900	200	50	1.8	4.3	4.2
20/1/11	260	900	200	50	1.7	4.2	4.2
24/1/11	270	1000	220	50	1.6	4.4	4
27/1/11	280	900	220	50	1.8	4.3	4.1
31/1/11	260	900	210	50	1.7	4.3	4.2
3/2/11	280	800	200	50	1.6	4.4	4.1
7/2/11	270	900	220	50	1.8	4.2	4.1
10/2/11	280	800	200	50	2.0	4.3	4.2
14/2/11	280	900	220	50	1.7	4.4	4.1
17/2/11	270	900	220	50	1.8	4.2	3.9
21/2/11	280	800	200	50	1.6	4.3	4.0
24/2/11	280	900	220	50	1.7	4.3	3.9
28/2/11	270	900	220	50	1.7	4.2	4.1

The NF pilot consistently produced a permeate flow of 271 L/h (± 7 L/h) during the period of observation, corresponding to a daily production of 6.5 m^3. This is notably higher than what expected when the system was installed (5 m^3/d) and mainly due to a higher feed inflow (480 L/h). To ensure smooth operation of the NF membranes, the recovery rate was maintained at a conservative level (57%). Chemicals to prevent scaling for pH control were nevertheless continuously added. Due to the higher feed flow and conservative recovery rate, the brine flow was higher than in the design scheme (209±10 L/h). All the brine was directed to irrigate the plot cultivated with red beet. The operating pressure of the NF membranes was stable in the range 4.2-4.4 bar and did not show any increase over the period of operation. The blending flow was initially set at 25 L/h and subsequently raised to 50 L/h on January 19 in order to increase the concentration of micronutrients (Ca^{2+} and Mg^{2+}) in the permeate flow (see Section 2.2 Water quality and suitability for agricultural use). The specific energy consumption of the pilot plant (1.37±0.02 kWh/m^3) was lower than in the period of operation preceding the start of the Oasis project (1.58 kWh/m^3). The pilot desalination plant worked with grid electricity during this first period of operation.

2.2 Water quality and suitability for agricultural use

Samples of feed water, permeate, and brine were collected on a weekly basis and analyzed in the laboratories of the Ben-Gurion University of the Negev for the concentration of the ions of principal interest to this study (Ca^{2+}, Mg^{2+}, SO_4^{2-}, Cl^-, HCO_3^-), pH and electro-conductivity (EC). In addition to these measurements, the concentration of K^+ and NO_3^- was measured on a non-regular basis. Table 2-4 show the results of the chemical analyses.

The chemical analyses of the feed water show that little variation occurred during the period of observation in the inflow concentrations of the monitored ions with the exception of Ca^{2+}, which shows a decreasing trend from the first measurement in November (190 ppm) to the latest measurement in March (151 ppm) that is statistically significant at the 10% level (p-value = 0.07). A corresponding decreasing Ca^{2+} concentration is observed in the brine.

Table 2. Chemical composition of feed water between November and March

	Ca^{2+} ppm	Mg^{2+} ppm	SO_4^{2-} ppm	Cl^- ppm	HCO_3^- ppm	K^+ ppm	NO_3^- ppm
29/11/10	190	90	560	350	235		
6/12/10	185	90	555	320	215		
12/12/10	185	90	560	330	215		
19/12/10	185	90	560	325	215		
27/12/10	170	82	409	277	254	9.6	
6/1/11	208	95	526	331	245	10.3	
16/1/11	215	100	547	376	230	10.6	33.8
30/1/11	170	81	490	321	232		
7/2/11	186	91	513	427	280		
13/2/11	165	78	487	302	250		
27/2/11	162	85	550	360	215		
6/3/11	151	79	516	360	210		
Average	181	88	523	340	233	10.2	33.8

Table 3. Chemical composition of permeate between November and March

	Ca^{2+} ppm	Mg^{2+} ppm	SO_4^{2-} ppm	Cl^- ppm	HCO_3^- ppm	K^+ ppm	NO_3^- ppm
29/11/10	28	14	85	120	52		
6/12/10	25	13	80	110	45		
12/12/10	27	14	85	115	46		
19/12/10	26	14	80	115	47		
27/12/10	17	8	35	78	37	3.2	
6/1/11	21	9	43	93	41	3.8	
16/1/11	20	9	43	93	35	3.3	20.1
30/1/11	44	21	120	126	75		
7/2/11	53	27	146	162	66		
13/2/11	36	18	110	102	67		
21/2/11	44	21	135	130	72		
27/2/11	50	27	172	164	77		
6/3/11	43	24	150	154	73		
Average	33	17	99	120	56	3.4	20.1

Table 4. Chemical composition of brine between November and March

	Ca^{2+} ppm	Mg^{2+} ppm	SO_4^{2-} ppm	Cl^- ppm	HCO_3^- ppm	K^+ ppm	NO_3^- ppm
6/12/10	430	210	1290	780	490		
12/12/10	455	215	1320	810	495		
19/12/10	460	220	1360	780	525		
27/12/10	410	193	1054	619	532	20.4	
6/1/11	425	200	1110	654	493	19.1	
16/1/11	498	230	1347	778	524	20.1	49.1
30/1/11	426	203	1220	714	546		
7/2/11	462	231	1280	860	450		
13/2/11	400	192	1216	622	567		
27/2/11	390	208	1420	760	486		
6/3/11	384	208	1330	780	500		
Average	431	210	1268	742	510	19.9	49.1

The desalination unit has performed according to model forecasts regarding the removal of the monitored ions. Retention of Cl^- ranged between 54% (February 27) and 75% (January 16), corresponding to an average Cl^- concentration in the permeate of 120±26 ppm. With the initial blending flow set at 25 L/h, the concentrations of Ca^{2+} and Mg^{2+} in the permeate were, respectively, 23 ppm and 12 ppm, values which are lower than the recommended minimum concentration of these nutrients for agricultural use[1]. Consequently the blending flow was increased on January 19 to 50 L/h, raising the average concentration of Ca^{2+} and Mg^{2+} in the permeate to 45 ppm and 23 ppm, respectively. Such values are well within or even above the recommended range of concentrations (32-48 ppm for Ca^{2+}; 12-18 ppm for Mg^{2+}). The concentration of SO_4^{2-} was well above the minimum recommended value of 30 ppm during the whole period. Figure 1 shows the time series of the permeate concentrations of Ca2+ and Mg2+ in comparison with the range recommended for agricultural usage by Yermiyahu et al. (2007).

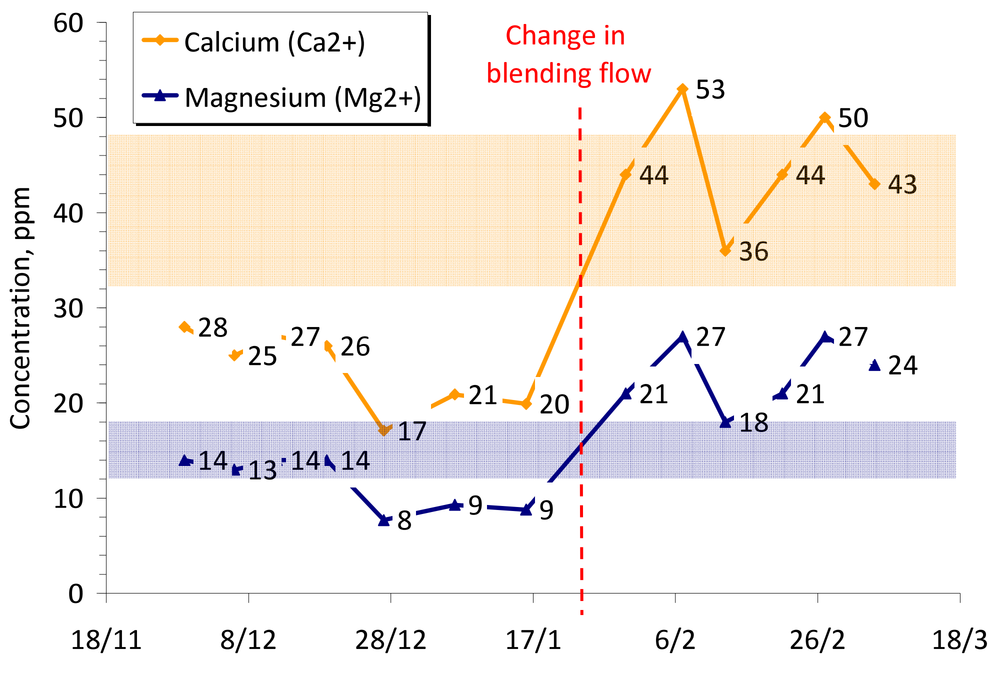


Figure 1. Concentration of Ca^{2+} and Mg^{2+} in the permeate and comparison with guidelines

[1] Yermiyahu, U., A. Tal, A. Ben-Gal, A. Bar-Tal, J. Tarchitzky, and O. Lahav. 2007. "Rethinking Desalinated Water Quality and Agriculture." Science 318 (5852): 920.

The electroconductivity of feed water, permeate and brine was measured in parallel to the ion composition of the water flows. Time series of the EC measurements are shown in Figure 2.

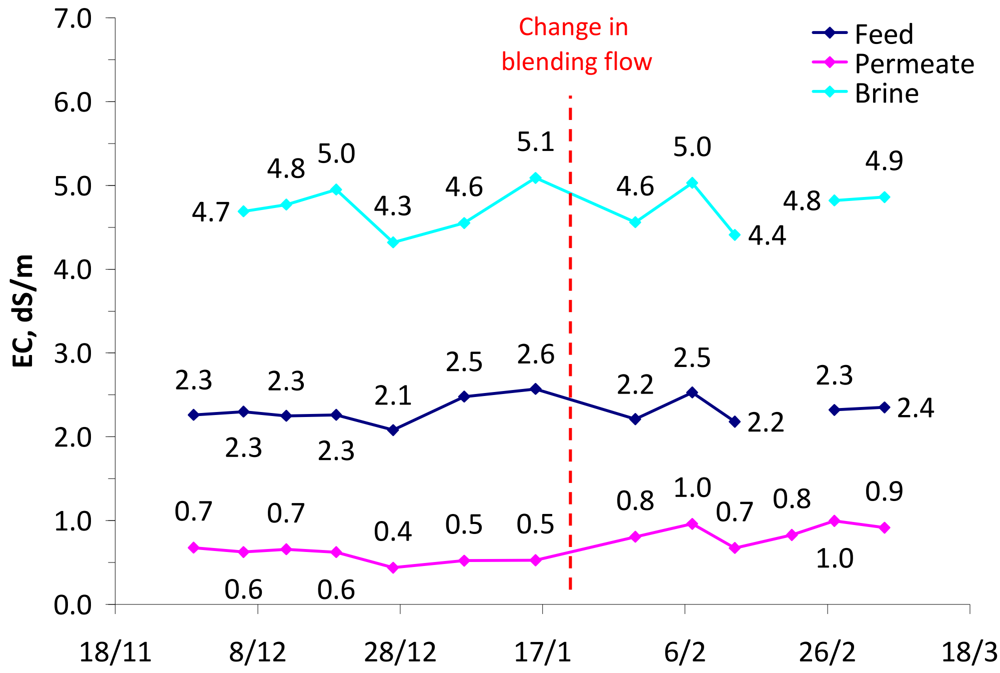


Figure 2. Electroconductivity (EC) of feed water, permeate and brine, in dS/m

The EC of the feed water shows little variation over the whole period, averaging 2.32 dS/m (±0.15 dS/m) and with no trend towards increase or decrease over time. Similarly, the EC of the brine is relatively constant at 4.73 dS/m (±0.25 dS/m) as it is unaffected by the change in the blending rate on January 19. The EC of the permeate flow averaged 0.71 dS/m (±0.18 dS/m) over the whole period of measurements. Before the increase in blending flow, the average EC of the permeate is 0.58 dS/m (±0.09 dS/m); after January 19 the average EC increases to 0.86 dS/m (±0.12 dS/m), a value that is satisfactory since it is still within the range tolerated by the most salt-sensitive crops[2].

[2] Ayers, R. S., and D. W. Westcot. 1985. "Water Quality for Agriculture. FAO Irrigation and Drainage Paper 29 Rev.1." Food and Agriculture Organization of the United Nations (FAO), Rome.

2.3 Chemical analysis of soil and compost

A first soil analysis was conducted by R&D Arava on October 26, 2010, before the crops were planted. The purpose of this analysis is to establish the initial electroconductivity of the soil and the concentrations of Cl^-, $N\text{-}NO_3$, Olsen P, and K^+. Follow-up measurements are foreseen during the growing season in order to monitor the build-up of potential salinity in the root zone of the crops. Two soil samples were collected, the first on the side irrigated with brackish water, the second on the side irrigated with desalinated water. Both samples are composite obtained representing the average conditions in a depth between 0 and 20 cm from the surface. The results of this first soil analysis are reported in Table 5.

Table 5. Results of soil analysis conducted on October 26, 2010

	EC dS/m	Cl^- ppm	$N\text{-}NO_3$ ppm	P (Olsen) ppm	K^+ ppm
Sample A	4.53	915	22.9	3.1	100.0
Sample B	4.91	1121	20.4	2.0	60.1

In addition to soil analyses, the chemical composition of the compost and fertilizer used for cultivation of the crops during the 1st winter cycle was investigated. Table 6 shows the chemical composition of the compost.

Table 6. Chemical composition of the compost used during the 1st winter cycle

Parameter	Unit	Value
Dry matter	%	87.0
pH	-	8.4
Organic matter content	%	29.0
Total carbon	%	17.0
EC	dS/m	10.2
Total N	%	1.68
Total P	%	1.360
Total K	%	2.12
C/N ratio	-	10.0
Base saturation	%	200

The C/N ratio equal to 10 indicates a less than optimal composition, since the optimal ratio is in the range 12-13.

2.4 Setting up the agronomic experiments with potatoes

A 1,000 m^2 agricultural plot was prepared in September-October 2010 for the cultivation of potato and red beet during the 1st winter growing cycle. The agricultural plot is adjacent to the pilot desalination plant, which is located inside the construction visible in Figure 3 (*left*). Soil suitable for the cultivation was transported and distributed on the site (30 m^3). The terrain was prepared distributing compost (50 kg) and granular fertilizers, which were then mixed with the soil by means of a rotovator.

Figure 3. The agricultural plot before sowing on October 26

The terrain that was intended for the cultivation of potatoes was organized in 44 parallel rows, each of which consisting of a hummock of height 20 cm. The distance between the tops of two adjacent hummocks was 90 cm (see Figure 4). The thickness of the newly reported terrain was maintained at a minimum of 15 cm from the original soil at the bottom of the furrow between the hummocks.

Figure 4. Preparation of the terrain for cultivation of potatoes (October 2010)

The seed potatoes were planted in 17 cm deep holes dug on the top of the hummocks, each with a diameter of 5-6 cm and distributed at suitable distances along the parallel rows. Seed potatoes were fully covered at the time of planting in order to protect them from pest infestation. After sowing, the holes were filled up to 5 cm from the surface, where the pipes for drip irrigation were installed. The sowing of the potatoes was postponed to November 1st, due to the high temperatures experienced in that period. Before sowing and during the first ten days after sowing, the agricultural plot was irrigated with sprinklers in order to keep the soil moist and cool its temperature but avoiding the exposure of potato seeds to decay due to excess water. Sprinklers were placed at 5 m distance from each other.

Two varieties of potatoes were sown: “Bellini” and “Mondial”. The available plot was divided into eight equal parcels, according to the scheme presented in Figure 5. Four of the parcels were directly irrigated with brackish water from the aquifer with the quality presented in Table 2; the remaining four were irrigated with desalinated water (see Table 3). The field was further subdivided into equal plots cultivated with the “Bellini” or “Mondial” varieties. A further distinction is made between the North and South parcels, although no difference in irrigation water quality or quantity was applied between the two. In addition to these, a ninth parcel was dedicated to the cultivation of the red beet irrigated with the desalination brine. For clarity, the field codes and corresponding water and crop types are reported in Table 7 as well.

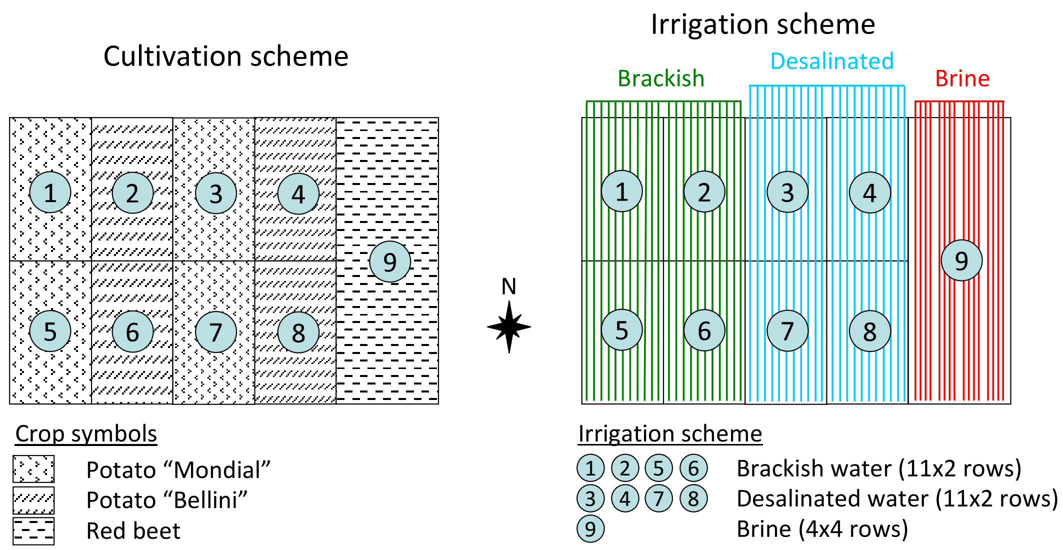


Figure 5. Subdivisions and irrigation scheme of agricultural field during 1st growing cycle

Table 7. Field codes and respective crop type, water type and orientation

Field code	Crop type	Water type	Orientation
1	Potato "Mondial"	Brackish	North
2	Potato "Bellini"	Brackish	North
3	Potato "Mondial"	Desalinated	North
4	Potato "Bellini"	Desalinated	North
5	Potato "Mondial"	Brackish	South
6	Potato "Bellini"	Brackish	South
7	Potato "Mondial"	Desalinated	South
8	Potato "Bellini"	Desalinated	South
9	Red beet	Brine	-

The irrigation strategy implemented during the 1st growing cycle was as follows. Before planting and for the first ten days immediately after planting, 60 m^3 of irrigation water were distributed through sprinklers, 30 m^3 before sowing and 30 m^3 after sowing. Each plot was irrigated with water of the intended final quality, i.e., brackish, desalinated or brine. After the initial period of irrigation with sprinklers, routine irrigation with the drip system was implemented. Irrigation volumes were determined based on the evapo-transpiration rate, which varies significantly over the period considered. The irrigation volume for desalinated water was set at 80% of the potential evapotranspiration and ranged between 6 mm/d in November and 3 mm/d in January. The irrigation volume of brackish water was consistently maintained at a value 25% higher than that of desalinated water. Figure 6 shows the development of the potato plants and tubers as of January 2011.

Figure 6. Potato plants as of January 11 (*left*) and sample of tubers from plot 7 on January 7 (*right*)

During the growing period, several of the plants became infested with *Erwinia carotovora*, a common pathogen of potato that causes tuber soft rot and blackleg and against which no chemical treatment is known to provide full protection in field conditions (see Figure 7). Such infestation from *Erwinia* likely had an effect on the final outcome of the agricultural experiments (see Results section). Samples of potatoes were collected on February 18, 2011 from 90 cm wide and 2 m long strips that had been previously cleared in each of the plots. The final harvesting of the potatoes occurred on March 23 (see Figure 8).

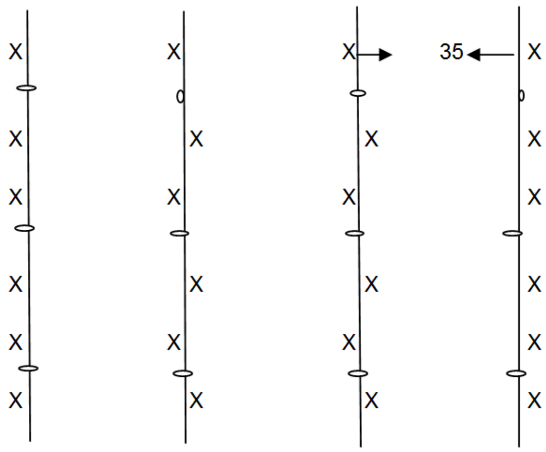
Figure 7. Potato plants showing signs of bacterial infestation (January 11)

Figure 8. Potato tubers during harvesting on March 23, 2011

2.5 Setting up the agronomic experiments with red beet

In parallel to the cultivation of potatoes with brackish and desalinated water, a part of the field was set aside for the cultivation of red beet irrigated with the brine produced by the pilot desalination plant. The surface dedicated to red beet was about 100 m^2 and is indicated with the field code 9 in Figure 5 and Table 7.

The red beets were sown in a nursery in October where they were kept for two weeks. They were subsequently transplanted to the field, one week after sowing of potatoes. Sowing was done manually, without the help of machinery. The red beet plants were put in the ground into 16 parallel lines, arranged into 4 groups of 4 parallel lines. A distance of 35 cm was kept between each line and the holes in the drip irrigation pipes were at intervals of 20 cm from each other. Within each of the groups the plants followed the arrangement illustrated in Figure 9, which reflects the guidelines of the Israeli national authority. The plants were put in the ground at a distance of 5 cm from the drip irrigation pipe. In each of the 16 rows, 230 red beet plants were put in the ground, corresponding to 3,680 plants over the whole field.



The symbol "X" indicates the location of a red beet plant

Figure 9. Arrangement of red beet plants within each of three groups of four rows

All the brine produced by the pilot desalination plant was used to irrigate the red beet plants. Figure 10 shows the growth of the red beet plants during the winter cycle. The plants grew strong showing no sign of being affected by the salinity of the brine or by bacterial infestations. Harvesting of red beet occurred in two stages on February 22 and 28.

Figure 10. Red beets on December 20 and February 27 (on the right side in both photographs)

2.6 Results of potato cultivation

The results of the harvesting of potatoes on March 23 are presented in Table 8-9. Table 8 (Table 9) presents the analysis of the number of potatoes (weight of potatoes in kg) produced in each of the plots, whose characteristics are summarized in Table 7. Four different diameters are considered for the healthy tubers, while cracked and rotted potatoes are included in two separate columns. The total number (weight) of potatoes and the average number (weight) produced in each plot include the cracked and rotten tubers.

Table 8. Number of potatoes produced in each plot, relative diameter and quality

Field code	Diameter, mm				Cracked	Rotten	Total	Average per m^2
	< 35	35 - 45	45 - 65	> 65				
1	18	34	65	74	29	10	230	28.40
2	18	41	133	61	25	7	285	35.19
3	44	31	90	64	32	15	276	34.07
4	17	24	83	40	27	55	246	30.37
5	25	20	81	80	12	5	223	27.53
6	13	40	98	53	35	41	280	34.57
7	14	41	78	70	22	3	228	28.15
8	10	20	70	41	34	35	210	25.93

Table 9. Weight in kg of potatoes produced in each plot, relative diameter and quality

Field code	Diameter, mm				Cracked	Rotten	Total	Average per m^2
	< 35	35 - 45	45 - 65	> 65				
1	0.322	1.746	10.870	24.628	7.640	1.341	46.547	5.747
2	0.239	1.973	20.438	18.320	4.439	0.949	46.358	5.723
3	0.745	1.764	13.161	21.088	8.102	2.529	47.389	5.850
4	0.267	1.213	12.781	11.872	6.030	8.901	41.064	5.070
5	0.401	0.977	11.688	27.146	3.010	1.060	44.282	5.467
6	0.229	2.018	12.990	15.847	5.734	5.713	42.531	5.251
7	0.238	2.185	11.527	23.914	5.979	0.631	44.474	5.491
8	0.180	1.031	9.500	11.785	5.821	5.530	33.847	4.179

The measured yield of potatoes exceeds the *a priori* expectations of 5 tons/ha. The average yield in all the eight plots is 5.35 tons/ha (±0.54 tons/ha), i.e., 6.5% higher than expected. The yield is particularly high for the "Mondial" variety, whose average yield was 5.64 tons/ha (±0.19 tons/ha; 11.3% higher than expectation). The yield of the "Bellini" variety is only slightly higher than expected (5.06±0.65 tons/ha), but this result is heavily influenced by the particularly low yield in plot 8, which was more severely affected by the *Erwinia* infestation.

The results presented in Table 8-9 do not allow for the identification of a positive effect of irrigation with desalinated water, either in terms of number of tubers produced or total weight. Figure 11 summarizes the results for the “Mondial” and “Bellini” varieties comparing the total yield and number of potatoes measured in the plots irrigated with desalinated and brackish water.

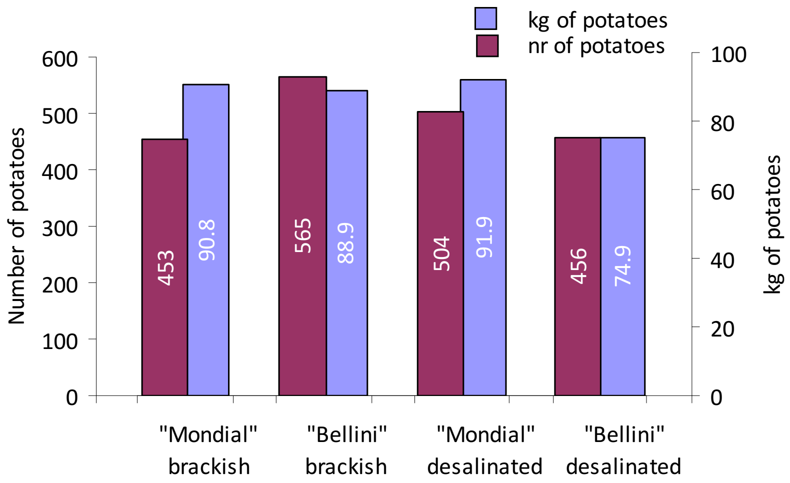


Figure 11. Summary of number of potatoes and yield (in kg) for different varieties and water quality

The number of potatoes and yield for the “Mondial” variety is higher for the crops irrigated with desalinated water. The increase in number of potatoes is significantly larger (11.3%) than the increase in the yield (1.1%), which indicates that the higher number is mainly due to an increase in potatoes with small diameter (see Figure 12).

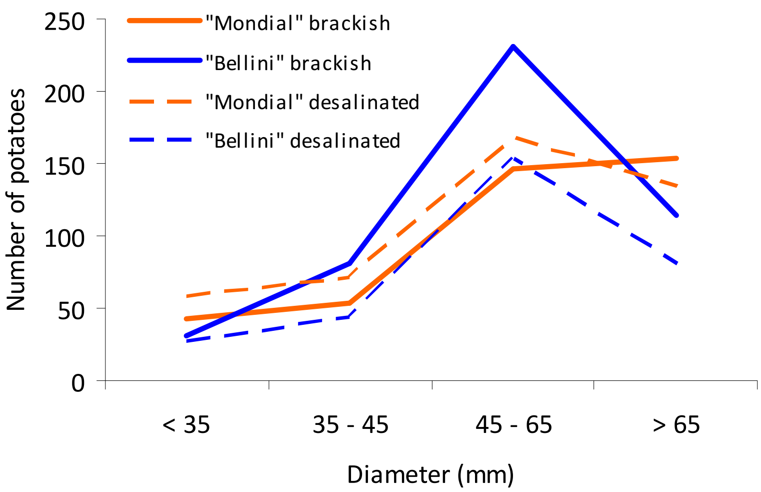


Figure 12. Distribution of potato sizes for different varieties and water quality

The lack of a detectable positive effect of irrigation with desalinated water on the yield of potatoes can be, at least partly, attributed to the *Erwinia* infestation, which afflicted the plots irrigated with desalinated water more severely than those irrigated with brackish water. Table 10 and Figure 13 show the results of laboratory analyses performed on February 24 on the sample of potato plants collected on February 18 and aimed at identifying the plants affected by *Erwinia*. The results of two independently conducted analyses are reported.

Table 10. Results of *Erwinia* infestation on a sample of potato plants (February 24)

Field code	Nr. of infected plants	
	Analysis 1	Analysis 2
1	10	12
2	1	0
3	14	13
4	12	13
5	4	3
6	5	5
7	10	13
8	3	2

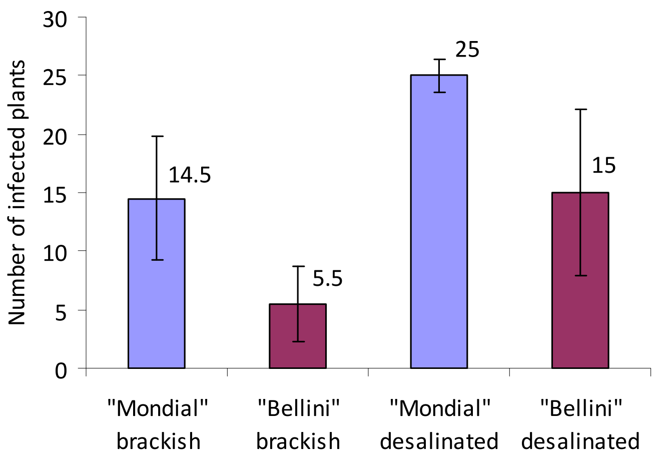


Figure 13. Number of plants infested by *Erwinia* within a sample of potato plants (February 24)

The number of plants infected by *Erwinia* is substantially higher among those irrigated with desalinated water. In particular the number of infected plants of the "Bellini" variety is 2.7 times higher among those irrigated with desalinated water. Plants of the "Mondial" variety irrigated with desalinated water are 1.7 times more affected than those irrigated with brackish water. The potential presence of a causal link between irrigation with desalinated water and incidence of *Erwinia* will be further investigated in the course of the project.

Table 11-12 show the results of the analysis of the samples collected on February 18 in terms of number of potatoes and yield according to potato variety and irrigation water quality. Figure 14 shows summary results from analysis of the sample.

Table 11. Number of potatoes produced within the sample collected on February 18

Field code	Diameter, mm				Cracked	Total
	< 35	35 - 45	45 - 65	> 65		
1	16	9	24	12	7	68
2	3	6	35	9	8	61
3	8	12	30	8	4	62
4	12	11	32	24	2	81
5	4	9	19	14	6	52
6	-	7	27	10	6	50
7	12	8	28	9	9	66
8	4	10	30	17	3	64

Table 12. Weight in kg of potatoes produced within the sample collected on February 18

Field code	Diameter, mm				Cracked	Total
	< 35	35 - 45	45 - 65	> 65		
1	0.250	0.490	3.900	3.720	1.560	9.920
2	0.060	0.340	4.790	2.520	0.910	8.620
3	0.140	0.800	4.430	2.000	0.800	8.170
4	0.160	0.650	4.560	5.890	0.420	11.680
5	0.050	0.380	2.820	4.290	1.480	9.020
6	-	0.370	3.960	3.330	1.140	8.800
7	0.210	0.430	4.080	2.970	1.830	9.520
8	0.090	0.540	4.700	4.550	0.170	10.050

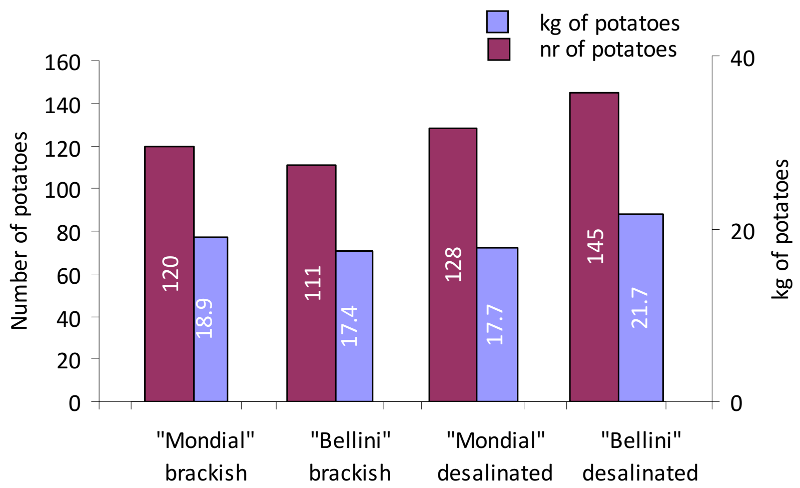


Figure 14. Summary of number of potatoes and yield (in kg) for the sample collected on February 18

Despite the higher incidence of *Erwinia* among the plants irrigated with desalinated water within the sample collected on February 18, the analysis from the sample hints to a more substantial positive effect of irrigation with desalinated water than recognizable from the analysis of the whole harvest (see Table 8-9). The analysis of the sample suggests that the highest beneficial effect from irrigation with desalinated water is experienced by the "Bellini" variety, whose overall yield increases from 17.4 kg to 21.7 kg (+25%) and the number of potatoes from 111 to 145 (+31%). Within the sample, the effect on the "Mondial" variety is less marked and of unclear direction. While the number of potatoes slightly increases from 120 to 128 (+7%), the total yield decreases from 18.9 to 17.7 (-7%).

2.7 Results of red beet cultivation

The cultivation of red beet with brine from the pilot desalination unit was successful and even exceeded the initial expectations. Plants grew strong, showing no sign of being affected by the salinity of the irrigation water or by parasites and pathogen organisms. Table 13-14 provide a summary of the two harvests performed on February 22 and 28.

Table 13. Weight (in kg) of red beets harvested on February 22 and 28

Plot	1st harvest: February 22			2nd harvest: February 28		
	< 8 mm	8 -11 mm	Cracked	< 8 mm	8 -11 mm	Cracked
A	0.54	5.69	0.73	4.33	1.26	-
B	0.84	4.76	0.31	5.28	1.61	-
C	0.82	4.01	1.10	3.97	1.36	0.22
D	0.99	5.26	0.88	3.45	1.41	0.54
Average	0.80	4.93	0.76	4.26	1.41	0.38

Table 14. Number of red beets harvested on February 22 and 28

Plot	1st harvest: February 22			2nd harvest: February 28		
	< 8 mm	8 -11 mm	Cracked	< 8 mm	8 -11 mm	Cracked
A	2	17	2	31	4	
B	3	12	1	37	5	
C	4	12	3	35	5	1
D	4	14	3	23	5	2
Average	3.25	13.75	2.25	31.5	4.75	1.5

Extrapolating the results obtained to a hectare of land, one obtains a yield of 6,081 kg/ha, which is 22% higher than the expected yield of 5,000 kg/ha.

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