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The influence of avocado rootstocks on the tree resistance to salinity

M. Zilberstaine, E. Lahav, A. Aycicegi, E. Sokolowsky, A. Ben-Ya'acov, A. Meiri, Y. Krukowsky and J. Tarchitzky

I would like to add some information from commercial orchards which are grafted on different rootstocks just to show you some results from what we call "real life". The results that I am going to present are from a long-term project that has been taking place in two different areas of Israel for the last twelve to thirteen years. One area is in central Israel, and the other is in the north with two different soil types and different rootstocks. As you can see, the researcher team comprises people with expertise in avocado research and soil and water.

This presentation with deal with 2 main aspects of these projects. First we have examined the impact of water quality on rootstock performance (grafted trees) in relationship to yield, trunk growth and leaf tip burn. The second aspect that we have quantified is the impact of heat stress (40-43ºC; 10-20% RH) in combination with salinity stress on rootstock performance as related to branch dieback.

Water quality and rootstock performance

In this portion of the project we asked the question whether it is possible to irrigate avocado trees with low quality water and maintain high yield. Site 1 (Akko) was an orchard in northern Israel planted on heavy soil with water containing 150 mg/L Chloride (Cl) and 0.7 mg/L Boron (B). The potable water for this area contains 70 mg/L Cl and has a very low concentration of B (Table 1). At site 2 (Hama'apil), in central Israel, we compared very high concentrations of chlorides, about 270 mg/L in the potable water with very low concentration of boron, and reclaimed water where the chloride concentration ranged from 220 to 320 mg/L Cl and 0.2 mg/L B.

Table 1. *Summary of water quality at the two experimental sites.*

	Chloride (mg/L)		Boron (mg/L)	
	Potable	Brackish	Potable	Brackish
Site 1 - Akko (northern Israel)	70	150	0.05	0.70
Site 2 – Hama'apil (central Israel)	270	220-320	0.05	0.20

Yield. At Site 1 we had both the 'Ettinger' and 'Hass' grafted on several seedling rootstocks. Figure 1 presents the yield data for 'Ettinger' grafted on 3 rootstocks: Nahal Oz 8, Degania 113, and Eilon 1. Eilon 1 is the only Mexican rootstock; the others are

West Indian or West Indian hybrids. When the trees are irrigated with potable water, there is no difference in yield per tree. Once we change the water quality, we can see that in the trees that are grafted on Mexican rootstocks, there is a decrease in yield.

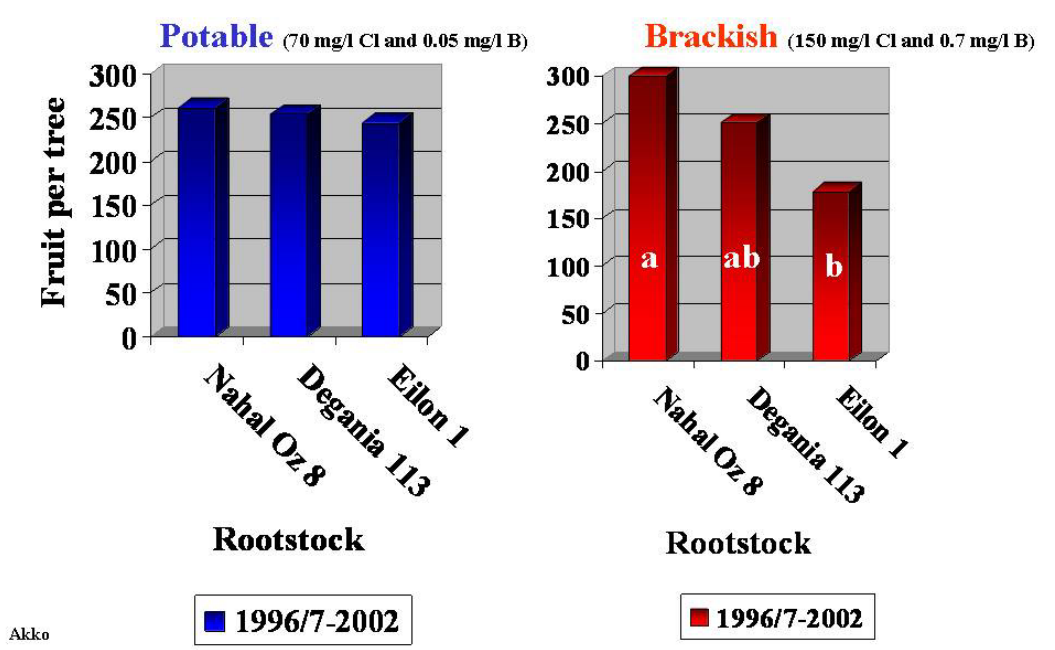

Figure 1. *Comparison of 'Ettinger' fruit per tree as a function of rootstock and water quality from 1996 – 2002. Data from Akko experimental research site.*

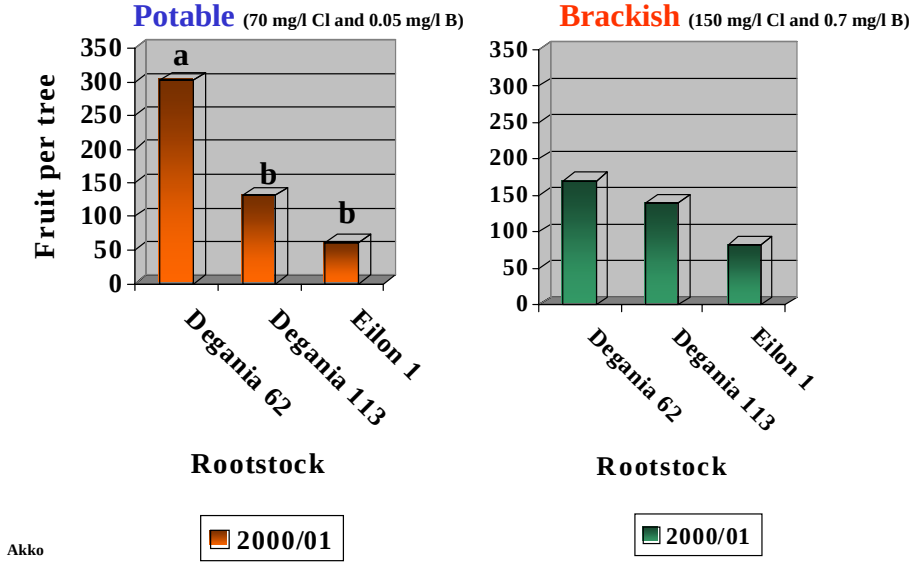

Figure 2. *Comparison of 'Hass' fruit per tree as a function of rootstock and water quality in 2000/01. Data from the Akko experimental research site.*

The trends are somewhat different for 'Hass' (Figure 2). The yield of 'Hass' is much more sensitive than 'Ettinger' to salinity, even with potable water. We observed a statistical difference in yield per tree between Degania 117 and Degania 62 which are selections of Dr. A. Ben Ya'acov from 30 to 35 years ago. Yield is even lower when 'Hass' is grafted on Eilon 1, a Mexican race rootstock. Once we change water quality to the brackish water and the trees are exposed to 150 mg/L Cl and high boron, the yield decreases further even in the two Degania rootstocks. Figure 3 illustrates the yield results of 'Hass' trees grafted either on Degania 117 or VC 51 at the Hama'apil site. The latter rootstock is one of the selections by Ben Ya'acov, which he selected for high yield under high saline conditions. Even when the 'Hass' trees, in this case for five years, were exposed to the high concentration of salinity in the reclaimed water, we can see very high yields.

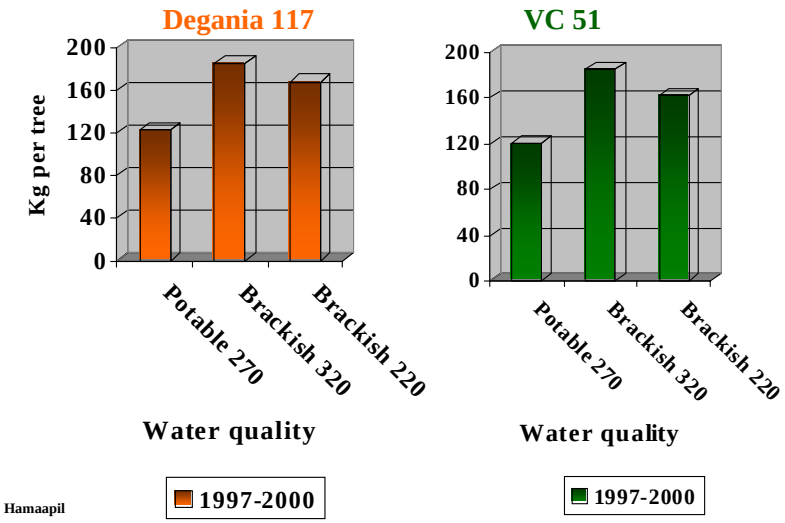

Figure 3. *Comparison of 'Hass' fruit weight per tree on Degania 117 and VC 51 rootstocks using potable and two types of brackish water. Chloride levels in the irrigation water varied from 220 to 320 mg/L (ppm). Data from Hama'apil research plot.*

When we look at tree growth parameters such as trunk circumference we also saw differences between rootstocks. For instance at the Hama'apil site, 'Ettinger' trees grown on VC 40 showed little response to decreased water quality whereas 'Ettinger' on VC 51 showed reduced trunk circumference in response to increased salinity. The same trends were observed with the 'Hass' grafted on either Degania 117 (no reduction) versus VC 51 (reduced growth).

We also rated leaf tip burn as a function of rootstock and water quality in February 2002. Figure 4 illustrates the amount of leaf burn observed in 'Hass' when irrigated either with potable water or brackish water. In this case, the Eilon 1, a Mexican race rootstock, had significantly more leaf burn than either the Nahal Oz 8 or Degania 113 when exposed to the brackish water. The 'Ettinger' variety responded in a similar manner (Figure 5); in this case there was significantly more leaf tip burn on the grafted

Eilon 1 trees with both potable and brackish water. Note for both scion varieties, that irrigation with brackish water for all rootstocks resulted in greater tip burn.

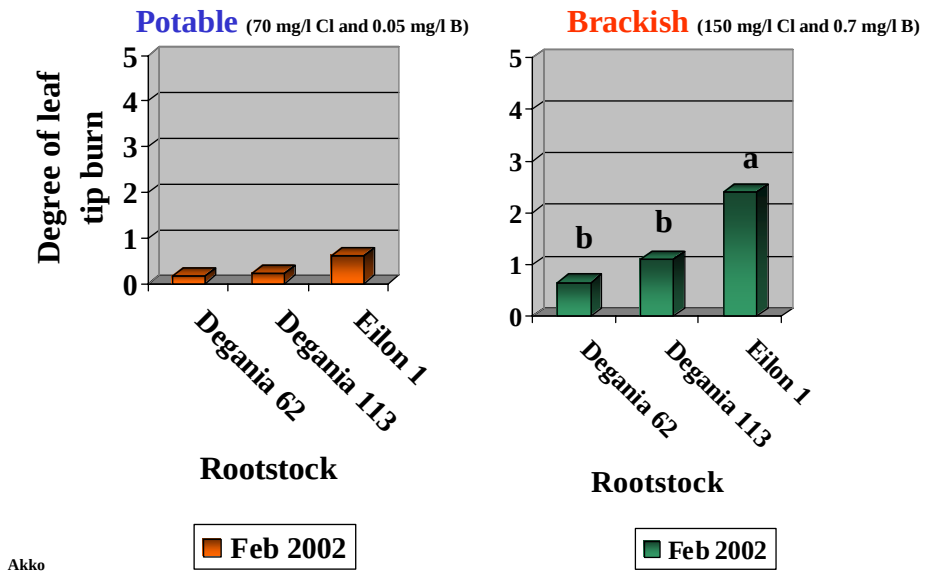

Figure 4. *The amount of leaf tip burn in 'Hass' as influenced by rootstock and water quality. Data from the Akko research site.*

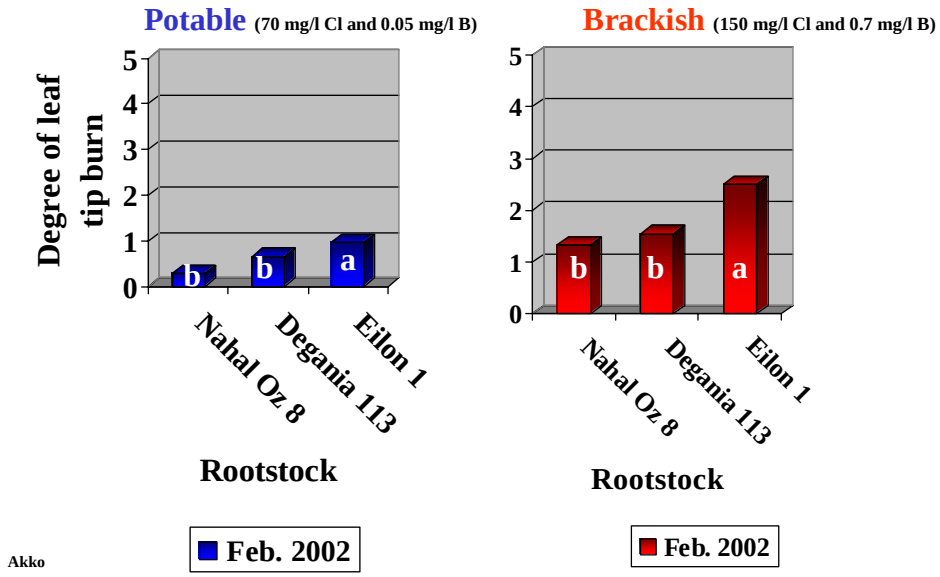

Figure 5. *The amount of leaf tip burn in 'Ettinger' as influenced by rootstock and water quality. Data from the Akko research site.*

Figure 6 shows a view of how orchards in Israel look as a result of management during the last 6-7 years. They are usually irrigated with high concentrations of chlorides, pruned each year, and irrigated, in this case, every day.

Figure 6. *Dr. Miriam Zilberstaine in a typical orchard in Israel.*

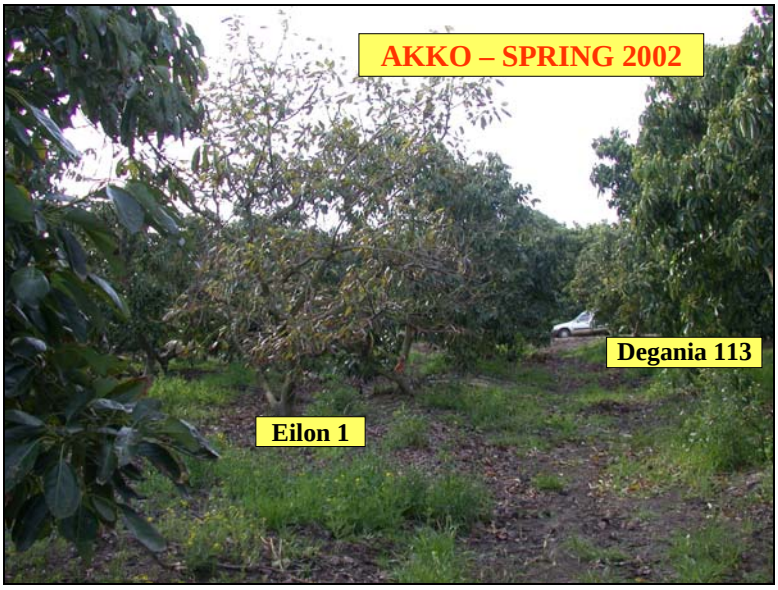

Figure 7. *Visible effects of heat stress on Eilon 1 versus Degania 113. This picture was taken in 2002 following hamsin conditions.*

Heat stress and rootstock performance

I want to emphasize another point. Unfortunately, we had the opportunity to observe and measure the influence of the rootstocks on the health of the tree under very extreme heat that we have had in Israel. It happened to us during the spring of 2002, when we had very high temperatures (43-45ºC) and very low humidity (10-20%), a situation we call “hamsin”. We can see (Figure 7) that the ‘Hass’ trees that were grafted on Eilon 1, the Mexican rootstock, suffered a lot and had a greater percentage of the

branches with severe dieback. On the other hand the trees that were grafted on Degania 113 looked very well as though nothing has happened to them. We took a survey and we believe that the best trees were grafted on Degania 117.

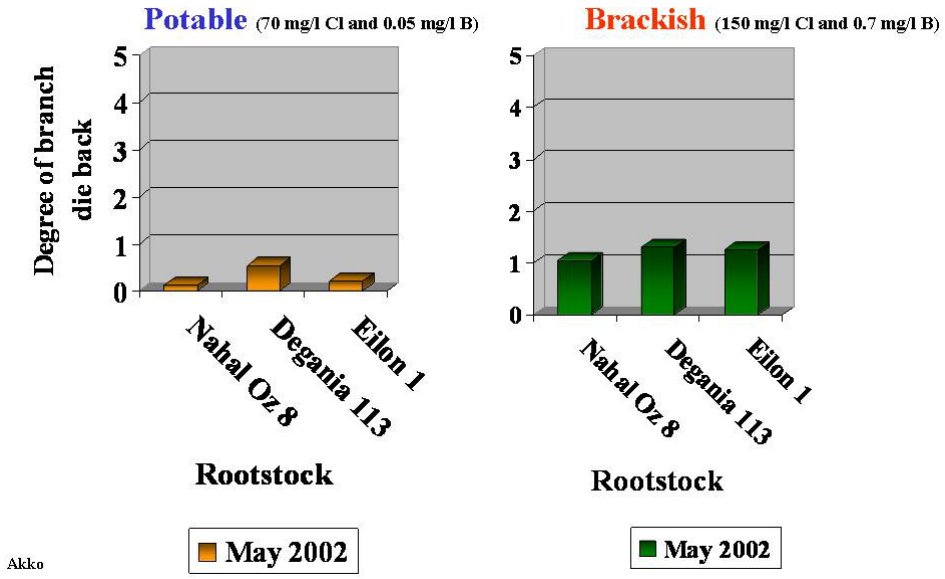

Figure 8. *Comparison of branch dieback of 'Hass' on various rootstocks irrigated with potable and brackish water. Data from the Akko research site.*

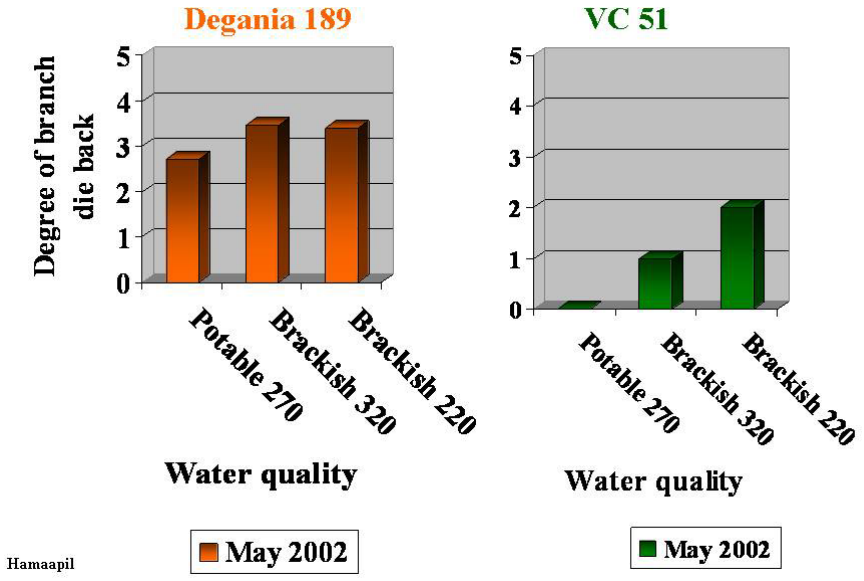

Figure 9. *Comparison of 'Hass' branch dieback on Degania 117 and VC 51 rootstocks using potable and two types of brackish water. Data from Hama'apil research plot.*

At the Akko site, the trees that were irrigated with potable water did not show extreme symptoms, while when the trees were irrigated with the low quality water, all showed damage; with no differences between rootstocks (Figure 8). At this site we did not have the Degania 69 rootstock, which has shown better results. At the other experimental site (Hama'apil) which has "light" soil, we can compare the Degania 189 with VC 51 (Figure 9). Here we can see that there are noticeable differences between the rootstocks with the VC 51 more tolerant to the saline conditions; this is what I wanted very much to emphasize.

The Degania rootstocks in Israel, which are Degania 117, Degania 113, Degania 189, are yielding very well even under high concentration of chlorides, and VC 51 which is a selection that Ben Ya'acov made many years ago, there was no difference in the yield potential of the trees when they were only exposed to salinity stress. However, once the trees are exposed to another stress, like the heat that we had in February 2002, we can see that the 'Hass' trees that were grafted on VC 51, even under the high concentration of salinity, did not sustain as much damage as the trees that were grafted on Degania 189. This means that when we combine some stresses together, the VC clonal rootstocks always show better results in the field.

Current experiments

What are we doing now? In the long-term research we are looking at the influence of the brackish water or reclaimed water on the trees, not only from the point of view of chlorides but also boron, which is a major factor in the reclaimed water we have. We were asked to answer the question: is it possible to irrigate or to grow avocados not only with high salinity, but also with the combination of chloride, boron and sodium in the long-term? Table 2 shows the water quality of the experiments currently under way.

Table 2. Water quality in long-term research currently underway in Hama'apil.

Water quality	Chloride (mg/L)	Boron (mg/L)
Potable	250	0.01
Potable	250	0.80
Brackish	220	0.25
Brackish	320	0.25
Brackish	220	0.80
Brackish	320	0.80

After ten years we will see if the trees will remain high yielding also under this high concentration. Our treatment includes potable water but only with 250 mg/L Cl. But we have the reclaimed water with the combination of different levels of chloride from 220 to 320 mg/L. With boron, we have different concentration from 0.01 to 0.8 mg/L; the latter concentration is very high level of boron in the water. If we will have good results after eight to ten years, we can say, yes, we can use the water as delivered. If not, the

people who supply us the water will have to decrease the concentration of boron in the reclaimed water.

Just to summarize, different avocado rootstocks differ in their influence on yield response and tree growth of scion varieties in response to water quality and other environmental stresses. I did not show results on tree growth, because it is not so important in our orchards in Israel anymore, since we prune the tree at least once a year, and sometimes even twice a year. So, the tree growth as affected by our rootstocks is not an important consideration from our perspective.

You have to remember, to just compare the rootstocks in California and the rootstocks that we have in Israel. In experiments that we conducted ten years ago, the Duke 7 could not survive in Israel more that two or three years; the trees just died. While the trees that were grafted either on Degania 117 or all other West Indian rootstocks, the trees did very well showing mainly differences between them in yield.

The final important point I would like to make is that the different avocado rootstocks differ in their response to heat stress in addition to different water quality.