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THE POSSIBLE USE OF AVOCADO (*Persea americana* Mill.) GERMPLASM MATERIAL AS ROOTSTOCKS FOR SOIL STRESS CONDITIONS

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SUMMARY

Avocado gene pool plots, established in Mexico (CICTAMEX) and Israel (Volcani Center) during the last 10 years, include a few hundred germplasm items. They were evaluated in Israel as rootstocks for avocado under soil stress conditions. Several items showed tolerance to either one or more factors, such as salinity, lime, poor aeration, root–rot and drought.

KEY WORDS: Genetic resources, evaluation, gene pool.

INTRODUCTION

Avocado is very sensitive to many soil stress factors, (Ben–Ya'acov and Michelson, 1995) among which salinity, lime, exchangeable sodium, non–aerated soil, root–rot and dryness, each one by itself or in combination with others, limits the planting possibilities and cause damage and degeneration in existing orchards.

Rootstock selection is one of the best means of action when soil problems must be solved. But all around the avocado industries, there were only very few selection projects, and they were aimed only to solve a specific problem, like the root–rot problem in California (Zentmyer, 1980).

The Californian investigators found that local seedling rootstock populations, although varying in many characteristics, showed similar sensitivity to root–rot, and they decided to enlarge the genetic spectrum by exploring the countries of origin, collecting diverse material and examining its tolerance to the disease (Zemtmyer and Schieber, 1987). The wild material of many species is in a rapid degradation process all around the countries of origin and this is also the case with the avocado and its botanical relatives. Hence, conservation of this material has become an urgent task itself, and not only in order to solve one problem. For this reason we commenced a germplasm collection and conservation project, through a cooperation between Israel, Germany, Mexico and people all around the countries of origin in Central and South America (Ben–Ya′acov *et al*., 1992a). Once the collected accessions were grafted and planted in gene pools, the time came for local investigators to study their characteristics in general, and their ability to serve as rootstocks for commercial cultivars. The aim is to find out if some of the items may have better adaptability to

soil stress factors than regular rootstocks, due to their wider genetical spectrum of traits. Preliminary report was published on 1992 (Ben–Ya′acov *et al*., 1992b).

MATERIALS AND METHODS

Fifty four germplasm accessions were propagated clonally and received VC (Vegetative Clone) numbers, like other clonal rootstocks. The resulting rooted saplings were planted in experimental plots, under different soil stress conditions. This procedure was repeated a few times, mostly without grafting the rootstocks to a cultivar. Randomized replicates were planted in each plot.

The different experimental plots and their local conditions were:

1. **Givat Haim**: A. This orchard is in the central part of Israel, on the coastal plain. The soil is very heavy clay soil and not aerated. The root–rot agent, *Phytophthora cinammomi*, was located here a few years before the planting of the experimental orchard. The original avocado orchard degenerated and died. Ridges were prepared before the new planting. Fifty germplasm items were planted here, six trees per item, organized as three replicates. An annual survey of growth, tree size, leaf burns and general condition of the trees was performed.

   B. Another plot was planted at Givat Haim a few years later. The items were grafted here with the Reed cultivar. Five germplasm items were included, among 10 clonal rootstock. All of them were pre–selected for root–rot. As all the trees did no′t show stress symptoms, only their size was graded, on the scale of 1 (small) – 5 (large).

2. **Neve–Ya′ar**: Neve–Ya′ar is an experimental station in the Valley of Jezreel, where intermediate levels of salinity and lime cause some leaf burns and chlorosis. Here 42 items of germplasm sources were planted. The follow–up included surveys as earlier mentioned. When the plot reached the age of 12 years, irrigation was eliminated for two summer periods, and the trees′ reaction was investigated.

3. **Maoz–Haim**: The dry and warm climate in the Bet Shean Valley, and high level of soil exchangeable sodium – are the two important factors here. Twenty two items were planted and then grafted to cultivar Reed. Surveys were conducted during the years.

4. **Emek–Hefer regional orchard**: This site was chose as one half of it was a swamp, and the other one–sandy aerated soil. The germplasm items were equally represented in both halves.

5. **Bet–Dagan**: At the experimental orchard of the Volcani Center, a small plot, characterized by very sandy soil was chosen. Trees previously planted in this plot were unable to survive. Here 20 different types were planted. After more than 10 years, irrigation was eliminated for a few summer months. The survival of the rooted rootstocks before and after the irrigation was eliminated – was investigated.

6. **Gilat**: Another experimental orchard of the Agricultural Research Organization, at the center of the Negev desert was included in our investigation because of the lime and salinity prevailing there. Only 15 types were planted, two trees of each. Later on a few other types replaced those which failed.

7. **Ha′maapil**: Under saline conditions and poorly aerated soil, eight items were planted.

RESULTS AND DISCUSSION

Givat–Haim:

A.

During the first 3 years after planting most of the germplasm items planted at this infected orchard had degenerated and died. The best groups of trees were of the VC 256, and then VC 207 (Day), VC 218 (Antigua), VC 225 (Galvan), all of them West–Indian type, and VC 239 (Gainesville, Mexican type) and VC 241 (*Persea nubigena* 1/7, Guatemalan type).

More details about this experiment were published (Zilberstaine *et al.*, 1992) and will be given by Dr. Miriam Zilberstaine in another report in this Proceeding.

B.

The results of this experiment are presented in Table 1. From Table 1 it can be seen that the clonal rootstocks that showed best during the first selection, i.e. VC 207 and VC 256 are also the best when grafted by the Reed cultivar.

Table 1. Evaluation of avocado tree size, Reed cultivar grafted on different germplasm resistant rootstocks.

Clonal rootstock			Tree size in
Name	VC No.	No. of trees	grades
Day	207	8	4.8
PIC 9615	210	8	2.8
Galvan	225	8	4.5
(not identified)	256	7	5.0

Tree size grades – 1 (small) – 5 (large).
Survey date – January 1997, at Givat–Haim.

Neve–Ya′ar:

Although growing conditions here were not very poor, some germplasm items suffered and were lost. After the dryness period of two summer periods, few items were found to be healthy and vigorous: VC 247 (‘Stuart’, Mexican cultivar), VC 227 (Orizaba 4, West–Indian), VC 231 (Maskaria 1, not identified), and VC 207 (Day).

As a result of the dryness, Maskaria 2, Apakia, Avocatoza 2 and ″No Race″ – were lost.

Maoz–Haim:

Under these stress conditions, a few types out of 22, were better: VC *213 (P. americana* C2), VC 207 (Day), VC 209 (Mayo 133, Mexican), VC 226 (Orizaba 1) and VC 235 (Orizaba 3). Over the years, the Mexican rootstock condition was improved. This can be explained by their better adaptability to compact soil, resulting from the high content of exchangeable sodium.

Table 2. Avocado tree response to water stress, 1-1-1997, on sandy soil in the Bet–Dagan experiment.

Name of Accession	Number of Trees	Foilage Percentage (100% = full cover)	Leaf Burn 0–9 (9 = totally burned)
Day	3	100	0
PIC 9615	2	95	0.5
Mayo 133	2	100	2
Orizaba 1	1	80	0
Orizaba 4	2	60	0
Km 145	4	80	6 (2 trees died)
Antigua	5	20	0
Comitam 1	5	15	0
Guzman	2	30	3
Amatenango	2	30	0
Galvan	2	25	0
Orizaba 3	2	15	0
Maskaria 1	2	10	0
Stuart	6	30	4
Sholola	2	35	5
P. nubigena 1/7	2	60	5
P. nubigena 1/8	2	35	5
Apakia 2	2		died

Emek–Hefer:
No difference was found between the two compared parts of the orchard, where either swamp or sandy soils were prevalent. The best in terms of development were the following types: VC 207 (Day), VC 225 (Galvan), VC 235 (Orizaba 3). The other 27 types planted here were significantly weaker. Severe leaf burns were found on the Mexican types planted here due to the bad water quality and the sandy soil.

Bet–Dagan:
Under very light sandy soil conditions, many trees did not survive. Out of 20 germplasm types, the following showed good development: VC 202 (Avocatosa 2), VC 207 (Day), VC 218 (Antigua), VC 225 (Galvan), VC 227 (Orizaba 4), VC 235 (Orizaba 3), VC 237 (Sholola), VC 241 (*Persea nubigena* 1/7) and VC 242 (*Persea nubigena* 1/8).

This order of priority was changed after a long period of water elimination. The situation now is presented in Table 2. We found only a few rootstock types that did not suffer from total leaf drop and from leaf burns: VC 207 (Day), VC 210 (PIC 9615), and the Orizaba types. Two Mexican representatives, namely Mayo 133 and Km 145, managed to keep their leaves, but the last one had high degree of leaf burns.

Gilat:
Under Negev (desert) stress conditions, only 3 types out of 15 showed advantage. They were VC 207 (Day), VC 210 (PIC 9615) and a Mexican one – VC 247 (the Stuart cultivar).

Ha′maapil:
Under saline conditions and poorly aerated soil, one Mexican type was particularly good. We were convinced that its identification was mistaken, so it received VC 257 number (a new one).

CONCLUSIONS

From Table 3 it is clear that, when planted as rooted trees, different types differ in their behavior under different ecological conditions. Of course, this result was expected. Table 3 includes 24 accessions out of 54 that were planted in the experimental plots (the other 30 showed poor performance in all these plots). Moreover, as can be seen in the table, even those rootstocks included were not represented in each plot. From the different types distributed in most of the plots, some more universal in their adaptation, such as 'Day' and Orizaba 3, while some such as 'Sholola' or 'Stuart', were adapted to one site only.

Of special importance, the following should be mentioned: The four accessions that developed well under root–rot infection (even after they were grafted); the Mexican type 'Stuart', has shown no symptoms of salinity or lime–induced chlorosis under Negev conditions; the Mexican type Mayo 133, that managed well on alkaline soil; the Mexican non–identified VC 257 (mentioned in the text), that developed better than all other types under a combination of salinity and poor aeration (usually Mexicans are sensitive to salinity and West Indians to poor aeration).

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Table 3. The best developed avocado trees from germplasm rooted clones in different orchards.

VC No.	Name	Givat Haim	Neve Ya′ar	Maoz Haim	Emek Hefer	Bet Dagan	Gilat
202	Avocasta 2	–	–	x	X	+	–
204	Guzman	+	–	x	–	–	X
207	Day	++	+	+	+	+	+
209	Mayo 133	–	+	+	–	–	X
210	PIC 9615	–	+	–	–	–	+
213	*P. americana* C2	–	–	+	–	–	–
214	Dade	+	–	X	X	X	X
217	*P. americana* T2	–	–	+	–	X	–
218	Antigua	++	–	–	–	+	X
225	Galvan	++	–	X	+	+	–
26	Orizaba 1	–	–	+	X	X	–
227	Orizaba 4	+	+	X	–	+	X
231	Makaria 1	–	–	–	–	–	–
232	Km 145	–	–	X	–	–	X
235	Orizaba 3	+	+	+	+	+	–
237	Sholola	–	–	–	–	+	X
239	Gainsville	+	–	X	X	X	X
240	Amatlan	–	+	X	X	X	X
241	*P. nubigena* 1/7	+	X	–	–	+	X
242	*P. nubigena* 1/8	–	X	–	–	+	X
245	*P. gigantea*	–	+	–	X	X	–
246	*P. floccose*	–	+	X	X	X	X
247	Stuart	–	–	–	–	–	+
256	Not identified	++	X	x	x	X	x