The Division of Subtropical Agriculture. The Volcani Institute of Agricultural Research 1960-1969. Section A. General. Pg 7-21.

A. GENERAL

1. HISTORY AND ORGANIZATION OF THE DIVISION

Ch. Oppenheimer

The Division of Subtropical Horticulture was officially established in 1942. However, it had already been in existence for some years as part of another division of the Agricultural Research Station, and many of its projects were begun during this earlier period. For many years the division remained small, and only in the middle 1950s did the development to its present status begin. In 1958, the Horticultural Department moved to Bet Dagan, which gave to the division greatly expanded living room, in both laboratories and orchards. A considerable expansion of its budget in the early 1960s, from both local and foreign sources, and the teaching activities of its head, made it possible to enlarge the staff of post-graduate students and research workers. Somewhat later, the work expanded through the organization of a group of regional scientists. In the summer of 1969 the division had on its staff 12 scientists and 16 assistants and technical workers.

The division has undertaken — in close cooperation with members of the extension divisions, the marketing boards and many fruit growers — to solve some of the many problems which stand in the way of the development of the subtropical fruit industry. We have been working mainly with four crops — avocado, mango, banana and date — but have also done some work with persimmon, annona, loquat, passion-fruit, litchi and macadamia.

The division is at present organized into the following research groups:

Problems of salinity of irrigation water and lime content of soil in relation to the avocado and the vegetative propagation of selected rootstocks — Group Leader: Dr. A. Kadman.

The research is divided along two main lines: Selection of resistant rootstocks, and their vegetative propagation.

The selection has been carried out at the research center from seed-grown material under irrigation with saline water and also by locating healthy trees in affected orchards. These types were propagated directly, if seedlings; or the rootstocks were recovered, if they were budded trees. This very long-term research is now in its third phase — the final selection of the resistant rootstocks after vegetative propagation and grafting with standard varieties. Parallel work in the orchards is carried out by A. Ben-Ya'acov.

Research work to establish a method of vegetative propagation suitable not only for

producing the small number of plants needed for the research work, but for the practical nursery-man, is going on at the same time; the method should be ready when the final selection has been made. M. Shafrir and the group leader both work on propagation.

Problems of flowering and fruit development of avocado, mango, persimmon and annona and problems of mango nutrition — Group Leader: Dr. S. Gazit, lecturer at the Hebrew University; A. Blumenfeld, participant in the basic research.

The group studies the development and ripening processes of the avocado fruit along two lines: Basic research on the role of endogenous growth substances, and applied work in which the group gives the lead to the Fruit Marketing Board, as to the beginning of the harvest of the different avocado varieties (especially of the two leading early varieties — Ettinger and Fuerte) from different orchards and regions. Studies on the flowering, fruit set and fruit development of the mango are carried out especially with the Haden variety, with the aim of preventing the formation of worthless, seedless fruit. In mango nutrition, work is done on zinc and iron deficiencies and on the problems connected with heavy and high-lime soils. A method was worked out with persimmons to obtain firm, non-astringent, ripe fruits of the varieties Triumph and Hachiya, which formerly had to be eaten soft. Studies are being carried out on pollination problems of annona, and on the possibility of obtaining seedless fruits by hormone treatments.

Problems of banana growing in the coastal plain — Group Leader: M. Gottreich.

Many problems have been investigated, among them the influence of planting distances and thinning of suckers, daily growth rate of roots, importance of number of living leaves at different stages of development of the plant, and others. The central interest of the group is the reaction of the plant to low temperatures, both during the winter and during its recuperation in spring. Trials are being carried out with the banana fruit, to delay ripening in the orchard and to develop a method which will enable us to establish the exact stage of ripeness at the time of harvest.

Problems of date growing, especially in the Rift Valley (Arava) — Group Leader' Dr. O. Reuveni.

The group carries out research on the possibility of developing a modern method of date propagation, with the ultimate aim of mass propagation of new and superior varieties. The use of the tissue culture technique is being investigated; H. Kipnis takes part in this work. On the immediate, practical side, the group tries to solve many different problems of the establishment of a date industry in the Arava, among them water duty, nutrition requirements and fruit development.

Acclimatization — For more than 30 years, this has been the main interest of the Head of the division. Dr. A. Kadman, Dr. S. Gazit and others participate in this work; the actual work is now being done by E. Slor. The work is carried out along four different lines:

(a) Introduction of plant material selected in other countries. During the 1960s material was imported from many countries — budwood of avocado, persimmon, annona and macadamia, and seeds of passionfruit and actidinia.

(b) Selection of local seedling types, with work on avocado, mango, annona and feijoa.

(c) Trials with known species, like mango and avocado, in new districts — specially in the southern part of the country (Negev, Arava).

(d) Trials on a single-tree or small-orchard scale with new species like passionfruit, macadamia and litchi.

The regional work

In addition to the work each member of the division, in his line, carries out in different regions, the division now benefits from the work of three regional scientists:

Dr. A. Ben-Ya'acov works in the central coastal plain, mainly on the relationship between avocado rootstocks and soils, including salinity problems and the influence of inarching. In addition, he has undertaken to isolate productive strains of avocado varieties and to investigate other reasons for lack of fruitfulness of the Fuerte variety.

E. Lahav works in the Western Galilee, the northern part of the coastal plain. His work includes studies on nutrition of banana and avocado, on avocado irrigation, on the influence of girdling on productivity, and of thinning on fruit size in avocado.

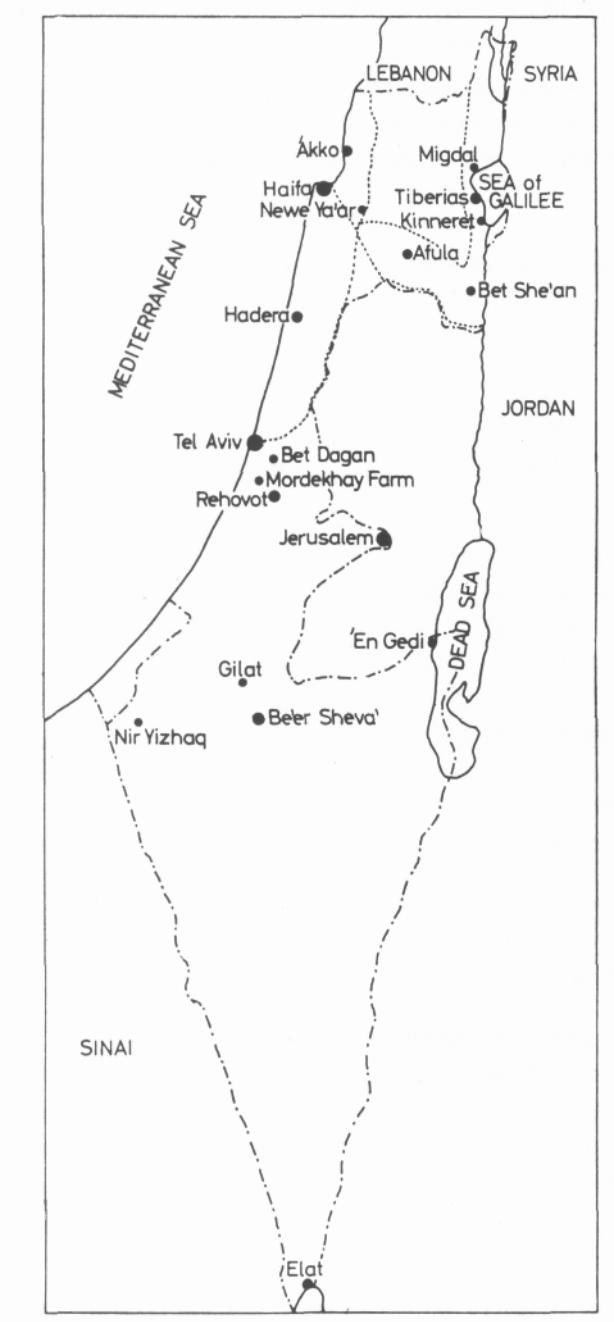
E. Tomer started his work in the interior valleys in 1968, with plans to concentrate on two problems: fruit set in avocado, mango and annona, and the prevention of low temperature damage to avocado.

The laboratory — Head: R. Spodheim

The laboratory staff work together with all research groups in the many analyses which they require. New methods are developed continuously, including, recently, methods for the determination of the oil content of avocado, and the starch and sugar contents of bananas and dates.

The orchards

These are not part of the division from an administrative point of view. H. Lippmann, who is in charge, works in very close cooperation with the Head and members of the division on all the horticultural problems of the orchards. In the orhards in Rehovot, Kubeiba, Bet Dagan and Gilat (see map), varieties and root-stocks of avocado, mango, persimmon and other fruits are grown.



Breeding of subtropical apples

This work was planned in the 1930s by the Head of the division, whose concern alone it was for many years. During the 1960s most of the work was taken over by E. Slor. In 1968 three varieties were released, and many types are still under observation. Strictly speaking, this work does not belong to the division.

List of Members of the Division (as of August 1, 1969)

Yitzchak Adato, B.Sc., assistant
Zvi Ben Chez, field assistant
Rachel Ben Simon, laboratory worker
Dr. Avraham Ben-Ya'acov, regional scientist
Amos Blumenfeld, M.Sc., junior scientist
Vera Dori, laboratory technician
Ruth El-bazri, senior laboratory technician
Miriam Elimelach, laboratory technician
Dr. S. Gazit, Lecturer, Hebrew University, Head of research group
Eitan Gidron, field assistant
M. Gottreich, agronomist, Head of research group
Ovadia Japheth, field assistant
Dr. Amnon Kadman, Head of research group
Zohar Kaplan, B.Sc., assistant
Hannah Kipnis, M.Sc., junior scientist
E. Lahav, M.Sc., regional scientist
H. Lippmann, plantation manager
Menashe Mezuyanim, field assistant
Prof. Chañan Oppenheimer, Head of Division
Dr. O. Reuveni, Head of research group
Carolina Roll, laboratory worker
Nurit Roñen, laboratory technician
M. Shafrir, M.Sc., scientist
E. Slor, co-ordinator of introduction
Rachel Spodheim, Head of laboratory
Chaim Sterenbach, field assistant
Elihu Tomer, M.Sc., regional scientist
D. Zameth, B.Sc., assistant
C. D. Gustafson, University of California (Guest of the Division, 1968/69)

2. THE LABORATORY

R. Spodheim

The laboratory staff carry out analyses which are needed by the scientists of the division in their research. A fair amount of their time is expended on the development of new, and the improvement of existing, methods.

The team consists of one chemist, two technicians and one laboratory assistant. The main work consists in the analysis of macro- and microelements in plant material (roots, leaves and fruits), soils, culture solutions and mediums, as well as oil, starch and sugars in fruits and chlorophyll and enzymes in leaves.

All three members of the team work together and the results are decided upon after critical discussion. This gives the technicians more interest in their work and also

improves it.

The analyses are done mostly by various colorimetric or titrimetric methods. During the last few years these methods have been improved, with the result of more work of higher quality. One of the factors was the use of improved instruments. Nitrogen analyses were formerly done by distillation in micro-kjeldahl. Today, the material has only to be wet-ashed, and the results are obtained by use of an Auto-analyser (Unicam) which gives 40 measurements per hour, as compared to 40 per working day with distillation.

Analysis of chlorine in plant material was formerly done by the Volhard method (ashing and titration), which involved the danger of losing part of the chlorine in prolonged ashing. For small amounts of chlorine the titration was not sufficiently accurate. Now, we use direct extraction with nitric acid and potentiometric titration with a titrimeter (Methrom). This method allows even very small amounts of chlorine to be measured exactly.

Sodium and potassium are analyzed with the aid of an E.E.L. Flame-photometer after dry ashing. If only NPK analyses are needed, they can be measured in the same solution after a wet ashing.

Calcium and magnesium are analyzed by a complexometric method (titration with versenate), using a micro-burette with magnetic stirrer. This makes for higher accuracy in the titration. In avocado fruits, where calcium is a minor element together with much magnesium, and where phosphorus is also present in large amounts, the versenate method can not be used. In this case, calcium and magnesium are measured with an Atomic Absorption Spectrophotometer (Unicam), using standards which contain the two interfering elements in the same ratio as in the fruits.

The microelements — copper, zinc, manganese and sometimes iron — are also analyzed by the Atomic Absorption Spectrophotometer instead of the formerly used colorimetric methods.

Total and reducing sugars are analyzed by an optical method in the Spectrophotometer (according to Sumner, after adaptation to our specific requirements), instead of by the titrimetric methods used formerly. Starch is measured in the residue from alcoholic extraction for sugar, according to Nielsen's method, which is quick and gives good results. However, this method is standardized for one sort of starch (potato) and we had to work out specific factors for any other type of starch. To find this factor, each new starch-containing tissue is also, at first, analyzed by Poucher's hydrolytic method.

Oil analysis of avocado fruits, for both practical and research purposes, forms a fairly large part of the work. The old Soxhlet method was too slow and a new, quicker and more reliable method had to be developed. It consists of refractometer readings of avocado oil in another oil, with a much higher refraction index. With this method we can now carry out about 50 analyses per working day, while the old method was limited by the number of extractors available, and took 48 hours to produce results.

During the year 1968/69 the following numbers of analyses were carried out: nitrogen, 1500; potassium, 1800; sodium, 1300; calcium, magnesium, chlorine, phosphorus, iron, zinc, and boron — about 1000 each; copper and manganese, 700; and about 1500 oil

determinations.

3. THE ORCHARDS

Ch. Oppenheimer and *H. Lippmann*

In the summer of 1969 the division had at its disposal a total of 180 dunams, distributed over eight orchards at Rehovot, Kubeiba, Bet Dagan and Gilat (in the Negev). There are other orchards in the Western Galilee, the interior valleys, the central district and the Negev in which we do research work but which do not belong to the Institute. These will be mentioned in the appropriate chapters, as will the results of the research in our orchards. Here we shall describe only some general features of all our orchards, beginning with the oldest — planted in 1931 — and ending with the youngest — planted in 1969.

The acclimatization garden at Rehovot — Area 8 du, soil light to very light, mostly deep sand underlaid with loamy sand. The garden was planted in 1931 by the Jewish Agency as part of a botanical garden in honor of the late Prof. O. Warburg. During the 1930s this garden formed the first representative collection of species and varieties of subtropical fruits — avocado, mango, persimmon, guava, annona, loquat and many minor species.

For many years the garden was the center of our activities, being the most important source of knowledge, seeds and budwood. Today, most of its trees are over-age and its importance has declined. Still very important are the nearly 40-year-old mango trees which are still in excellent condition. The aggregate yield (in tons) of about 60 trees, seedlings and grafted, 25 to 38 years old, was as follows:

1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	Average
4.6	2.8	5.0	2.3	6.3	3.3	5.0	6.9	7.0	5.8	4.9

The trees are very large and not planted together. Thus, it is impossible to calculate the yield per dunam, but it is clear that yields are still rising in spite of the age of the trees. A few litchi and macadamia trees are also of importance in the garden.

The mango orchard at Rehovot — Area 8 du, the same type of soil as the acclimatization garden; planted in 1943. Most of the orchard is a trial of three varieties on three rootstocks. On other trees there is a large variety collection. During the last ten years, the yields (in tons) of the orchard as a whole (including a large number of less productive trees) were:

1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	Average
14.5	6.3	17.7	1.9	13.1	6.7	4.1	17.4	16.9	6.8	10.7

The high variability of yields from year to year is typical of mango orchards. The stock/scion trial has been concluded, and the varieties have been transferred to the newer Bet Dagan orchard; the original orchard now serves mainly for additional

observation on the behavior of old trees.

The avocado orchard at Kubeiba — Area 16 du, planted in 1949, soil medium to heavy with some drainage problems. There was a variety collection in the guard rows, but it was transferred to the Bet Dagan orchard. The major part of the orchard— 12 du — was planted in the form of a stock/scion trial with five root-stocks (Mexican, Guatemalan and hybrid) and four varieties — Fuerte, Anaheim, Benik and Nabal — in four replications. The yields (in tons) of this part of the orchard have been:

1959/60	1960/61	1961/62	1962/63	1963/64	
14.1	16.1	17.1	24.4	14.5	Average (per year and du) 1.7
1964/65	1965/66	1966/67	1967/68	1968/69	
26.3	20.9	24.0	25.4	20.2	

The orchard now furnishes material for many experiments of the division.

The mango orchard at Bet Dagan — Area 25 du, planted in 1956 on a northern slope, on medium to light soil. There was a very pronounced difference in frost damage (especially in the winter of 1963/64) between trees high or low on the slope. In the highest rows there was practically no damage, while many trees were killed outright in the lowest rows. The orchard consists of three groups of trees:

(a) A trial of three varieties (Haden, Maya and Mabroka) on three rootstocks in 27 replications of one tree each, for a total of 243 trees.

(b) A trial of 20 additional varieties in four replications of five trees for ten varieties, and of three trees for the other ten (total of 320). Some of these trees have been regrafted with promising varieties from the collection.

(c) A collection of about 50 varieties, for a total of 142 trees.

The total yields (in tons) of the orchard, including the unproductive varieties in (b) and (c), during its ten years of yield bearing:

1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
0.5	2.9	5.7	6.3	15.1	13.5	13.5	38.1	29.1	42.5

During most of the years the orchard was still young. The mean yield for the last three seasons was 1640 kg per dunam.

The persimmon orchard at Gilat — Planted in 1957, on the typical loess soil of the region. The orchard consists of 530 trees in 13 rows, each row covering 1 du. The orchard was planned as an irrigation trial, which could not be carried out due to lack of uniformity of the trees. Four varieties — Triumph, Tamopan, Hachiya and Fuyu — were planted in three rows each, but the composition was later changed by regrafting most Tamopan trees to Triumph. In the thirteenth row there is a collection of 14 varieties. As of 1969, none of these seems to be suitable for commercial cultivation. The yields of Tamopan and Hachiya have been very low; the other two varieties gave the following yields (in kg) per dunam:

Variety	1961	1962	1963	1964	1965	1966	1967	1968	Mean, 1963–68
Triumph	100	600	1000	2100	1700	1000	2000	2100	1650
Fuyu	100	800	860	750	900	1000	1000	2400	1150

The avocado orchard at Bet Dagan — Area 50 du, including two plots for minor species and subtropical apples, planted in 1958. The soil is not uniform, changing from rather light in the southwest to rather heavy in the northeast. The orchard consists of 45 plots of 10 trees each (2 Ettinger, 1 Fuerte, 1 Anaheim, 2 Benik, 2 Nabal, 2 Hass), for a total of 16 du, and guard rows bearing a large (about 80) variety collection on 15 du. A fertilizer trial is being carried out on the main plots. Many of the varieties in the collection have been discarded and the trees grafted with newly imported or selected varieties. The minor fruits include litchi and macadamia.

The yields (in tons) during the eight years of yield-bearing were:

1961/62	1962/63	1963/64	1964/65	1965/66	1966/67	1967/68	1968/69	Average, 1965–69
0.7	9.8	13.9	20.3	32.8	25.1	32.9	30.7	30.4 (1.9/du)

Mixed orchards at Bet Dagan, for introductions, selections and mother trees — These orchards were planted between 1965 and 1969 on an area of approximately 30 du. The soil is light, similar to that of the neighboring mango orchard. These plantings include: *(a)* mother trees for salt- and lime-resistant avocado types; *(b)* newly introduced varieties of avocado, persimmon, macadamia and trees of litchi and carambola types; (c) Hayani dates, furnishing material for laboratory experiments. According to their composition, these plots serve a variety of purposes in the research of the division, and they are not planned to give commercial yields.

The new mango orchard at Bet Dagan — Area 25 du, planted in 1969, light soil, on a northern slope. Dwarfish varieties (Palmer, Keitt and Irwin) have been planted between standard varieties (Haden, Maya and Nimrod). There are three replications of 36 combinations: each dwarfish variety with each standard variety (nine combinations), each standard alone (three combinations), and all 12 on three different rootstocks. Each plot is 24 m long. The main block covers an area of 16 du; the rest of the orchard consists of a variety collection and of the three dwarf varieties, one row each, in close planting.

4. THE REGIONAL RESEARCH WORK

Ch. Oppenheimer, A. Ben-Ya'acov, E. Lahav and *E. Tomer*

The regional work started with the appointment in 1964 of E. Lahav as regional scientist for the Western Galilee. Dr. A. Ben-Ya'acov started his work in the central district in 1967, and E. Tomer started in the interior valleys and the Upper Galilee in 1968.

The work of the regional scientists is based on extremely close cooperation among many bodies: the Ministry of Agriculture and its regional offices, the district councils and

their committees of growers, the instructors in fruit growing, and the members of the division at the center. The local functionaries and fruit-growers furnish the material basis for the research work and participate in its planning, and, frequently, also in its execution. The planning of the research has to be carried out by the regional scientist in cooperation with other members of the division. The instructors frequently participate in the trials.

The activities of the regional scientist fall into three categories: *(a)* long-term research, for which he is the head of a team, and cooperates with other members of the division; *(b)* long-term research, for which he is a member of a team and carries out the work which needs to be done in his district; and (c) short-term research, frequently in cooperation with instructors in his region.

The regional scientist cannot develop in his work if he is not able to carry out at least one project under (a); the planning of the whole research program of the division needs his cooperation in projects under *(b);* the carrying out of projects under *(c)* is required for the solution of many purely local problems, and supplies the necessary close relationship between the regional scientist and the farming community in his district. We are trying to establish team-work among the regional scientists, so that for many problems each does his part in his district, sometimes as group leader and sometimes under the leadership of one of his colleagues.

This chapter presents an outline of those activities which are not described elsewhere in this booklet.

a. Western Galilee

Growing avocados with and without bananas — Planting young avocado trees together with bananas is assumed to be of advantage in Israel, but no trials comparing this method with pure avocado stands have been carried out in the past. The young avocado plants enjoy the highly intensive growing conditions of a banana orchard (water, manure, fertilizers, windbreaks and shade, and freedom from weeds). The method of non-tillage common in banana orchards prevents the disturbance of the shallow avocado roots. There is no need of any investment other than the price of the avocado plants, as the banana orchard can easily support the additional small cost. But some disadvantages have been observed, especially the too rapid and too tall growth of the young avocado tree, and a comparison trial was needed.

In 1966 two parts of one orchard were planted, one with avocado alone and the other with avocados and bananas. No replications were possible. After two seasons the bananas were removed. Three avocado varieties — Ettinger, Fuerte and Hass — were included in the trial. Tree development and yields were recorded, as well as leaf mineral content. After three seasons the trees grown with bananas show an advantage, both in growth and in yield (Table A. 4. 1.). The biggest difference was in tree height, and this, as mentioned above, is not an advantage. The number of fruits on the young trees is still small. There are also important differences in leaf composition: trees which grew without bananas had more sodium, chlorine, iron and manganese, and less nitrogen, phosphorus and zinc (Table A. 4. 2).

TABLE A. 4.1

THE SIZE AND YIELDS OF THREE VARIETIES OF AVOCADO TREES GROWN WITH AND WITHOUT BANANAS

Parameter	*Without bananas*			*With bananas*		
	Ettinger	Fuerte	Hass	Ettinger	Fuerte	Hass
Girth increment, 1966–1968 (mm)	53.0	53.7	45.7	59.5	58.9	70.1
Size of tree on 7.VI.1968 (m^3)	2.71	2.16	2.38	3.70	2.86	3.40
Mean number of fruits per tree:						
1968/69	2	3	30	17	3	62
1969/70	1	0	36	4	2	99

TABLE A. 4.2

COMPOSITION OF LEAVES OF THREE VARIETIES OF AVOCADO GROWN WITH AND WITHOUT BANANAS

Component	*Without bananas*			*With bananas*		
	Ettinger	Fuerte	Hass	Ettinger	Fuerte	Hass
Nitrogen (%)	2.37	2.37	2.55	2.45	2.55	2.92
Phosphorus (%)	0.137	0.137	0.150	0.150	0.155	0.168
Sodium (%)	0.011	0.012	0.011	0.008	0.005	0.007
Chlorine (%)	0.34	0.39	0.48	0.22	0.23	0.22
Iron (ppm)	100	88	78	60	60	45
Zinc (ppm)	25	20	22	30	25	24
Manganese (ppm)	185	130	175	115	75	130

There may be too much nitrogen in the leaves for optimal yield in Fuerte and Ettinger. The trial will have to be continued for a number of years, after which time it may be possible to compare the possibly better yields and lower investment costs against the higher costs due to too high trees.

A new parasite growing on avocado trees — On some trees of the Ettinger variety a parasite plant was found and determined to be *Cuscuta cassytoides* Nees von Esenb. This is the first occurrence of this species in Israel, and the first report of *Cuscuta* on avocado trees anywhere. There is no knowledge of how to get rid of the parasite, and so infected branches have been destroyed.

The relative yield of different rows in a non-wind-protected banana orchard — During two seasons, yields were recorded from the first six rows of a wind-exposed banana orchard, and large differences were found (Table A. 4. 3).

Healing chlorosis in bananas — In the search for a less expensive but no less effective remedy than treatment with Sequestrene 138, extremely chlorotic banana plants were treated with Fetrilon and Quelacros-56. These two materials cured chlorosis but were later found to be less efficient than Sequestrene 138. S. 138 was applied to a non-chlorotic orchard at doses of 5, 10, 15 and 30 g per mat. The highest concentration

resulted in earlier flowering by one week in the first year, and by three days in the second year.

TABLE A. 4.3

YIELDS OF THE FIRST SIX ROWS OF A WIND-EXPOSED BANANA ORCHARD

Year	*Parameter*	*Row No.*					
		1	2	3	4	5	6
1st	Number of missing bunches	16	14	14	7	2	0
	Mean weight of bunch (kg)	13.2	13.6	14.9	16.2	16.9	17.7
	Total yield (kg)	317	353	388	533	643	709
2nd	Number of missing bunches	15	11	6	2	0	0
	Mean weight of bunch (kg)	15.9	17.4	18.5	19.2	20.2	20.5
	Total yield (kg)	414	591	833	997	1130	1146

b. Central District

The work has to be done mainly in commercial orchards, and is therefore planned to cover as wide a field as possible. Trials with avocado include: the influence of stock and marked scion trees; the influence of cultural techniques; inarching; salinity in orchards and its influence on tree development and yield; soil physics — in connection with orchard performance — in cooperation with the soil scientists of the Volcani Institute; and new avocado selections.

Influence of growing conditions on avocado trees — Work was started in 1967 with the aim of achieving higher yields — especially of the Fuerte variety, larger fruit of the Hass variety, and smaller fruit of the Nabal variety, through a study of cultural techniques, soil and local climate. Some fertilizer and irrigation trials have been started, but the main work is concentrated now on the preparation of uniform orchards for further trials.

Mulching trial — The trial was started in 1968 with trees of the Hass variety, and includes a control plus three treatments — straw, compost and manure — in four replications of four trees each (total of 64 trees). The trees in each plot are identical as to stock and scion, and as uniform as possible. Between the trees asbestos insulation has been put into the soil. Early results show that both compost and manure lead to a higher chlorine content in the leaves and more tip burn.

Pruning trials — Different types of pruning and bending were compared on Ettinger trees. Two methods of letting more light into the orchard — hedge pruning and tree thinning — are being compared with the Nabal variety.

Work with other species — Rootstock trials with mango on heavy soils; pruning trials with persimmon, variety Triumph; variety and stock trials with annona; and artificial pollination of annona.

c. Interior Valleys and Upper Galilee

Most of the work is in the planning or very early stages.

Frost protection — Frost is the one major factor limiting avocado cultivation in the Upper

Galilee. Orchards should be planned so as to avoid the risk of low temperature as far as possible. The following trials will be carried out: *(a)* To determine whether wind machines might be justified; the existence and size of an inversion layer were investigated by the Meteorological Service, *(b)* Sprinkler irrigation with different water rates during cold nights; study of the tree after disappearance of the ice cover, (c) Orchard heating with solid fuel bricks.

West Indian rootstocks for avocado orchards under conditions of lime and salinity in the interior valleys. Four trial plots, of four West Indian rootstock types, were established in 1968. The varieties are Fuerte and Hass.

Inarching — In one avocado orchard on soil with about 50% lime, and grafted on Mexican stocks, chlorosis was once severe. After treatment with Sequestrene 138 and additional zinc sprays, most trees became normal. Three West Indian types are used as additional rootstocks through inarching, in order to see if this leads to a more permanent improvement.

Damages from flooding and impaired drainage — During the winter of 1968/69, many avocado orchards were flooded for varying lengths of time, and considerable damage occurred where drainage was poor. The question arose whether severely damaged trees would recover, and if so, under what conditions. In one orchard the trees were either left unpruned or severely pruned, at 60-100 cm above ground. It was found that more non-pruned trees than pruned trees recovered, and that the young growth of pruned trees was severely damaged by strong hot winds in early summer, while that of non-pruned trees was somewhat protected by the dead leaves of the crown.

d. The Negev

The division has, so far, no regional scientist in the south of the country. The rapid development of subtropical fruit growing in that area demands a parallel growth of research. We have grounds to hope that a regional scientist for this area will be added to our team in 1970. In the meanwhile, much work is being done by members of the division from their headquarters at Bet Dagan, especially by S. Gazit, A. Kadman, O. Reuveni and E. Slor, together with the regional instructors. Research on date growing in the Arava, and on mango and avocado in the western Negev, will be described in the respective chapters of this booklet.