

THE AVOCADO IN ISRAEL

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This is the first of two reports from Israel. In the effort to present a more diversified viewpoint, some duplication of material appears in the two reports.

In the third decade of this century there were only a few avocado trees in Palestine. Avocado culture grew very slowly during the fourth and fifth decade, but during the last 12 years plantings have increased at a more rapid rate. There are now over 2,000 acres of avocados in the State of Israel. Since 1964 the planting of avocados is subject to the approval of the Fruit Marketing Board and is limited to a total of about 200 acres a year.

THE CLIMATE

The climate of certain regions in Israel is eminently suitable for this fruit crop. The incidence of radiational frosts in these parts is somewhat less than in Southern California. The use of heaters and of wind machines is not warranted even though the temperature inversion on clear nights is very pronounced. In the following table a comparison is given between the monthly minimum and maximum temperatures of a typical avocado area in Israel (Acre) and that of San Diego (in degrees F).

Month	San Diego*		Acre**	
	Mean Min.	Mean Max.	Mean Min.	Mean Max.
January	46.6	62.4	49	65
February	47.9	62.9	48	66
March	49.8	63.8	50	68
April	52.5	65.1	54	73
May	55.7	66.2	61	79
June	58.8	69.2	67	82
July	62.4	72.4	71	86
August	63.7	73.9	72	88
September	61.4	73.0	69	85
October	56.7	70.4	63	83
November	51.7	68.2	58	78
December	48.2	64.5	52	68

*U.S. Department of Commerce

**Meteorological Service of Israel 1952

Most avocado orchards in Israel are located in the undulating coastal plain. Two cold spells in the winter of 1963-1964 caused some damage to avocado orchards which taught us the hard way to avoid low-lying spots which are prone to frost damage. However, the recovery in the following spring was very rapid. The lowest temperatures experienced in recent history occurred in 1950, but then avocado culture was still in its infancy.

In recent years a new area has been initiated for avocado culture in the upper Jordan Valley. A narrow strip of land at the base of foothills (a thermal belt) has been found to be sufficiently free of damaging frosts to suit avocados. Another region fairly suitable for avocados is located on the shores of Lake Tiberias, 650 feet below sea level. However, irrigation water is generally too saline in this area for avocados.

SOILS

Avocados are adaptable to a wide range of soils. However, the best soils for avocados are of medium texture and drain quickly of excess moisture. Young avocado trees may, on sandy soils, become chlorotic. On poorly drained, heavy soils avocados may decline sometimes due to a root rot, not caused by *Phytophthora cinnamomi*, which has not yet been found in Israel. Soils suitable for avocados should have over 7% non-capillary pore space and there should not be any perched water table even for a short period within the strata occupied by roots. We are about to introduce the O.D.R. as a criterion for choosing avocado soils.

Avocados are fairly resistant to lime (similar to citrus). Unfortunately, there is no possibility to assess beforehand the influence of lime on the severity of chlorosis. Lime-induced chlorosis and also yellowing of foliage on light soils have been successfully treated with Chelate 138 (ref. 1, 2).

RAINFALL AND IRRIGATION

The rainfall in Israel is limited to the winter months starting usually in October and ending in April. The average rainfall in the coastal plain is 20-24 inches. It is less in the Jordan Valley. Obviously, irrigation has to be resorted to during the remainder of the year. But even in winter, whenever there is a dry spell, avocado trees have to be watered.

Avocados are very shallow rooted; at least 80% of their roots are generally found within the upper two feet. Therefore, frequent and small applications are indicated. They are given in mid-summer at about 10-14 day intervals and about $1\frac{1}{2}$ -2 acre inches are applied at each irrigation totaling about 40 acre-inches annually. A heavier application is made at every third watering in order to leach accumulated salts beyond the root zone.

Nearly all avocado orchards (like most other plantings in Israel) are sprinkler irrigated, the usual method being underhead sprinkling at 4-7 degrees from the horizontal.

Avocados are customarily grafted on Mexican stock; on that stock avocados are the most salt sensitive fruit in Israel. Compared to the irrigation water used in Southern California most of the water sources in Israel have a relatively high proportion of

chlorine and it is justified under our conditions to use the chlorine contents as a criterion in judging water quality—120 mgs. per liter of chlorine (about 3.5 M.E.) are considered to be the upper limit. However, some very good avocado orchards are irrigated on well-drained soils with water containing 170-180 mgs. of chlorine per liter (5 M.E.).

Considerable research work is being done with salt resistant West Indian types as rootstocks. However, the degree of salt resistance within the seedling population of one single tree is highly variable. West Indian avocados are being propagated by cuttings in order to obtain a homogeneous clone. This has not yet been utilized commercially. There are some quite satisfactory plantings on nondescript West Indian stock. Fuerte, Duke and Nabal seedlings have been tried as stocks (ref. 3), but have not found acceptance in the industry (they are highly sensitive to lime).

PROPAGATION

Until about eight years ago avocados were propagated almost exclusively by budding Mexican seedlings in the nursery row (ref. 4). The buddings were planted in spring 2¹/₂ years after sowing the seed in the nursery.

Nowadays seeds are sown in containers in the fall and the young seedlings are tip grafted or side-grafted a few weeks after sprouting. They are ready for planting in situ in fall or in the spring, i.e. 12-18 months after the seed is sown in the nursery. Fall planting (September) is generally preferred because it enables the young plant to strike roots prior to the inception of top growth in spring. We prefer this to planting in spring even though we have to protect the young plant from frosts shortly after planting.

MIXED PLANTINGS

Generally, interplanting two or more kinds of fruit trees is—for various reasons—discouraged. However, it has been found that avocados develop better when planted together with, or in an already existing banana plantation (young coffee plants in Central America do well when grown in the shade of banana plants). Planting bananas and avocados together provides the grower with an income before the avocados come into bearing (the fourth year after planting). The cost of establishing an avocado orchard (which is about \$1600 an acre) may be cut thereby into half.

The usual planting distance is 21 x 21 feet (6x6 m), i.e. 112 trees per acre. Sometimes the planting distance is wider, 21 x 26 feet (6x 7.5 m). The objective is to thin out the orchard after the trees start crowding each other when they are 8-12 years old. As a matter of fact, very few orchards have been thinned according to plan. The close planting ensures heavier crops during the early bearing stage, and reduces wind damage and the cost of weed control.

VARIETIES

Many California varieties have been introduced to Israel and, as a result, the choice of commercial varieties resembles that of California. There is only one local selection,

Ettinger, which has become prominent. In most recent plantings in Israel there are no more than five varieties. In the near future this number will be reduced in certain areas to three. Here follows a brief description of our standard varieties in their order of ripening:

1. *Ettinger*: This Mexican- type variety is picked from the middle of October until December. The fruit resembles slightly the Fuerte, but does not reach its quality. It is the most cold and wind resistant variety grown commercially in Israel. The tree is very vigorous and upright, and has the same tendency as the Fuerte to produce at times seedless fruits ("cukes"). It is a heavy bearer and has been in many orchards the most profitable variety. We are trying now to limit its plantings in order to ensure a more evenly supply of avocados throughout the season. It has a rather short optimum picking season.

2. *Fuerte*: Fuerte is also in Israel the ideal variety from the consumers' point of view. However, it has a number of drawbacks: it is in many orchards not bearing satisfactorily and it suffers also at times from partial non-softening. It has been found that there is a high correlation between low yields and non-softening. Another contributing factor is late picking (ref. 5, 6). Therefore, low yielding trees should be picked early. The ripening season extends from November until March. Due to the selection of budwood from consistently high yielding trees, Fuerte has been more productive in most of the more recent plantings. The present recommendation for future plantings includes a high percentage of Fuerte (at least two-thirds).

3. *Nabal*: This Guatemalan variety has a greater tendency to alternate bearing than other commercial varieties, but it is a good yielder. Its fruit is generally bigger than optimum size. In windy areas (all interior districts as well as the north coast), it is very much subject to shedding when nearly ripe, and to wind scars. It is the most frost-sensitive variety grown. Its picking season is from February to April.

4. *Benik*: This variety is grown to some extent in order to cross-pollinate the Nabal.

5. *Hass*: This is the only variety which has in recent years been added to the recommended list. It is a heavy producer. The fruit tends to be small and hand-thinning may be justified in some instances. Some trees bearing a heavy crop have not enough foliage to protect the fruit from sunburn. The Hass carries well to distant markets and tops even the Fuerte in quality, but its well known drawback is its black and warty surface. It reaches good eating quality before January, but its marketing season may extend until May. The degree to which this otherwise excellent variety should be planted is a debatable subject.

SOME MANAGEMENT PROBLEMS

Young avocado trees need some protection against the direct rays of the sun and against the wind. The latter is very important during the winter months of their first year. Avocados raised in banana plantations do not need such protection.

Some of the upright varieties (especially Ettinger and Nabal) have their terminal growth cut back from time to time in order to produce a more spreading tree. This is done several times during each of the first three or four growing seasons. Some growers here

are bending branches and tying them down instead of cutting them back. They achieve the same result—a more spreading tree.

The need for cross-pollination has not yet been experimentally proven, although there is observational evidence in its favor. The varieties Nabal and Benik are grown together for that purpose and some claim that it is advantageous to grow Fuerte and Hass side by side.

There is an abnormally high percentage of "cukes" with Fuerte and Ettinger this year (1965), which we are trying to relate to adverse climatic conditions during the flowering season. Lack of available moisture during the flowering season may reduce the set considerably.

Due to the shallow rooting habit of the avocado any kind of cultivation may do damage to the root system. Avocado orchards are kept, therefore, under a system of non-cultivation. Old groves are dense enough to prevent weeds from growing. Roots are often found in the top soil.

Nitrogen is the only element applied to most avocado groves. It is also customary to add small amounts of organic manure. Heavy applications of chicken manure have caused certain deficiencies such as Fe and Zn—to appear, as well as marginal leaf burn. Avocado leaf analyses have been studied (ref. 7, 8).

YIELDS

Compared with citrus, avocados are intrinsically a low yielding crop. It seems that any fruit tree producing a crop which contains oil as the elaborated material (in contrast to sugars) is limited in its yielding capacity. Furthermore, avocados may produce as many as 10,000 flowers per one fruit set and this heavy flowering may be a bigger drain on the reserves of the tree than the actual crop. Some of these heavily flowering trees may drop their entire foliage during the flowering season (a similar situation obtains with profusely flowering male carob trees). No one has yet attempted (to our knowledge) to limit this excessive bloom.

As a result of all the above-mentioned factors an annual average yield of three and one half to four tons per acre is considered a fair average. However, there are some orchards in Israel which average six tons per acre. It is our belief that most orchards under good management and environmental conditions should be able to maintain that level of average production.

There are quite a number of orchards planted in too heavy or too light soils, which will never produce satisfactory crops. It is estimated that about one third of all groves may become marginal as soon as prices drop below the present level of 15-20 cents a pound.

MARKETING

All avocados in Israel are at present sent to three packing houses, where the fruit suitable for exports is packed for shipment abroad and all the remainder of the fruit sold

locally. Since most of the plantings are young, the total yield has not yet reached 2000 tons.

Some research work has been done on the storage of avocados (ref. 9, 10).

PESTS AND DISEASES

a. *Sunblotch virus*: This disease has apparently been brought to Israel by one of the very early avocado introductions. Due to the selection of mother trees as sources of budwood, it is hoped that the incidence of this disease in the newer plantings will be negligible.

b. *Sudden wilt*: Trees on heavy soils are sometimes subject to a sudden wilt which resembles the *Verticillium* wilt in California. The causal agent has not yet been found. Trees recover sometimes by making growth from the scaffold branches.

c. *Stem end rot*: Certain varieties (especially Anaheim) are subject to stem end rot, which may be caused by a number of fungi. It has been suggested that, when picking avocados, about one-half a cm. of the fruit stalk be left protruding.

All other pests and diseases are of no general importance. Avocado groves are not sprayed in order not to disturb the biological equilibrium.

FUTURE PROSPECTS

The prospects for avocado culture in Israel are strictly limited by nature (quality of irrigation water, topo- and macro-climate, soils). Due to these limiting factors it is not expected that avocados will be in the course of the next five to six years increase in acreage by more than 1.000 acres.

The European market may absorb one-half to two-thirds of the crop. It is suggested that the countries supplying Europe with this new fruit should get together and plan and finance a joint promotion program.

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