

## SOME NOTES ON THE CITRUS INDUSTRY OF PALESTINE

A. W. R. JOACHIM, Ph.D. (Lond.), Dip. Agric. (Cantab),  
*AGRICULTURAL CHEMIST*

IN April-May 1935 I had the opportunity of visiting Palestine and during my month's stay in that country was enabled, through the kind services of the Imperial Chemical Industries (Levant Ltd.) and the Department of Agriculture, Palestine to obtain a first-hand acquaintance with the present position of its citrus industry, the main industry of the country. It was somewhat unfortunate that the visit coincided with the tail end of the citrus season, but that did not interfere to any extent with the main objective of the visit from the agricultural standpoint. In view of the increasing interest being taken in citrus cultivation in Ceylon, it was thought that some notes on the subject would not be without value to local citrus growers. The observations do not cover the whole field of citrus culture, but are mainly confined to the climatic, soil and general cultural aspects of the crop in Palestine. In the course of my stay I visited in connection with this study the Mikveh Israel Agricultural College, the Jewish Agency Experiment Station at Rehovoth, the Sieff Research Institute, the Department of Agriculture Horticultural Stations at Acre and Sarafand, the Kadoorie Agricultural School at Mount Tabor, the Hebrew University, the Government Chemical Laboratory, the Fruit Inspection Service at Jaffa, a number of private citrus groves, both Jewish and Arab, some of the new Jewish settlements, the Rehovoth Co-operative Growers' Factory and the Palestine "Frutarom" Ltd.

### CITRUS AREAS AND TRADE

Citrus is cultivated in Palestine, mainly on the coastal plain, but the extension of the crop to the slopes and foothills is gradually taking place. Typical citrus country is level or gently rolling. The belt extends from Gaza in the south through Jaffa to Haifa in the north, a distance of about 105 miles, and has a maximum width of about 15 miles with an average of about 5. The acreage reported under the crop was in October 1932, 132,225 dunams or over 30,000 acres. Later

reports indicate that this area has been appreciably increased. The export of citrus fruit from Palestine in the 1934-1935 season was reported to amount to nearly  $7\frac{1}{2}$  million cases, and it is expected that in a few years this figure would be doubled, if not trebled. The export season for oranges is from November to April and for grapefruit from October to about March. The first date of export of citrus fruit from Palestine is governed by Regulations under the Fruit Export Ordinance of 1927.

### CLIMATE

The climate of the citrus area of Palestine may be considered to be of the Mediterranean type—hot, dry summers and mild, rainy winters. The mean average temperature in the Jaffa district, a typical citrus area, is  $19.4^{\circ}$  C. or  $66.9^{\circ}$  F., the minimum being in January with an average of  $12.1^{\circ}$  C. or  $53.8^{\circ}$  F. and the maximum in August with  $25.9^{\circ}$  C. or  $78.6^{\circ}$  F. The average annual rainfall in the district is 554 mm. or approximately 22 inches, practically all of which falls from October to April. Areas further north have lower average temperatures and a somewhat higher rainfall. A rainfall of 30 inches is considered very good in Palestine. The relative humidity of the Jaffa area is 71 per cent. varying from 68 in September to 75 in December and January.

### GEOLOGY AND SOILS

The geology of the citrus area is comparatively simple. With the exception of the sand dunes and a narrow alluvial belt, the entire area is underlain by marine and terrestrial flood deposits (diluvium). The former is considered to give rise to the characteristic red sandy soils of the coastal region and the latter to the dark brown to grey black marly loams (2). The red soils are generally deep extending to over 2 metres or 6 feet depth. They vary in texture from light sands containing 2 per cent. clay and silt and 98 per cent. sand, to fairly heavy loams containing 30 per cent. or more of clay and silt and 70 per cent. or less of sand. The lighter soils predominate in the coastal belt. The sub-soils are of slightly heavier texture. These soils drain well, sometimes excessively. Free calcium carbonate is normally absent, but small fragments of limestone do occur occasionally. The lighter red soils appear to be derived from calcareous sandstone (3) and the heavier types from other calcareous rocks. The soils are generally classed by Raczkowski (2) as Mediterranean red soils *terra rossa*, though this term appears more applicable to the red

loams. The value of the red sandy soils lies mainly in their beneficial physical properties. Citrus is a crop very susceptible to bad soil drainage, and heavy loams and clay soils, unless they contain a sufficiency of lime either free or available, are generally unsuitable, especially for oranges. Excessive amounts of free calcium carbonate in the soil are also harmful. Chemically, the red soils are generally poor in organic matter and nitrogen and also in potash and phosphoric acid when compared with the most local soils. The averages for nitrogen, phosphoric acid and potash are .03–.09 per cent., .01 to .03 per cent., and .04 to .14 per cent. respectively. These amounts are however considered adequate for normal grain production in the country. For citrus however, manuring is considered essential. The replaceable base contents of these soils are nevertheless much higher than those of local soils. On sandy soils they vary from 6 to 18 mgm. equivalents and on the heavier soils from 40 to 80 and more. Lime predominates. In reaction the soils are generally neutral to slightly alkaline. The more loamy types are similar to the Jaffna and other limestone—derived soils of Ceylon.

On the light red soils areas occur occasionally in which a clay hard pan with concretions of iron oxide and alumina, are found at varying depths. These soils, called the 'Nazaz' soils, are quite unsuited for citrus as the clay layer prevents root penetration and impedes drainage and soil aeration. In other areas shallow soils occur with calcareous sandstone so near the surface that root development is restricted and crop growth very poor. In others again a calcareous gravel known as "Kurkar," formed by the weathering of sandstone, is found. Both these types of soil are definitely unsuited to the crop (3).

The other classes of soils on which citrus is grown, though to a smaller extent, are the marly loams. The sub-soil is of heavier texture and reaches considerable depths. Calcium carbonate is usually found in fairly appreciable amounts. Drainage conditions are generally favourable and soil reaction is neutral or slightly alkaline. Analyses of these soils show that the clay content may be as much as 38 per cent., but their heavy texture is counteracted by the lime. For citrus cultivation a soil containing 15 to 25 per cent. clay and sufficient replaceable lime is ideal. These soils are richer chemically than the red soils. Potash is high, 0.5 per cent., on the average; nitrogen, regarded as adequate, averages .06 to .09 per cent.; and phosphoric acid varies from .01 to .05 per

cent. Great care is required when irrigation is practised on these soils lest harmful alkali be formed.

The lighter soil types in Palestine are found more suitable for oranges and the heavier types for grapefruit. For either species of citrus, good soil drainage is essential.

#### VARIETIES AND CULTIVATION

*Varieties.*—The two most common local types of oranges in Palestine are the *Shamouti*, which only is legally entitled to the designation “Jaffa Orange” and the *Beledi*, the round and seedy type. The only other variety grown to any extent is the Valencia Late. Of grapefruit, Marsh’s seedless is the chief variety cultivated.

*Stocks.*—The two main root stocks used for budding are the sour or bitter orange (*Citrus aurantium*) and the sweet lime or lemon (*Citrus aurantifolia*). The sour orange stock is used on heavier soils and the sweet lime on the light soils. The use of the latter stock is however gradually being given up owing to its susceptibility to gummosis to which the former is very resistant. Sour orange is found to be the best stock for grapefruit and Valencias. Trees on sweet lime stock are reported to fruit earlier than those on sour orange, but the latter bear better after a certain period. The effects of the stock on the vitality of the tree and its yield were very clearly demonstrated at Lord Melchett’s Farm at Migdal on the Lake of Tiberias. The soil is a heavy loam, not quite suitable for oranges. Trees planted on sweet lime were carrying only fair crops and were showing “gummosis” and die back. Those on sour orange, though younger, were much bigger, bearing better, and free from disease.

*Budding and Training.*—The practice in the past in Palestine was to bud high—18 to 24 in. from the ground in order to avoid trouble from gummosis; but the normal budding height is now more generally from 8 to 10 in. Great care is devoted, when planting new groves, to training the young plants to give suitable shaped trees. High planting of budded plants is advocated owing to the danger from gummosis of low planting.

*Planting Distances.*—In the older groves the trees are very closely planted. In newly planted groves the planting distance for oranges varies from 4 × 4 metres (approx. 13 × 13 ft.) to 6 × 6 metres (20 × 20 ft.) and even 7 × 7 metres. For grapefruit the distances are somewhat greater, 5 × 5 metres or 16 × 16 ft. being common.

*Cultivation.*—In the older groves hand cultivation is still adopted owing to the closeness of planting. In modern groves mechanical cultivation is being employed with success. The importance of organic matter for citrus on these soils is well recognised and the planting of green manure crops in the winter to be ploughed in later, is frequently done. Lupines (*Lupinus* spp.) are often used for the purpose. Not much pruning is done, a good foliage on the tree being considered advantageous from the point of view of moisture conservation.

*Irrigation.*—Owing to the almost total lack of rain from May to September, irrigation is essential during this period. Irrigation water is obtained mainly from wells and from pipe lines with filters sunk to much greater depths than those of the water table, when the quantity of ground water is insufficient for intensive irrigation. It is distributed in some groves, through open concrete pipes or flumes. Water table depths vary from 10 to 40 metres (30 to 130 ft. approximately) in summer and pipe lengths from 14 to 60 metres (45 to 190 ft. approximately). Palestine well waters are generally rich in lime. Very occasionally river water is used for irrigation, if available.

The system of irrigation commonly practised especially in closely planted groves and on light soils is that known as 'basin irrigation,' the water being let into depressions around the trees. Irrigation is given once a fortnight or about 10 to 12 times a year on the heavier types of soils. On the lighter soils more frequent irrigation is done. These soils require much more irrigation water than the former. Experiments are in progress to determine the optimum duty of water for citrus cultivation, at some of the Stations of the Department of Agriculture. Great care has to be taken with this system of irrigation to prevent the development of gummosis. On some groves mounds of earth are made round each tree so that the water does not come into actual contact with the trunks of the trees while irrigating. In groves where the planting distance and soil conditions permit, furrow irrigation is adopted. The quality of the irrigation water is very important, for it has been found (4) that if its chlorine content is greater than 350 parts per million, indicating an excess of sodium chloride, the development of the tree is bad, yields are poor, the leaves become mottled or chlorotic and the tree itself may die, should the irrigation be continued over long periods. The texture of the heavier soils is also adversely affected thereby.

*Manuring.*—The manuring of groves in some form or other is general all over Palestine. Farmyard manure is applied to bearing trees just before or at the beginning of the rains, *i.e.*, in September-October, at the rate of about two baskets (30 kgm. or 66 lb.) per tree. The manure is ploughed between the rows of trees. Artificials are generally applied a month or so before blossoming, *i.e.*, about February or March.

Nitrogen has been found essential for good yields of citrus crops and about half of this constituent is applied in organic form, *i.e.*, as farmyard manure. The other half, if supplied in the form of sulphate of ammonia, as is often the case, is given at the rate of about 1 to 1½ kilos (2 to 3 lb.) per tree. Nitrochalk (containing 15.5 per cent. nitrogen) is being used in increasing quantities. Potash and phosphoric acid have been found at the Mikveh Israel Agricultural School to be indispensable for the first ten years after planting the crop. This is borne out by the comprehensive lysimeter trials there. At one private grove these constituents are applied in the following proportions: superphosphate 500 gm. (about 1 lb.), sulphate of potash 250 gm. (about ½ lb). They are applied with the cattle manure, at the same time as the nitrogenous fertiliser or even a little later. The method of application of fertilisers varies. Occasionally they are applied in the irrigation furrows, in some groves round the trees and in others between the rows.

Liming is generally done on the red sandy soils devoid of lime once every two or three years at the rate of 4½ to 6 cwt. per acre. Ground limestone is recommended for light soils and slaked lime for heavy soils. Lime appears to be essential for proper citrus growth (5). A deficiency is occasionally indicated by a chlorosis, scorching or mottling of the leaves.

*Yields.*—With proper care and attention citrus plants begin to bear in four years. The average yield on well-cultivated, bearing groves is two boxes per tree. On some groves up to three boxes per tree are obtained. The variation in number of fruit per case ranges from 96 to 360 (average 144) with oranges and from 54 to 150 (average 80) with grapefruit.

*Pests and Diseases.*—The most serious pest in Palestine is Black Scale (*Chrysomphalus aonidium*) which is mainly confined to the north of the country. Government regulations prohibit the transport of fruit from north to south for this reason. Compulsory fumigation with hydrocyanic acid gas once or twice a year is now in force, the method of tent fumigation

being adopted. The fumigation is carried out by individual growers themselves or by the Government contractors (The Imperial Chemical Industries, Levant Ltd.) at a pre-arranged rate. This was approximately 4 piastres or 9d. per tree in 1935. The other pest which is causing anxiety is the Red Scale (*Chrysomphalus aurantii*). Fumigation has been found preferable to spraying as a control measure. The Mediterranean Fruit Fly (*Ceratitus capitata*) is only serious from March onwards.

The most serious diseases of citrus in Palestine are those comprised under the general term "gummosis". The use of sweet lime stock, improper irrigation, low planting and the accumulation of soil around the trunk are mainly responsible for the trouble. "Black rot" (*Diplodia natalensis*) is unusually severe in Palestine. "De-buttoning" of fruit and the pruning away of "die back" is advocated as control measures. A new disease of a rather serious nature called 'Xyloporosis' which appears to be caused by physiological factors, was discovered in 1930 (6). Neither canker (*Pseudomonas citri*) nor leaf miner (*Phyllocnistis citrella*) so prevalent on citrus in Ceylon occurs in Palestine. Lime washing of the trees every year with a mixture of lime and sulphate of copper is adopted by progressive growers.

*Grading, Packing and Export.*—Under the Regulations of the Fruit Export Ordinance 1927, registered exporters are permitted to export citrus fruit from Palestine only after they have satisfied the officers of the Fruit Inspection Service that the consignments are up to the standards prescribed. The sizes of boxes, grades of fruit, number of fruit to the box, labelling of fruit and boxes, etc., are regulated by law. The grades are as follows: Extra Large, Large and Ordinary. The American system of packing appears to be generally adopted. Grading has in the past been done largely by eye, but modern methods of grading and packing are being employed by progressive export agencies. Washing of the fruit is not done, neither is artificial colouring on any scale at present.

*Citrus By-Products.*—At the Rehovoth Co-operative Growers' Factory, the manufacture of orange oil, orange juice, pectin and other by-products of citrus is undertaken. The manufacture of fruit juices, marmalade, essences, etc., is also carried out in one or two private factories. The canning of oranges, etc., is not yet done on a commercial scale, though the question was investigated by an expert from England—Mr. F. Hirst, Director of the Campden Fruit Preservation Station.

*Research.*—Much valuable research work on citrus cultivation is being done at the Mikveh Israel Agricultural School, in particular on questions relating to vegetative propagation and the manuring of citrus soils ; at the Jewish Agency Research Experiment Station, Rehovoth, on all aspects of citrus cultivation and the utilisation of the by-products of citrus ; at various Horticultural Stations of the Department of Agriculture and elsewhere. The Government grants an annual subsidy to the Jewish Agency for citrus research at Rehovoth and close co-operation exists between this station and the Government citrus demonstration station at Sarafand. At the Sieff Research Institute work of a more fundamental and long-range nature is undertaken.

### POINTS OF LOCAL INTEREST

Sufficient has been written to indicate the general lines of citrus cultivation in Palestine. It may perhaps be advantageous before concluding to draw the attention of local growers of the crop to certain points relating to citrus soils and manuring in particular, which may prove of some benefit to them.

These are as follows :

(1) Not all soils are suited for citrus cultivation. A soil of depth about 6 ft. is generally necessary for successful cultivation. It should neither be too sandy nor heavy, loamy sands and light to medium loams being best. Soils derived from limestone rocks whether sedimentary or crystalline are very suitable. Good drainage is essential, a clay or other hard pan within a 6 ft. depth, even on light soils, being harmful.

(2) Nor are all climates suited to the crop. The rainfall must not be too high nor continuous. A fairly long dry season would appear to be beneficial, especially for oranges. Irrigation during the period of drought may be found essential. The irrigation water must however be of good quality. Where irrigation is not possible, the conservation of soil moisture by mulching and other dry farming measures is most important.

(3) A stock suited to the nature of the crop grown and the climatic conditions of the district should be chosen.

(4) Manuring with organic manures and with artificials, especially the former, will be necessary if continued good crops are to be obtained. Nitrogen is an important plant food constituent of citrus. Potash and phosphoric acid will also be required, especially on the lighter soils. Periodical liming, especially of our acid soils, would be found essential. Ground

limestone is advised for the lighter soils and burnt lime for heavy soils. The growing and turning in of green manure crops should also prove advantageous on soils poor in organic matter.

(5) Tree sanitation, and treatment against pests and diseases are very important with citrus.

(6) Some of the areas in Ceylon which appear to satisfy, to some degree at any rate, the soil and rainfall (its incidence) conditions required for citrus cultivation, are : the Bandarawela, Welimada, Bibile, Medagama and other areas of the Uva Province, the Jaffna and Vavuniya districts, Nalanda and Dambulla districts, Embilipitiya and surrounding areas, certain areas in the Chilaw-Puttalam district, and certain inland parts of the Tangalle-Hambantota district. Grapefruit appears to be much less selective in its requirements in these respects than oranges. The latter would probably give better quality fruit in the cooler districts. Long-period trials alone would show whether other factors militate against the successful establishment of citrus in these and other areas.

#### REFERENCES

For those who are interested in the subject of citrus in Palestine, the following references are suggested :—

1. The citrus industry in Palestine. H. Clark Powell. Dept. Agric., Palestine. Leaflets, Series IV. Horticulture, No. 9.

2. Agriculture and soils of the Jaffa sub-district. H. E. Z. Raczkowski. Dept. Agric., Palestine. Agric. Leaflets. Series XI. Soil Survey, Nos. 1 and 2.

3. Citrus groves and soil conditions. A. Reifenberg and S. Adler. *Hadar*. Vol. VII, Nos. 1-3.

4. Irrigation water and cultivation of citrus. A. Reifenberg. *Hadar*. Vol. VIII, Nos. 8-9.

5. Problems of citrus nutrition. H. R. Oppenheimer. *Hadar*. Vol. VII, No. 12 and Vol. VIII, No. 1.

6. Xyloporosis. The new citrus disease. L. Reichert and J. Perlberger. *Hadar*. Vol. VII, Nos. 7 and 8.

#### ACKNOWLEDGMENT

Grateful acknowledgment is made to Messrs. the Imperial Chemical Industries (Levant Ltd.) and the officers of the Department of Agriculture, Palestine for the facilities given me to see so much in a comparatively short time.