Citrus Growing in Australia

BY

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CITRUS fruits are popular in Australia, and are grown on a commercial scale in areas where soil and climatic conditions are favourable for healthy tree growth and high fruit quality. Fruit of the best quality is produced under irrigation in semi-dry sub-tropical areas with less than 20 inches of annual rainfall. But some good fruit is also produced under natural rainfall in the coastal belts. The following are the principal citrus growing areas :—

New South Wales

(*a*) Gosford and Mangrove Mountain district in the coastal belt (under natural rainfall).

(*b*) Paramatta and Windsor in the " Hawkesbury River " district.

(*c*) Yanco, Leeton and Griffith in the Murrumbidgee Irrigation area.

(*d*) Curlwaa and Coumealla on the Murray River.

Victoria

(*a*) Mildura, Cobram, and Murrabit on the Murray River.

(*b*) Wangaratta (under natural rainfall).

(*c*) Metropolitan area round Melbourne (under natural rainfall).

South Australia

(*a*) Renmark, Berri and Waikerie on the Murray River.

Queensland

(*a*) Gayndah district on the Burnett river.

(*b*) Maroochyshire (under natural rainfall).

GOSFORD AND MANGROVE MOUNTAIN DISTRICT

This is one of the largest citrus producing centres in the coastal belt about 50 miles north of Sydney. The citrus orchards are situated in sheltered positions on the valley floors and sides of hills which rise to about 1,000 ft. The hills are covered with virgin timber which makes an effective natural shelter belt for citrus.

The rainfall is fairly well distributed, but in some places on the hills where the soil is of a light sandy type which dries out quickly the growers find it beneficial to provide spray irrigation during the dry spells. The soils on the valley floors are of the heavy loamy type, and are inclined to become too sodden for citrus in wet winters.

Varieties.—The principal citrus varieties grown are the Eureka lemon, Valencia and Washington Navel oranges. In the case of lemons the demand is for summer fruit, the winter crop which is not worth marketing is pulled from the trees and disced into the soil. The Valencia orange is in season from October to January, and the Navel orange from late May to September during the winter period. Being grown under natural rainfall there is a tendency for some trees to produce a second crop in October, but it is of poor quality.

Orchard Practice.—Lemon trees which are unthrifty and on the decline are given a drastic " Skeleton " pruning to rejuvenate them, but it is not always successful. Orange trees do not seem to stand such heavy pruning.

In recent years the practice of keeping poultry in the citrus orchard has been found to be quite effective in improving the health and vigour of the trees. About 100 birds to the acre are given free range, and provided with portable houses containing nests for laying eggs (Fig. I). But the poultry has to be made to pay its own way if the benefit to the orchard is to be economical. Among the advantages claimed for this practice are (*a*) effective control of weeds by the poultry and hence lower cultivation costs, (*b*) improved tree vigour and cropping through the incorporation of poultry manure into the soil in addition to normal fertilizers, and (*c*) better retention of soil moisture in the summer months by effective weed control. Against these are the disadvantages of having to pay special attention to the poultry which cannot be neglected even for a short period, and the risk of increase in scale pests on trees subject to dust near poultry houses. Nevertheless the practice of combining poultry farming with fruit growing has become popular because of the remarkable improvement shown by declining lemon and orange trees which are not too far gone.

Contour Planting.—Another practice which is being recommended and demonstrated by the Horticultural Division is contour planting on the hill slopes. Many of the old orchards are planted in rows running up and down the slope, and very little attention is paid to soil conservation. Growers are beginning to appreciate the value of contour planting although it involves more labour than rectangular or square system of planting.

Disease Control.—Citrus trees growing near old tree stumps on the light sandy soils on Mangrove mountain are often killed by Armillaria fungus (*Armillaria mellea*) which is present on the old tree roots, but in the lower sections where the soil is inclined to be rather heavy and wet the trees are attacked by Phytophthora root rot (*Phytophthora citrophthora*). The fibrous feeding roots are killed, the trees become unthrifty and present a wilted appearance for some time before they die. The treatment for Armillaria

in the early stages is to expose the roots and apply Bordeaux paste to the affected parts after scraping out all dead tissue. Trees which are badly affected are pulled out and the soil disinfected by carbon bisulphide, but for the control of Phytophthora the soil has to be well drained, and this is not practicable in many orchards on heavy soils which are subject to flooding during winter. The disease attacks both rough lemon and sweet orange stocks which are used in this area, but the Trifoliata stock (*Poncirus trifoliata*) has been recently found to be resistant to it.

Exanthema due to copper deficiency is common on Navel orange trees grown on the heavier type of soils. The Valencia orange trees are sprayed regularly with copper sprays such as Bordeaux mixture for the control of Black Spot disease on the fruit and do not therefore develop symptoms of exanthema except in rare cases. Trees affected by exanthema also become chlorotic and show gumming and dieback of the twigs. But the most serious disease in this area is Black Spot caused by the fungus *Phoma citricarpa* (McAlp.) which attacks the citrus fruit as it matures during the summer months and produces ugly lesions on it. Control is by spraying with Bordeaux mixture at different periods from "petal fall" stage to maturity. But Navels which mature during the winter months are hardly attacked by this disease.

Pests.—At one time the Mediterranean fruit fly *Ceratitis capitata* (Wied) was prevalent in this area, but now it has been almost completely ousted by the Queensland fruit fly *Strumeta* (*Chætodacus*) *tryoni* (*Frog*) which is larger and more aggressive in habit. Because of the presence of fruit fly no citrus fruits are allowed to be exported from this area to New Zealand. Spraying with Tartar emetic and sugar, or D. D. T. Nicotine sulphate and sugar is recommended, but is not altogether effective. The pest appears in summer and attacks grapefruit badly, but in the case of oranges only the fully ripe Valencia is attacked late in December. The bronze orange bug *Rhoecocoris sulciventris* (Staul) is another pest which attacks young citrus shoots. It is controlled by the assassin bug which feeds on it, but trials are being carried out with systemic sprays which unlike D. D. T. do not kill beneficial predators.

Grading and Packing

The Sungold Rural Co-operative Packing House at Gosford handles much of the fruit produced in that area. The fruit passes over a conveyor belt into a warm solution of sodium silicate maintained at a temperature of about 100°F in a tank. This solution helps to loosen the dust on the fruit which then passes over revolving brushes sprayed from above with warm water to remove dirt and any sooty mould on it. The fruit then goes into a borax bath containing about 4 per cent. of borax at a temperatue of 110°F. The borax treatment is to prevent the development of moulds on the fruit, but if the solution is too strong shrivelling takes place, and the borax crystallises as a white bloom on the fruit and spoils its appearance. After treatment

with borax the fruit passes over revolving rollers to remove excess of borax solution, and then goes into a Brytene wax and borax bath which helps to makes the fruit glossy and improve its keeping quality. From this it passes over revolving rollers into a hot air chamber to dry, and then goes on a conveyor to be sorted into plain grade and standard grade fruit. The plain grade consists of fruit showing slight blemishes caused by Black Spot, melanose, &c. The standard grade fruit is sorted according to size, and all rejected fruit is sent on a separate conveyor to the cull bin. Each grower's fruit is packed separately and despatched to his Agent at the Sydney market. The boxes carry attractive labels giving the name of the packing house, names of the growers and agent, the number of fruits per box and the name of the variety.

HAWKESBURY RIVER DISTRICT

Paramatta and Windsor in "Hawkesbury river" districts were some of of the chief citrus producing centres in the early days, but with frequent flooding and water-logging in wet winters many citrus trees have been killed by Phytophthora root rot. The disease has been so severe owing to flooding that even leaves and fruit hanging close to the ground are affected by brown rot which has a characteristic smell. In one orchard only the few Navel trees on trifoliate orange stock remain healthy, while those nearby on rough lemon stock, which were once healthy, have now declined badly along with all the mandarines on rough lemon stock. But even trees on trifoliate orange stock, if subject to frequent flooding, are attacked by Phytophthora gummosis on the main orange stem.

Armillaria is another disease which is troublesome on sandy soils, the fungus comes with the debris brought by floods.

One of the most serious pests on heavier type of soils in this area is the citrus root eating weevil, which attacks roots of trees in weak condition. The weevils come out of the soil late in spring and go up the trees to lay eggs. An effective control method is to apply sticky band of Ostico with D. D. T. on the shady part of the trunk.

Owing to scarcity of labour citrus fruits not meant for export are not clipped but pulled and thrown into trucks driven between the rows of trees in the orchards. The fruit is then sent with the least delay to the nearby markets in Sydney for sale locally.

The sweet oranges grown in this area are Navels and Valencia. Navels flower slightly earlier in the spring than Valencia, and the fruits mature from about late April to August, but the Valencia ripens late in September and may last till about January. Both varieties mature a month or so later on the hills.

MURRUMBIDGEE IRRIGATION AREA

At one time about a third of the citrus produced in New South Wales used to come from the Murrumbidgee Irrigation Area, but in recent years with the occurrence of wet winters many trees have become affected by Phytophthora root rot, and production appears to have declined.

The total area under horticultural crops is about 20,755 acres, of which 6,588 acres are under citrus, 8,946 acres under deciduous fruits such as apricots, peaches, pears, &c., and 5,221 acres under grape vine. About 25,000 acres are under rice which is grown in rotation with wheat and pasture once in four years or so. The average size of the horticultural holdings is about 25 acres, and of the large area farms where rice is grown 500 acres, but a maximum of only 80 acres is allowed to be planted under rice on each farm each year.

Water for irrigation is stored above Burrinjuck dam on the Murrumbidgee river 240 miles up stream from Berambed where it is diverted into the main irrigation canal. Most of the water is stored during winter and early spring, and released for irrigation from September to April inclusive. The main canal runs for nearly 100 miles from the off-take at Berembed to the furthest point in the irrigation area beyond Griffith. The first point where water is drawn from the main channel into the reticulated system of field channels is at Yanco about 40 miles from the off-take at Berembed. There are in the irrigation area about 840 miles of canals, 810 miles of drainage channels, and 980 miles of roads.

In the horticultural holdings the grower is entitled to a water right of about an acre foot per acre for which he pays at the rate of 10 shillings (Rs. 5.25) per acre foot, and for any water used in excess of this at 15 shillings per acre foot. The water right in the large area farms is about an acre foot for 3 to 5 acres or so, and the charge is 5 shillings per acre foot initially, and 9 shillings per acre foot for any excess water.

Climate and Soil.—The climate of the area is somewhat of the Mediterranean type with an annual rainfall of about 15 inches. The winter rainfall is the most reliable ; the summer rains occur as spasmodic thunderstorms. But the rainfall in any one month seldom exceeds 2·5 inches or so. Frosts may occur in winter making it necessary to burn oil in pots between the rows of trees to prevent frost injury.

The soils of the Murrumbidgee Irrigation Area are highly variable and are grouped as follows :—

1. Soils of the flood plains—Alluvial origin.
2. Soils of the hill slopes—Colluvial origin.
3. Wind blown soils—Aeolian origin.
4. Soils of mixed origin.

The soils of the aeolian origin, which are best suited for citrus consist of sandy material piled 6 feet or more on the original surface of the plain, or deposited in old depressions. But most of the surface soils in the area are also believed to have been partly resorted by wind action.

The large area farms are on the heavier type of soil well away from the horticultural holdings which for the most part are on the lighter soil types. But the sandy alluvial fan below the clay layer allows lateral seepage, and as a result of over irrigation in the past the water table has risen alarmingly high to within a few feet of the surface in certain sections causing serious tree decline in horticultural holdings. Recurring wet winters have aggravated the problem, and many citrus orchards have gone out of production within a very short period.

In order to lower the water table experimental bore holes have been sunk to a depth of 20 to 30 feet in a few places, and water is pumped out by electric turbine pumps into surface drains. The water contains salt in concentration of 40 parts per 100,000 parts of water and is unfit for use in irrigation channels, since the irrigation water is very pure with a salt concentration of only about 20 parts per million or so.

Varieties.—The principal citrus fruits grown in the Murrumbidgee Irrigation Area are lemons and oranges. The orange varieties consist of Washington Navel and Valencia late. The Navels flower slightly earlier than Valencia in spring, and are in season in late autumn and winter, but Valencia mature only during the late spring and summer of the following year.

Grapefruit which was popular during the war when American troops were stationed in Australia is now grown only on a limited scale because of the poor demand for it.

Rootstocks.—Both rough lemon and sweet orange were used extensively in the early days, the former for the light sandy soils and the latter for the loamy types, but the occurrence of the so called "perched" water tables even in the lighter type of soils during wet winters has resulted in heavy incidence of Phytophthora root rot to which both varieties are susceptible. Under normal conditions the citrus tree is apparently able to produce more fibrous roots than those destroyed by the Phytophthora organism present in the soil, but wet soil conditions caused by over irrigation, excessive rainfall, or poor drainage favour the development of the fungus, and the balance is upset making it difficult for the tree to replace the diseased fibrous feeding roots. The effect is noticeable during the following summer when the trees present an unhealthy wilted appearance. Dr. Lilian Fraser (1950), Plant Pathologist of the New South Wales Department of Agriculture, has shown by inoculation experiments that the trifoliata orange is highly resistant to Phytophthora root rot, but even so it will not stand prolonged water logging. Fruit quality is very high on this stock, and the storage life is longer than that of fruit produced on other stocks.

The following are the main disadvantages :—

(*a*) As trifoliata roots do not stand exposure the budgrafted plants have to be planted in the field with the minimum of delay and carefully nursed. Plants in which the roots have been allowed to dry even for a short while take long to make growth in the field, and may even die.

(*b*) Being less drought resistant than rough lemon the trifoliata orange stock does not grow well on light sandy soils which are liable to dry out.

(*c*) Washington Navel orange and grapefruit more often exhibit unhealthy dwarfing on trifoliata orange stock than Valencia orange, but it has been shown by Dr. Lilian Fraser that this so called incompatibility is due to the presence of the scaly butt virus in the scion budwood. Plants raised from budwood of healthy virus free trees of Washington Navel or Valencia on trifoliata stock make normal healthy growth and do not develop scaly butt on the trifoliata stock. Those in which stock over-growth appears early in the nursery are less likely to develop scaly butt than those with a more uniform budunion, and this characteristic is used in the selection of planting material. But there is the danger of the virus being carried by an insect vector although none has been recorded so far. Nearly all the new plantings on loamy soils have been made with plants on trifoliata stock and they show great promise.

Irrigation.—Spray irrigation which involves high capital expenditure of over £100 per acre on pumps, piping, &c., is practised on permeable light sandy soils or on undulating land. There are portable spray equipments and fixed overhead types which throw a spray in a circle.

Furrow irrigation is practised on land which has been graded to ensure an even application of water. Water is allowed to flow along 3 to 4 broad shallow furrows running between the drip of the trees in the rows. A soil auger is used between irrigations to determine whether a dry soil condition is being approached in the feeding root zone. Water is applied before the trees begin to wilt. Irrigation is used to supplement the natural rainfall, and the quantity applied each year varies according to it and the nature of the soil. About 5 to 6 acre inches of irrigation water per year are applied 3 or 4 times during the summer in October, December and February with a late watering if the autumn is dry, but for 15 to 20 year old trees on sandy soils 8 to 12 acre inches may be given in three or four applications. The tendency in the past has been to over-irrigate, and this practice is now discouraged because of the incidence of Phytophthora root rot. Moreover injurious salts are likely to be brought to the surface by capillary action if the water penetrates to great depths.

Drainage.—A net work of surface drains is provided to carry away surplus water from the horticultural holdings. In many cases the soils are not sufficiently permeable to enable under ground tile drains to be used as in Mildura and Renmark, and the initial costs are high.

Cultivation.—The normal routine practice has been to clean cultivate in summer, and grow a green manure crop of field beans or vetches with the rains in winter for discing in spring, but continuous summer clean cultivation tends to destroy organic matter and soil structure, and injure the feeding citrus roots which are generally found at shallow depths. The alternatives to summer clean cultivation which are being tried out are—

(*a*) Reduced summer cultivation.

(*b*) Cultivating only alternate strips.

(*c*) Sod culture, using grass and legumes like Dutch white clover which are sown periodically.

In some private orchards at Griffith lemon and orange trees show remarkably healthy growth under sod culture (Fig. 2) but the sod contains a high proportion of legumes such as Dutch white clover and Burmedic or trefoil, and is mown regularly before the grass runs to seed. But in the sod culture plots in the citrus trial at the Commonwealth Irrigation Research Station, Griffith, the trees show chlorosis and other symptoms of marked nitrogen deficiency. The best growth is shown by trees in the plots sprayed with oil to suppress weed growth.

Manuring.—Citrus trees in the Murrumbidgee Irrigation Area show little response to potash and phosphate, but nitrogen has a marked effect on tree growth and yields. The fertilizer recommendation is 8 lb. of sulphate of ammonia per tree in three dressings of which the first one of 4 lb. is given in early August, the second of 2 lb. in November, and the third of 2 lb. in January. The initial heavy dressing in early August is to promote flowering and good fruit setting. Zinc spray is applied to the foliage as a routine practice once a year to correct mottle leaf condition.

Packing and Grading.—Most growers pick, grade and pack their own fruit for despatch to their commission agents in the large markets at Sydney and Melbourne. Picking is often done by the grower himself and his family with the assistance of some casual labour during the peak of the season. But labour is very scarce and expensive nowadays, and most of the work has to be done by the grower himself. So much so he has become mechanically minded, and has improvised various labour saving gadgets in his workshop, which is a characteristic feature of nearly every horticultural holding. The fruit is generally not washed but brushed mechanically between revolving brushes and graded according to size. Some fruit is sent to the co-operative cannery at Leeton which puts out the famous "Leetona" brand of canned products. Here it is peeled by hand after treatment with hot water to

facilitate peeling, sprayed with hot lye to remove the albido, then washed, sliced into about 3 circular slices and put into cans ; 60 per cent. sugar syrup is then added and the cans exhausted in a steam chamber, sealed mechanically, cooked and stored in a cool place. The canned orange slice which is good for use in fruit salad is a new line which is being put on the United Kingdom market under contract. It provides an outlet for surplus Valencia oranges which have been held long on the trees. The small sized culls are used for making cordials and canned orange juice.

Pests and Diseases.—Red scale *Aonidiella aurantii* (Mask) is the major pest and causes yellowing and defoliation of the foliage and blemishes on the fruit. The control is by spraying with white oil or fumigation with hydrocyanic acid gas. For fumigation each tree is covered at night with a tent under which sulphuric acid diluted with water is allowed to act on sodium or potssium cyanide to produce the gas. No fumigation is done at day time. Spraying is done during February and March, but if the infestation is severe fumigation is done in addition to spraying.

There is no black spot here, but Septoria spot caused by the fungus *Septoria depressa* affects the fruit producing numerous dark brown sunken spots on the rind. It is controlled by application of Bordeaux mixture (2—2½—100) with ½ gallon white oil in mid-March. But the major disease which has been responsible for large scale tree decline is Phytophthora root rot, control of which is largely dependent on environmental factors. The collar rot or gummosis phase of this fungus is not so common here as in the coastal area.

MURRAY RIVER SETTLEMENTS

Mildura

Mildura together with Merbein and Redcliffs is on the Victorian side of river Murray within a few miles of Curlwaa and Coumealla which are comparatively new soldier settlements on the New South Wales side. They are in an area of low rainfall of about 10 to 12 inches per year with high summer temperatures ranging to as much as 110°F and very cold winters. The irrigation settlement at Mildura was established by Chaffey brothers from Canada. They were men of great courage and foresight who had established similar settlements in California. Despite initial failures they were successful in establishing a flourishing irrigation settlement at Mildura. The original wood burning steam engine pump made in England by Trangee Engineering Firm according to design prepared by Chaffey, and installed in 1888 is still in use lifting water from the Murray river to a height of 20 ft. from which it is again lifted twice by two pumps. A coal burning engine pump is now in use at Redcliffs, and electric power is also generated there for working turbine pumps some distance away. Irrigation water costs more here than in the Murrumbidgee Irrigation Area because of the high costs of pumping from the river.

Soils for Citrus.—The best soils for citrus in this area are the well drained sand ridges carrying a good stand of Murray pine (*Callitris sp.*) on certain sections on either side of the river Murray. On other soils the trees tend to be short lived in spite of efficient underground tile drainage. In some sections boron toxicity is pronounced.

Varieties.—The main citrus varieties are Valencia and Washington Navel oranges with lemons second in importance. Some grape fruit of high quality, and mandarins are also grown. An improved strain of Valencia orange called " Newton's late-hanging Valencia ", which produces smooth skinned fruit of excellent quality and flavour, and holds it long on the tree in good condition, is in great demand for planting. It originated in a private orchard as a budsport like the Leng's early Navel, which is vigorous and produces fruit of high quality very early in the season.

Rootstocks.—In the early days extensive plantings were made on sour orange stock because of its resistance to Phytophthora root rot and gummosis, but many trees on this stock have died in recent years owing to a virus which affects it below the budunion and which is carried by an insect *Aphis citricidus.* This budunion decline is in many respects not unlike the Tristeza disease of Brazil and the Quick Decline of California both of which affect citrus on sour orange stock. Over 8 million trees are estimated to have been killed in Brazil, and the disease is a potential threat to citrus on sour orange in other parts of the world. Fortunately for New South Wales no extensive plantings on sour orange were made, since early attempts to grow citrus on this stock were a failure. Many trees on sour orange stock die almost overnight when affected by this virus (Fig. 3) but some may show slow decline in the orchard. (McAlpin 1948).

The most popular stock now is sweet orange, but rough lemon is used on very sandy soil types. Interest is also being shown in the trifoliata stock for the heavier type of soils.

Pests and Diseases.—There is no fruit fly in this area. The major pest is the red scale which with yellow scale *Aonidiella citrina* (coq.) causes much damage in neglected orchards. Control is by spraying and fumigation. The citrus white fly *Aleuroplatus citri* has been recorded recently in Curlwaa. It is associated with fumigene or sooty mould which spoils the appearance of the fruit. It is easily controlled by spraying.

Cobram and Murrabit

Citrus soils in Cobram area are similar to those at Mildura, but at Murrabit citrus is planted on relatively heavy clay soils. The trees grown at Murrabit have characteristic dark green foliage, and are comparatively small. The earlier plantings on clay soils died out through Phytophthora root rot within about 10 years. But trees planted on a mixture of river sand and clay

overlying 14 feet or so of deep sand have an economic life of about 20 to 25 years. The fruits mature later and retain flavour longer than at Mildura, but they are inclined to be coarse. Some have peculiar reddish markings on the rind.

Wangaratta

The rainfall is fairly well distributed and enables citrus to be grown without irrigation at low cost. But the soils consist of coarse acidic material of low fertility derived from decomposed granite, and as a result the fruit produced is of poor quality and of unattractive light orange colour. Some of the oldest seedling sweet orange trees in the State are still growing here in spite of neglect and heavy red scale infestations. They are believed to be over 90 years old and are of the Paramatta type. Plants raised from seed of these trees have been used in the rootstock trials.

Metropolitan Area—Melbourne

Lemon is the chief citrus fruit grown in this area under rainfed conditions to supply the local market. It is propagated on rough lemon and sweet orange stock. On the trifoliata stock growth is variable and some trees become affected by scaly butt and remain stunted.

Renmark, Berri and Waikerie

The soil and climatic conditions here are similar to those at Mildura, but in the recently established soldier settlements at Cooltong and Loxton citrus is planted only on well drained light sandy soils which are best suited to it, and is spray irrigated. The Cooltong settlement is about 1,000 acres in extent of which nearly 300 acres are under citrus. Each holding averages 20 acres, and the settler is provided with a house costing £2,000. The Loxton settlement started in July 1948 is larger and has about 900 acres under citrus. Water for irrigation is pumped from the Murray river by electric turbine pumps.

At Waikerie, where the soil is only about 2 feet deep overlying lime stone and clay band, no tile drains are provided, but a hole 4 feet radius is sunk to a depth of 20 feet, and from there a 4-in bore is put down to a depth of 80 to 100 feet in drift sand or lime stone having porous honey comb structure. The water drains off into the hole and is believed to find its way eventually into the river bed. An efficient drainage hole is able to draw water from a radius of 11 chains. The holes cost from £100 to £150. This type of drainage is unique and is found only in Waikerie.

Gayndah District—Queensland

The best citrus fruits produced in Queensland come from Gayndah district where they are grown under irrigation on alluvial soils of light texture on the banks of the Burnett river which some 25 years ago were overrun with

prickly pear. The soils have good natural drainage. The annual rainfall is about 25 inches, but the distribution is so erratic that in most years a dry spring is experienced. Frosts are generally mild and do not necessitate orchard heating. Water is pumped direct from the river by each grower, and is applied by means of portable spray lines or fixed overhead sprinklers.

Varieties.—The Ellendale mandarin which originated in the Howard district, probably as a nuceller seedling budsport, grows to perfection here producing large attractive smooth skinned fruits of excellent quality and flavour. Its main defects are the tendency for the branches to split at the crotch and for the rind to crack at the bottom end of the fruit. The trees grow well on sweet orange stock, but on rough lemon they develop chlorotic symptoms which are suggestive of virus infection. The Beauty of Glen Retreat mandarin also grows equally well. Of the other citrus varieties lemons and Navel orange of high quality are produced, but the mid-season Joppa variety and the late Valencia are grown only on limited scale because of the demand for the early varieties.

Rootstocks.—Sweet orange is in favour as a rootstock although on very light soils rough lemon is used. Phytophthora root rot being not a serious problem here on light sandy soils little interest is shown in the resistant trifoliate stocks on which mandarins generally produce fruits of the very best quality. Emperor mandarin has become popular as a rootstock for Beauty of Glen Retreat mandarin.

Cultivation.—Clean cultivation was practised throughout the year in the past, but it is now recognized that it rapidly depletes the soil organic matter, destroys soil structure, and exposes the soil to erosion. The recommended practice is to do minimum of cultivation during the winter months and grow green manure crops in early spring and summer. Green manure crops are not grown in winter because they interfere with harvesting.

Pruning.—Citrus trees are given more drastic pruning in Queensland than in the other states because of the tendency of the trees to grow large in the more subtropical climate. The pruning is done in winter after the fruit is harvested and before blossoms appear. Hardly any summer pruning is practised. The main reasons for pruning are—

(*a*) to keep the trees within manageable size and shape to facilitate cultural, spraying and harvesting operations.

(*b*) to maintain a continuous supply of new wood to produce fruit of high quality.

The most drastic pruning is given to Beauty of Glen Retreat mandarin which has a tendency to overbear. Hand thinning of the crop is always necessary with this variety to produce fruits of good size and quality. Consequently very heavy pruning is practised in winter and many of the buds which would produce fruit are removed with the prunings.

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The upright growth of the Emperor mandarin is also checked by cutting back the top and shortening the laterals, but the Ellendale mandarin is only lightly pruned. Oranges and grapefruit are pruned more lightly than mandarins.

Pests and Diseases.—Fruit fly is not so common here as in the wet coastal districts. The fruit piercing moth *Othreis fullonica* is troublesome in certain seasons, and there is no effective method of control except picking them by hand when they alight on the fruit at night to puncture it and suck the juice.

Many citrus trees in Queensland are affected by scaly bark or Psorosis, a virus disease which makes the trees unthrifty. But the most serious disease is " Stem Pitting " which has stopped commercial grapefruit production in Queensland. The trees develop depressions in the trunks and main branches, become unhealthy, and produce small fruits with thick rind and no juice. They do not last more than 10 years.

In the Howard district Emperor mandarins are attacked by Brown Spot which is believed to be a bacterial disease causing blemishes on the fruit and young leaves. No other mandarins are attacked. Spraying trials are being carried out for the control of this disease.

Maroochyshire—Queensland

This was at one time the largest citrus producing area in Queensland, but in recent years many trees have declined very badly owing to excessive clean tillage, wet soil conditions caused by rains, and attack by the citrus gall wasp (*Eurytoma fellis*) and borers. Allowing grass and legumes to grow between tree rows and keeping them mown has resulted in striking improvement in tree growth and yield in some orchards. No irrigation is given as the rainfall is often adequate.

The varieties grown are the early Navels, midseason Joppa and late Valencia. The Ellendale mandarin does not grow so well here as at Gayndah, but Beauty of Glen Retreat is satisfactory.

Lemon and grapefruit are badly attacked by the gall wasp which is a native species. Beauty of Glen Retreat Mandarin is also attacked, but Navel orange is more resistant. Large ugly galls are produced on twigs, thorns, leaf stalks and veins, fruit stalks and even on the fruit itself, and they restrict growth and ruin the appearance of the fruit. There is no effective treatment, but systemic sprays under trial show some promise.

The borer is also very destructive on stems and roots of lemons and other citrus trees.

Tropical North Queensland

Citrus is grown commercially on a very limited area, but most home gardens have few trees which provide local requirements. The fruits do not travel well to distant markets and are not of the same high quality as those produced in the semi-dry sub-tropical areas. Pink disease (*Corticium salmonicolor*) is troublesome in the wet areas and necessitates regular pruning of diseased branches and disinfection of cut ends.

REFERENCE

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Fig. 1.—Poultry in the Citrus Orchards near Gosford, New South Wales

Fig. 2.—Healthy Lemon trees under Sod Culture at Griffith, New South Wales

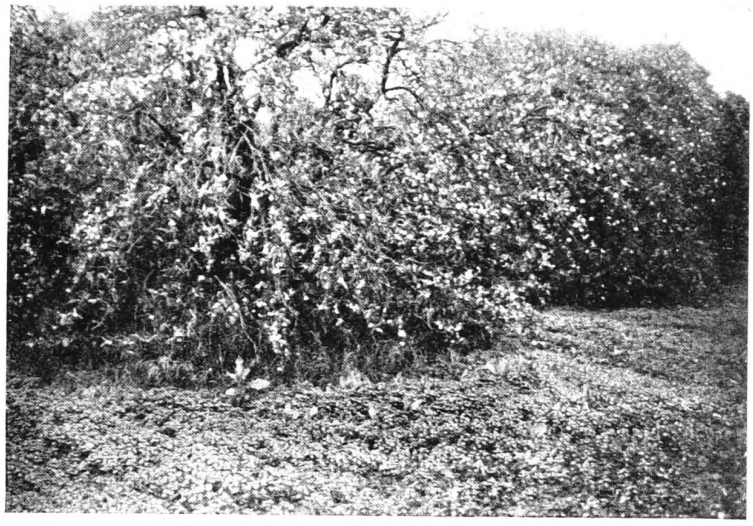

Fig. 3.—Sudden collapse of Sweet Oranges on Sour Orange stock due to Bud Union Decline at Irymple, near Mildura, Victoria