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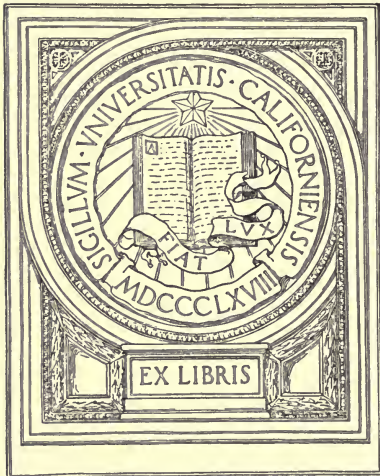
THE CULTIVATION OF ORANGES AND ALLIED
FRUITS
in the
BOMBAY PRESIDENCY

By
H. P. Paranjpe, B.A.
Bulletin No. 95 of 1919.
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Department of Agriculture, Bombay.

BULLETIN No. 95 OF 1919.

**THE CULTIVATION OF ORANGES
AND ALLIED FRUITS**

IN THE
BOMBAY PRESIDENCY.

BY

H. P. PARANJPE, B.A.,
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DIVISION OF METEOROLOGICAL DEPARTMENT
COLLEGE OF AGRICULTURE
BERKELEY, CALIFORNIA



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**THE CULTIVATION OF ORANGES
AND ALLIED FRUITS**

IN THE

BOMBAY PRESIDENCY.

DIVISION OF SUBTROPICAL HORTICULTURE

COLLEGE OF AGRICULTURE

BERKELEY, CALIFORNIA

BY

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AGRICULTURE



The Cultivation of Oranges and Allied Fruits in the Bombay Presidency.

CHAPTER I.

THE CITRUS FRUITS AND THEIR VARIETIES.

Citrus fruits are among the most paying orchard crops in the Bombay Presidency. The acreage under oranges is increasing fast, but the demand for the fruit so far exceeds the supply that large imports are made from the Central Provinces and a few other sources. Nevertheless there are many orange orchards which find it difficult to make a profit. The present bulletin is issued in order to place before the public the methods which have been found to yield the best result and give the largest profit, not only with oranges, but also with other kinds of citrus fruits.

The citrus fruits commonly cultivated in Bombay belong to three species, distinguished as follows:—

1. The juice sacks in the fruit are easily separated from one another and do not adhere into one mass. The young shoots and leaves of the plant are hairy. *Citrus decumana*, the Pomelo.

2. The juice sacks in the fruit are not easily separated from one another and adhere in one mass. The young shoots and leaves of the plant are not hairy.

(a) The fruits are mammillate, that is to say, the stigma end is more or less distinctly produced. *Citrus Medica*, the Citron and its varieties.

(b) The fruits are not mammillate, that is to say, the stigma end is flattened. *Citrus aurantium*, the orange and its varieties.

Citrus decumana, the Pomelo (Marathi—*Papnas*; Kanarese—*Pampari*) occurs in two forms, with white pulp and red pulp, respectively. The fruit and leaves of the pomelo are the largest of all among the citrus fruits. The red variety generally fetches a better price than the white. An intermediate variety, with pink flesh, is occasionally found. *Citrus Medica* is found in four distinct varieties as follows:—

(a) *Citrus Medica* proper, the Citron (Marathi—*Mahalung*; Gujarati—*Bijoura* or *Turanj*; Kanarese—*Madalada hannu*). The fruit of this variety is large, weighing up to three pounds, the skin is warty and rough, and the rind very thick (sometimes more than an inch thick) with a carrot-like consistency. The pulp is somewhat bitter and acid, pale white in colour. The tree on which this variety is produced is rounded and flattened from above, and has generally yellowish appearance. The fruit is used for pickles, preserves, and marmalade. It is rarely, however, cultivated alone.

(b) *Citrus Medica*, variety *limonum*, the *Jamburi*. The first of this variety has a wrinkled and somewhat loose skin, and the pulp is exceedingly acid. The plant is only used as a stock in which to bud oranges. There are, however, many sub-varieties of *Jamburi* into which, however, we need not enter.

(c) *Citrus Medica*, variety *limetta*, the true Sweet Lime (*Sukhar Limbu*). The fruit of this tree has a sweetish taste at all stages, like sugar and water. The tree is yellowish in appearance. It is rarely cultivated in gardens and is of little practical importance.

(d) *Citrus Medica*, variety *acida*, the Sour Lime (*Kajdi limbu*). This tree has small leaves and small round fruits which are largely used for pickles and drinks. There is considerable cultivation of this tree all over the Bombay Presidency. Two sub-varieties are found. The first of these is thick-skinned and is termed *Godhadi*: the other is thin skinned and is the true *Kajdi limbu*. The former is specially suited for making pickles. A third variety is sometimes met with in the Sholapur District, called *Pat limbu*, with a long and thin skinned fruit.

Citrus Aurantium.—The orange occurs in two main types which are distinguished by the adherence of the skin to the pulp. In the *Santra* group, the skin is quite loose, and has a beautiful golden yellow colour; in the *Mosambi* group, the skin is tightly attached to the pulp. The following are the principal sub-varieties cultivated in the Bombay Presidency:—

1. *Loose-skinned varieties*.—

(a) *Santra*.—This is the most popular of all the citrus fruits, is easily recognised by the loose skin and beautiful golden colour and globose shape. The flavour is agreeably sweet, yet acid. The shape of the tree is that of an inverted cone. Its leaves are small and bright green. This sub-variety is largely cultivated in the Poona, Ahmednagar and Khandesh Districts.

(b) *Ladoo*.—The fruit of this tree is inferior in flavour to *Santra*. It is flattened on the top (the stigma end), and somewhat drawn out at the stalk end. The colour of the skin is deep orange. A miniature fruit, with about six carpels, is often found within the fruit at the stigma end. The juice is sweet, and the fruit is often almost seedless. The shape of the crown of the tree is rounded, the branches short, numerous and compact, and the leaves small. This type is only occasionally seen in *Santra* gardens.

(c) *Kawla*.—This is a very inferior orange. The colour of the skin is more attractive than that of *Ladoo*, but the pulp is much inferior in quality. The fruit is characterised by a circular ring near the apex. Its juice is scanty and the seeds are many. The tree is tall and the leaves look crumpled and pale yellow, as if the tree badly needed water.

This tree is rarely seen in orange gardens.

(d) *Reshmi Naring*.—The fruit of this variety is small and worthless containing many seeds, while the juice is very scanty. The tree is large and very prolific.

It is, however, rarely seen in gardens.

2. *Tight-skinned varieties.*—

The *Mosambi* is the only variety commonly grown in gardens on a large scale. The fruit has faint vertical ridges, and a flat ring on the top. The skin is closely attached to the pulp, and not easily separable from it. Its flavour is less piquant than that of the *Santra*, and the colour of the pulp is much lighter. The tree is large, with spreading branches and dark green foliage. There are two sub-varieties of the *Mosambi*. The fruit of one is thin-skinned (*Kaqdi*) and that of the other is thick-skinned (*Godhadi*). The former is the better, but both types are commonly cultivated in gardens.

The Navel Orange, the Malta Blood Orange, and the Jamaica Orange are sometimes grown in gardens, but these types have not yet found their way into the practice of the ordinary cultivators.

CHAPTER II.

THE CLIMATE SUITED TO THE CITRUS FRUITS.

The Pomelo thrives best in a moist climate such as that of the Konkan tract along the sea coast; it also thrives well on the western side of the Deccan where the rainfall is large. Under suitable climatic conditions, this is a very remunerative crop and commands a very high price in the Bombay market, as much as twelve annas a fruit being given. Gholvad and Chembur are two of the important centres of pomelo cultivation in the Thana District. There is a considerable scope for extension of this crop along the sea coast of the Surat, Thana, Colaba, Ratnagiri and Karwar Districts.

The *Mahalung*, *Sakharlimbu*, and the various types of *Jamburi* can be grown practically in any sub-tropical climate for ordinary purposes. These fruits are grown on a very small scale for local consumption and for medicinal use. It is worth noting that *Mahalung* plants suffer severely from flooding even of short duration.

The *Kagdi Limbu* adapts itself to a great variety of climate and is very largely cultivated throughout the Bombay Presidency. Along the sea coast from Karwar to Surat and in all Deccan villages where there are water facilities this tree is almost always found, as the fruit is used for daily consumption. In some parts of Kanara the crop does not find a ready market for want of suitable transport facilities.

The *Kawla*, *Reshmi* and *Ladoo* varieties of orange will grow very well wherever the *Santra* and *Mosambi* will grow, but their cultivation is not recommended because they are more or less inferior varieties and are therefore less profitable.

The *Santra* and *Mosambi* with its varieties enjoy a hot dry climate. The *Santra* is largely grown in Poona District at Saswad, Sirur, Talegaon-Dhamdhere, Junnar and in the neighbourhood of Poona itself. In many parts of Ahmednagar and Khandesh Districts there are many excellent plantations of *Santra*. In these Districts and in Gujarat there is a vast field for extension of orange cultivation. Both the climate and soil of Khandesh are admirably suited for orange cultivation. With timely help and directions to intending orange growers the Khandesh tract might successfully compete with the orange growers of Nagpur. Gujarat is notoriously deficient in fruit crops, but in the Goradu soils, *Santra* trees would thrive excellently provided the water of the wells is not in any way unfit. In the Konkan also the *Santra* is found to thrive well even with a rainfall of 100 inches per annum as at Wawoshi in the Pen Taluka of the Kolaba District.

The *Mosambi* probably enjoys a milder climate such as that of Poona where it is largely grown. Rahuri and the neighbouring places in the Ahmednagar District are important centres of *Mosambi* cultivation in the Deccan.

Frost is such a rare phenomenon in the Deccan that it may be neglected. It occurred in Poona in 1911 and orange trees did not suffer at that time. Citrus trees are known to be considerably frost resistant and no fear need be felt on that score in the Bombay Presidency.

CHAPTER III.

SOILS SUITABLE FOR CITRUS TREES.

Some of the varieties of Citrus fruits are very accommodating and some are very fastidious about soil conditions. A knowledge of the requirements of Citrus trees as regards soil conditions is very essential for an intending Citrus grower. A good many plantations have totally failed for want of such knowledge. The Citrus grower should therefore carefully see that his soil is of the right kind. Soils which are good enough for certain other kinds of fruit trees will not necessarily do for orange trees.

The Pomelo thrives best in sandy soils which drain freely in the rainy season, such as that of Gholvad in the Thana District. It likewise grows fairly well in medium black soil of the Deccan. Here however the fruit never attains that size or flavour which is so characteristic of the Gholvad plantations. A merely moist climate does not help the trees if they are in stiff black soil such as that of Surat.

The *Kagdi limbu* tree is not very exacting in its choice of soil; it is found to grow fairly well in the black soil of Puna-khumbharia near Surat. But it gives certainly a better result if the soil is well drained. A soil may be good in itself but its environment may make it quite unfit for this or any other kind of Citrus tree. For instance, a soil may be in close proximity to a main irrigation canal from which it may be receiving constant percolation. It is hopeless to expect a good crop, even of *Kagdi limbu* from such a garden.

Santra and *Mosambi* plants are not at present grown on a large enough scale specially in the Deccan and there is plenty of field for the extension of these two crops. Heavy black soils through which water does not percolate freely or which are constantly moist should not be used for orange trees. Extensive plains of black soils which are bounded by hills are particularly unsuitable. In certain parts of the Nasik District (Nasik, Dindori, Ugaon, Yeola line) the soil is three feet or more deep of which the upper one foot or so is fairly loose, but the lower soil is exceedingly sticky and shining black. It does not show any signs of drying even though there is no irrigation for more than three months in the hot season. In such soils orange trees grow fairly well for about four years but they do not bear, or if they bear a few fruits, the trees suddenly or gradually die; branches dry from top to bottom and no amount of pruning or manuring will help the tree to recover. Many a garden in the Nasik District has failed in this manner. Black cotton soils of Surat are also equally unsuited for orange cultivation. In some places of the Khandesh District the soils which are very deep black and are difficult to work and which crack deeply in the hot season should be avoided. In many places commanded by the Nira Left Bank Canal there is hardly any scope for Citrus cultivation, for two reasons (1) the soil remains so completely saturated with underground percolation that the trees hardly get sufficient resting however judiciously canal irrigation may be controlled; and (2) some soils have become so salty that it is hopeless to grow any kind of perennial irrigated crop. In the Mutha Canal tract the case is almost similar. *Santra* gardens surrounded by sugarcane fields can be maintained in good condition almost without water but the trees can hardly be brought to bear. It is a curious phenomenon that *Santra* trees in some places commanded by canals die out in course of time while *Mosambi* trees growing near by in exactly similar places, receiving similar treatment can hold their own for a longer period in spite of the fact that both are budded on *Jamburi* Stock (*Citrus medica* var. *limonum*). The *Mosambi* trees do, of course, show signs of bad drainage in course of time.

Another condition which orange trees do not tolerate is very light soil in which water is not held for any length of time. In this soil the *Mosambi* is more sensitive than the *Santra*. The young tree flowers at a prematurely early age and soon after turns yellow and dies. The *Santra* also suffers but not to the same extent as the *Mosambi* trees. The above remarks point to the necessity of choosing soils possessing the property of holding a fair amount of water.

Orange trees are also very sensitive to a layer of impervious rock, *murum* or stiff clay at a short distance below the surface of the soil. In such a case trees will grow apparently all right for a year or two or more according to the depth of the soil; then the flowers and fruits, if set, will commence to fall off on account of the unhealthy condition of the soil.

It is a mistake to plant orange trees in plots which have been used for sugarcane cultivation for some years and particularly so when the cane was grown on canal water coming from a long distance. Sugarcane requires heavy irrigations which make very favourable conditions for the growth of weeds like *lavala* and *hariali* (*Cyperus rotundus* and *Cynodon dactylon*). If these deep rooted plants get once established in the field, it is very difficult to eradicate them. Orange trees do not thrive in fields infested with these and similar weeds.

Sometimes it happens that by injudicious watering, salts from lower strata are brought up near the roots of orange trees which suffer gradually and ultimately become useless.

To sum up, typically orange-growing soils in Western India are (1) medium black soil as in Poona, Saswad and surrounding villages, (2) reddish alluvial soils on the river banks, (3) loamy whitish soils such as are found at Rahuri, (4) loamy or medium black soils of Khandesh underlaid with yellowish subsoil mixed with lime nodules and (5) goradu soils of Gujarat. Before finally selecting a soil for Citrus in Gujarat it is desirable to determine if the water with which the trees are to be irrigated is sweet. Many places which are very good in themselves for Citrus gardens have to be abandoned owing to the fact that the only irrigation water available is salt. The most important factor to be taken into consideration by the Citrus growers is how far the soil is naturally drained. Different varieties have different requirements as to drainage. As pointed out above, *Mosambi* plants will stand a much more retentive and less drained soil than *Santra* plants. One of the reasons why Saswad is so famous for *Santras* is that a number of small rivers rise from the Parandhar hills and flow heavily in the rainy season. In their brief life they often wash away large blocks of soils, thus leaving behind small islands. The land is, hence, very much cut up and the islands thus formed have excellent side-drains. The level of these islands is sometimes ten feet above that of the river beds. On such islands many of the orange gardens are situated. Whatever be the nature of the soil, water does not remain in it for a long time; hence when water is cut off for resting the trees, the effect of the stoppage is very quickly seen. Thus at Saswad three weeks' rest is quite sufficient for *Santras*, but on poorly drained soils six weeks' rest has only a slight effect. In some very well drained soils of Khandesh some of the *Santra* trees bear fruit without any special treatment such as resting, exposing of roots and manuring during the fourth year.

CHAPTER IV.

PROPAGATION OF CITRUS TREES.

Propagation by seed of Citrus plants except *Kagdi Limbu* is not desirable in this part of the country. We have seen by actual sowing of the seeds of Nagpur *Santra*, *Mosambi* and *Reshmi* Orange that seedlings of these plants are exceedingly thorny. In fact, there is hardly any leaf without a thorn. On the other hand these plants when budded on *Jamburi* or any other stock (although the stock be thorny) do not produce thorns. After careful examination of fifty budded *Santra* plants we have found two plants having two thorns each. *Mosambi* plants do occasionally have thorns but these are very rare, and the plants may be said to be practically unarmed. Absence of thorns is a great advantage in Citrus trees as the danger of puncturing the fruit is minimised and harvesting the fruit is facilitated. Also digging, manuring and pruning can be done with less trouble.

Another reason for the non-employment of plants on their own roots is that they will often not stand the same severe conditions as the stock used. For example, *Mosambi* seedlings if flooded for a short time are permanently checked in their growth; the bark of the stem which remains under water decays in a very short time, leaving the wood of the stem completely exposed. As a result of this the plants turn yellow and sickly and soon after become quite unfit for planting purposes. *Jamburi* plants if similarly flooded do not suffer at all. This shows that *Mosambi* plants will not be satisfactory on their own roots where such a flood is possible.

The pomelo can be propagated by budding on *Jamburi* stock, but the bud takes a very long time, sometimes six months, to germinate. It is not therefore convenient to propagate this plant by budding. At Gholvad and other places, it is customary to propagate this plant by the *gootie* (Marcotte) method, for which a branch three to four feet long is selected; a portion of the bark which is light brown in colour is removed without injuring the wood below, to an extent of about two inches, and a small quantity of earth is wrapped on the wound in a piece of gunny bag. The soil is kept moist by the dripping of water from a pot hanging over it. This operation is done at the commencement of the rains and the plant is ready for removal in about four months. There being generally plenty of rain during this period, the expenses of keeping the soil moist are considerably minimised and therefore this method is found very cheap and convenient.

The *Kagdi Limbu* also is propagated by the *gootie* method mostly in the Surat and Thana Districts. By this method roots are freely produced in the rainy season and a plant of about two feet in height is readily secured. In the Deccan this plant is mostly propagated by seed, but in favourable cases it is possible to bud this plant on *jamburi* stock. The lowest one or two buds on a season's growth are often without thorns. Such buds though normally very small, can be made to swell in about a week by pruning the upper thorny portion of the branch and then can be used as scions. The percentage of success in this method is, however, small as compared with what is attained with *Santra* and *Mosambi* plants. This method, though not useful for dealers in nursery plants, may be advantageously practised by growers in their plantations, as budded plants grow very vigorously and bear early.

The *Santra* and *Mosambi* plants are grown on a large scale. It is, therefore, necessary to examine the details of propagation of these two plants with more care. These two are propagated, as said above by what is called the budding process, which consists of inserting a bud of *Santra* or *Mosambi* (called the scion) on to another plant (called the stock). It often happens that a plant is put out in good soil, is receiving the best of attention as regards water and manure, still it is not making good progress and never yields good fruit. It is difficult to account for its bad health. In such cases the trouble may be due to either a bad scion or a bad stock. Thus arises the necessity not only of budding but of choosing the right kind of stock and scion.

The next question that arises is: what stock should be used for budding on. We have attempted budding mainly on four different kinds of stocks, namely, *mahalung*, *jamburi*, *reshmi* Orange, and *Nagpur Orange*. The essential conditions required in a stock are that it must remain in sap-flowing condition for a considerable time to facilitate the budding operation at any suitable time; that it must grow fast; that the bark when being loosened from the wood below must separate readily; that it should not tear irregularly; and that it must feel very watery to the finger inside. Such a stock is to be found in *jamburi* which may be safely used for budding on.

Whatever stock is chosen, the best fruits ripened on the tree should be collected and allowed to rot for some ten days. When sufficiently soft, the seeds should be extracted and the pulp buried in a manure pit. Of the seeds only the plump and well developed ones should be selected. A good method of selection is to place the seeds in water. Those that come to the surface should be rejected. Those that fall to the bottom are mostly safe for sowing. The seeds should be sown as early as possible, for their germinating power does not last long. If the seed is to be kept for a week or so it should be dried in the shade, smeared with ash and kept in a dry place. The seed is sown either in boxes or beds that should be protected from the heat of the sun. Seedlings when about four to five inches high should be transplanted in open sunny beds. Here the seedlings are planted fairly closely at a distance of six to eight inches, to induce the plants to grow without branches on the lower part of the stem for about eight inches. This distance is sufficient for the budding operation. When transplanting, roots may be trimmed short. If the beds are properly worked by deep digging and adding a good quantity of old farm yard manure with occasional stirring of the soil the plants grow fast and become ready for budding on in about eight to ten months; but ordinarily the plants take twelve to fourteen months.

For budding purposes the stock should be of the thickness of a lead pencil. The bark should be easily separable from the wood below, it should be soft and pliable and the inside mucilaginous. The external colour of such a bark is deep green closely streaked with whitish gray lines. These conditions are found when the sap is vigorously flowing in the plant. When the bark cannot be readily separated from the wood below or when it is dry inside it is futile to attempt to bud. Desirable conditions are to be seen in the stock from the commencement of the rains (the third week of June) till the end of the cold weather (February). However, the budding operation may be done at any time of the year, provided other conditions are favourable. If the stock is not in condition for budding on it can be made so in about ten days time with a light digging of the beds and light manuring followed by watering.

In choosing the scion we must first have regard to the general character of the tree and choose scion buds from a tree which has desirable qualities. The best buds can be had from young trees and, as the tree grows old, fewer buds are generally found. Buds from older trees do not make good plants. In choosing the actual branch from which to cut the buds we must look for the characters similar to those of the stock, namely, dark green colour of the bark with whitish gray lines, full flow of sap, and also roundness of the bud-wood and plumpness of the buds. If the scion plant is not in condition, it can be readily brought into it by the same method as that employed for the stock. It is also desirable in such a case to trim the branches of their youngest growth. This induces swelling of the buds. Buds from the current season's growth should not be selected for insertion as the wood is generally angled; a bud taken from angled wood does not fit snugly on the round wood of the stock. The bud wood should be as thick as the stock plant. It should not be selected from a water shoot even though it is round. This wood is not sufficiently old and ripe for using as a scion. It is generally thorny, the buds do not come off easily, and as a rule do not germinate at all. In selecting the bud the lowest and the topmost ones are generally useless. The topmost bud looks plump no doubt, but does not make a good plant. The lowest one is generally dormant and does not germinate. For this reason there is such a low percentage of success in inserting the lowermost thornless bud of the *Kagdi Limbu*.

If bud-wood is not available within a short distance or bud-wood of some reputed varieties is to be obtained from a long distance, suitable pieces of bud-wood (from which the leaves have been removed with the knife) having all the characters described above may be packed in sawdust. The sawdust should first be thoroughly soaked in water and then squeezed between the palms so as to remove all the free water from it. The moist sawdust should be spread on a piece of oil-paper, the bud-wood placed on it and covered with more moist sawdust. Care should be taken to see that the bud wood has a good layer of moist sawdust on all sides. The oil paper should then be rolled round the saw dust and bud-wood in it. The paper should again be wrapped in a piece of rubber or oil cloth (coated side facing inwards). The whole thing may again be wrapped in ordinary cloth or put in a tin box and may be sent by post as an ordinary parcel. We have seen that bud-wood so packed can remain in good condition for at least three weeks and stand a journey by post.

Each bud from the bud-wood is cut off by splitting the bark in a rectangle around the bud half an inch above and below the bud and one third of an inch to each side of the bud. It is then eased off and kept moist till insertion in the stock. The bud should be inserted in the stock about six inches from the ground. If the bud is inserted at a higher level than six inches the plant does not make good growth. We have seen that ordinary plants of three years' old had grown to a height of more than six feet but the plant budded at a higher level under otherwise similar conditions had hardly made a growth of two feet. The cut for the bud is simply two cuts in the form of a 'T' and the bark eased back to allow of the insertion of the bud. Both cuts should go only through the bark and in no case should they injure the wood inside; otherwise gum comes out of the wood and forms a thin partition between the cambium of the stock and that of the scion which, therefore, do not unite. Another method of easing the bark is to take only one vertical cut slightly longer than the bud itself and bend the stock over towards the cut, the bark is readily eased back and the

bud is slipped into the gap ; on releasing the stock the bud is nicely held in its proper position. Healthy and vigorous growing stocks readily allow of such bending. This method is largely followed by nurserymen. If the bud is inserted on the north side of the stock it gets natural protection from the sun. The operation should be done on a clear day when no rain is expected. After insertion the bud is firmly tied with *sopat*, i.e., the inner part of the banana leaf-sheath.

In about three weeks the bud begins to grow into a branch ; the stock is then cut off about six inches above the site of the bud, and the whole stock is cut off just above the bud when the branch from the bud is about six inches long. After this, care must be taken to rub off all buds that show any tendency to develop from the stock below the site of the bud. At no future period must any part of the tree produce branches except the scion.

Now referring to the different kinds of stock it may be mentioned here that the bark of the Mahaling stock is somewhat brittle and less mucilaginous, and the sap flowing condition lasts only for a short time. The *Reshmi* Orange is not at all suited as a stock, for the bark closely adheres to the wood below, and is not moist enough inside. This and the Nagpur Orange stock when cut off above the bud often turn black at the cut and thus decay. With the pomelo as a stock the great difficulty is that it does not stand well the trimming of its tap root and hence it is not well suited as a stock-plant which must stand repeated transplanting. The Mosambi stock as mentioned above is very sensitive to floods, for the part of the bark that remains under water decays in a very short time. The Jamburi stock is free from all these faults.

Soon after the heading in of the stock near the scion the budded plants should be transplanted to another bed which is properly worked by deep digging and enriched by a liberal supply of farm yard manure. This operation is rendered necessary by the fact that the roots have grown to a considerable length from the time when the tree was last transplanted, and the roots of one plant have intermingled with those of its neighbours. By repeated transplanting the roots remain under control and the plants can stand a long journey without any harm. If the time between the second transplanting and final despatch is long, the plants may be transplanted again. The plants are generally sold in the first month of the rainy season.

Plants which have a very thick stock should not be purchased as they do not make good growth at all. Plants which remain in the nursery for a long time for want of a customer should be thrown away. Again, plants which have not been transplanted into another bed at least two months before final planting are not worth purchasing. The purchaser should see that the bandage is removed from the stock, which must be free from constrictions and that the stocks of the plants should have a fresh green bark ; blackish or dark coloured bark indicates old and stunted plants.

CHAPTER V.

PLANTING OF TREES AND INTER-CROPS.

After choosing a suitable site for orange trees the ground should be prepared for them in their permanent place. It is desirable to have the whole plot level as far as possible, but a fall of three inches in a hundred feet may be allowed for the running of irrigation water. If the land is too rolling, it would be a mistake to level the land in one piece, for in that case good surface soil from the higher parts would be removed and the lower unweathered soil would be exposed in which trees will not thrive. In such cases it is desirable to have terraces at suitable distances. The whole ground must be ploughed several times and all deep rooted weeds such as *lavala*, *harili* and *kundu* must be carefully removed. It is desirable to sow sann-hemp seed in June and plough it in after six weeks, at flowering time, for green manuring. The soil must in any case be thoroughly worked and mellow free from all sorts of weeds before the trees are put in. In the hot season, holes three feet each way should be dug for planting trees.

The distance at which the trees are planted varies with the nature of the soil and climatic conditions. In the Poona District, *Santra* trees should be planted at fifteen feet apart. In Khandesh District, eighteen feet distance is preferred. With *Mosambi* trees the distance should be eighteen feet. Pomeles are planted at twenty feet apart. *Kagdi Limbu* trees should be fifteen feet from one another. In an inferior soil the distance may be less but in good and fertile soils the distance should not be less than that indicated above. The hole should be filled with river soil, if available, otherwise with good garden soil, and 100 lbs. farm yard manure per hole. It is desirable to add some bone meal to each tree, say 5 lbs., and if bone meal is not available simple raw bones crushed in a *chunam* mill may be used. Trees are generally planted at the commencement of the rains, or, if the rains are heavy, as in the Koukan, they may be planted at the end of August. When planting, the bud should face the side from which the wind blows; this makes the tree even on all sides. *Santra* and *Mosumbi* plants should not be mixed up in the same plot.

After the planting of the trees the intervening space should be utilised for some sub-crop which will meet running expenses. In choosing a sub-crop in an orange plantation, one should see that its requirements conform to those of the main crop. This is often neglected and the main crop suffers. In Khandesh, for instance, the *basrai* variety of banana is frequently planted in an orange garden. This variety, although it lasts for eighteen months only, does permanent harm to the orange trees, for the banana trees are planted at five feet apart, they are very dwarf (5 feet), they produce a large number of suckers and they require heavy irrigations. Orange trees, therefore, do not get sufficient light and receive too much water. This sort of association of two crops is very detrimental to the main crop, giving no advantage to the other. In some places lucerne is grown as an inter crop between orange trees. It is a dwarf crop, no doubt, but receives constant irrigation for about three years which very adversely affects the orange trees. The papaya is an unsuitable crop among orange trees as it is too shady. The inter crop for an orange garden should, therefore, be a low one, requiring as little water as possible. It should last not more than six months at the most. Such crops are vegetables of all sorts, chillies, onions, garlic, rozelle, or cape gooseberry. In some parts of Khandesh, the *neglectum*-

roseum variety of cotton is sometimes grown, doing apparently no harm to the tree. So also *jowar* and *bajri* are grown in severe famine years, when they may be allowed. Whatever crop is taken it should in no way cast its shade on the orange trees. It must be grown a little away, say 2 feet, from the tree. This ensures adequate space for the plant to grow. No inter-crop should be taken for more than four years at the most, preferably for three years only. If the ground shows a tendency to be sticky or weedy it is better to grow sann-hemp in the rainy season and plough it in the ground. By adding such bulky manure the soil is made porous; the sann-hemp will open up the lower portions of the soil and will add to its fertility. It would also be advantageous to add two to three baskets of farm yard manure per tree at the commencement of the rains.

From the time of planting, each tree must be carefully examined from time to time and if any shoots bearing thorns start from the stock they must be immediately removed. Occasionally a vigorous branch from the scion may bear thorns; such a branch need not be removed, for, as the branch grows it will not produce any more thorns; such a thorny branch must not be mistaken for a shoot from the stock. Leaves from the *Jamburi* stock emit a strong acid scent on crushing, while orange leaves have a sweetish and pleasant smell. One can with a little experience readily distinguish the leaves both from their look and scent. Again it is also desirable to train the plants in their early stage by pruning for two years some of the crowded short branches so as to open the centre; the remaining branches make a vigorous growth and come to bearing age at an early period. Pruning is practised in Khandesh where the plants show a decided advantage over unpruned plants in shape, size and in bearing. In Poona and other places plants are rarely pruned and as a result they bear a considerable mass of small stunted and crowded branches, which struggle among themselves for light and air. It is also necessary to see that every dead part is pruned clean from the tree at least once a year.

CHAPTER VI.

TREATMENT OF TREES FOR CROP.

If the trees are treated as explained in the foregoing chapter and if the soil is of the right kind they come to bearing age when they have completed their fourth year in their permanent home. They often flower without any special treatment. This is particularly so in East Khandesh, but as a rule orange trees do require some kind of treatment. Citrus trees, if they are continuously irrigated throughout the year simply produce a mass of leaves and no flowers. Orange trees apparently look like evergreen trees, but strictly speaking they are deciduous, and it is only in this condition that they bear flowers. For this reason, the tree has to be induced to drop its leaves and this can be done within certain limits according to the wishes and convenience of the owner, for, orange trees can flower in February or June or in October. These flowering times have three different names, namely, *amhe-bahar* or February flowering, which corresponds with the flowering of the mango; *mrig-bahar* or June flowering and *hatti-bahar* or October flowering. Orange trees should be induced to flower only once in a year and not twice or thrice, for, in that case the crop standing on the tree will suffer and the trees will be exhausted. One of the two first flowerings is usually chosen, as the trees require the cutting off of water and resting before each flowering and this is not so easy to secure for the *hatti-bahar*, as the rains continue to fall till the middle of October.

Now to take *umbe-bahar*, for the first time, water should be withheld from the trees during the second half of December, and first half of January. In ordinary cases one month's resting is usually sufficient, at least no more resting need usually be given to young trees for the first time; although in retentive soils six weeks' rest may be necessary. During the time when two watering turns are missed the whole garden should be carefully ploughed with a two bullock plough. If that is not possible the whole garden should be hand dug; at least the ground near the trees will have to be dug up. Withholding of water and ploughing between the trees will ripen off a considerable number of leaves which will then drop down. During the fourth week it is the usual practice to expose the roots of trees up to two feet all round the stem to a depth of four inches, in which condition they may be kept for about four days. Young fibrous and wiry roots which may be growing on the exposed roots or near the stem may be safely pruned but in no case large roots, which are the main stay of the tree, should be touched or injured. Pruning of the roots apparently increases the check on the water absorption without materially damaging the tree. Experiments are still necessary to determine how far this root pruning is desirable. While the tree is in a resting condition all the dead and weakly branches should be carefully pruned. Each tree should be treated with a mixture of manure of cowdung, ash and old village refuse, about three baskets per tree. This manure should be spread over the whole bed of the tree and mixed with soil. It should not be heaped up around the stem.

Beds and water channels should now be made and the trees irrigated by January 15. The first irrigation should be scanty, just sufficient to moisten the upper surface of the soil. This stimulates the formation of flowers. Copious watering at the first irrigation tends to produce leafy shoots. The second watering should be given three days after the first

watering. This is followed by a third watering five days after. After that irrigation should be given in the usual manner according to the needs of the plant. Flowers generally appear one month after the first watering and fruits ripen ten months after that.

In the case of trees that have already commenced to bear the *ambe-bahar* the usual water supply should be gradually lessened when half the crop is gathered, so that, by the time the last fruit is harvested the surface soil is fairly dry. The necessary resting period varies with the nature of the soil. In very well drained soils this period is very short and flowers appear almost immediately after the first watering. In the ordinary orange gardens of the Poona District four weeks resting is sufficient; and in retentive soils six weeks resting is necessary. In places which are surrounded by sugarcane fields from which the orange trees receive constant percolation, flowering is hardly possible or if it does occur at all, it is meagre and most irregular. Similarly, trees growing on an extensive plain with deep black clay soils do not produce flowers at regular intervals. Such plantations are rarely, if ever, paying. Suggestions for treatment of plantations of the latter type will be found in the next chapter.

Climatic conditions also seem to have some effect on the condition of the plants with respect to their resting season. Dry and hot conditions, such as those of Khandesh, remove soil moisture very quickly. Transpiration from the leaves is also very rapid. Trees in such a condition, therefore, quickly respond to resting operations and three weeks' rest is generally sufficient. At Wawoshi in the Pen Taluka of the Kolaba District, the atmosphere is very moist, the crop is harvested and finished by the end of March and from that time to the commencement of rains the trees are given no water at all. The soil is poor and trees have during the fruiting season to be irrigated at an interval of six days, lest the fruits drop. In spite of the long resting period of two months the trees remain in good healthy condition and flower well in the rainy season.

The water table in the sub-soil also has an indirect effect on the resting period. When the well water is very low, it is lifted up at a considerable expense and it is natural, therefore that no more water is given than what is actually necessary for the welfare of the plants. The trees, therefore, show the drying effect very quickly; but such is not the case with the trees which receive a liberal supply of water as, for instance, in gardens commanded by canals or wells with a high water table as in some places of Junnar Taluka of the Poona District.

For the *mrig-bahar* it is usual to withhold water during all April and the first week of May. The exposing and pruning of roots are done exactly in the same manner as explained above in the case of the *ambe-bahar*. The first watering is given in the second week of May and flowers appear in the second week of June; the crop is harvested in March. In some places where the water level goes very low in the wells or where the water supply altogether fails in the hot season, the resting period is either prolonged or shifted to May. In some parts of Khandesh resting is given in May and the trees flower in July; at Wawoshi in the Pen Taluka the trees are rested for two months (April and May).

For the *hatti-bahar* it is impossible to rest the trees in the months of August and September, as there is rain during this period. This crop therefore is not taken as a rule by the cultivator except when the rainfall is very scanty or when the *mrig-bahar* is missed.

It often happens that in spite of the regular treatment given to the plants they often produce flowers at odd times. Trees are often met with in a plantation where fruits are noticed in all the stages from flower to almost a ripe fruit. Again, from several causes a *bahar* may be altogether missed, even though the trees have received regular treatment. An abnormally heavy crop in one year is often followed by poor crop or no crop and this is accounted for by the exhaustion of the trees. The only possible remedy against this trouble is to give a liberal dose of manure especially potash and phosphatic manures when a heavy crop appears on the tree. This helps the trees to reconp its material for the next year while it is still developing its fruits. Another cause of the failure of a crop is that the resting operation is not commenced at the right time or it is sometimes unusually prolonged and this is particularly the case with the *ambe-bahar*, which is often missed. The resting period is sometimes cut short by unusual rains when the tree suddenly starts all-round vegetative growth before the buds have sufficiently matured. When the trees fail to produce a crop of flowers, say, of the *ambe-bahar*, it is necessary to treat them for the next *mrig-bahar*. With proper treatment, trees do flower at the time of the succeeding *bahar* and thus the bearing season is postponed for six months. Some cultivators, however, prefer for various reasons to take a *bahar* at a particular season and are prepared to forego almost a full year's crop.

Now which of the two *bahars* is the best to take is decided by certain factors, the most important of which are water, insect pests and market. We have seen above that the fruits of the *ambe-bahar* develop during the months of February to November and when once the fruit is set on the tree regular irrigation throughout the dry season is essential. In the months of April and May the water level in the wells goes very low; to irrigate the gardens from such wells is a very expensive business. Now if the *mrig-bahar* is taken the crop develops from the months of July to March of which the first three months are of the rainy season. When the water level goes low (April and May) the trees need no water; it is natural therefore that in regions where water supply is scanty the *mrig-bahar* is the favourite with the cultivator and where it is abundant, for instance, in the Poona District the *ambe-bahar* should be preferred. In Khandesh people always go in for the *mrig-bahar* and in Poona the gardens are generally treated for the *ambe-bahar*. At Wawoshi in the Kolaba District the well in the orange garden has practically no water in the months of April and May. It is therefore natural that the grower should take nothing but the *mrig-bahar*. From the last picking of the fruit he waits till the advent of the rains. His trees flower when rain is pouring in heavy showers and the fruit sets all right. The *ambe-bahar* in this case is an impossibility.

Near Poona the cultivator has to take into consideration the fact that in Khandesh and the Central Provinces orange trees are more prolific than those of Poona. He therefore so times his operations that his crop can be placed on the market when his competitors have less fruit to offer.

The second factor is the presence of insect pests, such as the moth *Ophideres*. These moths are very bad during the rainy season, July, August and September; they puncture well developed fruits at night time and thus cause a considerable loss of fruits of the *ambe-bahar*. Fruits of the *mrig-bahar* are just developing during this period and the moths do little harm to them. Thus the orange grower who places his crop on the market in March practically suffers no loss from the troublesome moths.

Local practice has much to do with the choice of the *bahars*. Orange cultivators of a tract become accustomed by long practice to perform their operations at certain times; they do everything almost automatically. To shift the operations to different seasons is a difficult job to them. To adapt oneself to changed conditions at a moment's notice requires considerable education and training. The cultivator in Poona District does not as a rule like the *mrig-bahar* and similarly the orange grower of Khandesh does not like the *ambe-bahar*. He is generally unwilling to purchase young orange plants from Poona as they are accustomed to bear the *ambe-bahar*; he procures his plants from Nagpur even at a higher cost where trees usually bear the *mrig-bahar*.

As regards other kinds of citrus trees, *ladoo*, *kawā*, &c., they are treated exactly in the same manner as *santra* plants. *Sakharlimbu* and *mihalung* plants bear some crop without any special treatment; but they too have the usual bearing seasons and respond to the same treatment as that given to *santra* and *mosambi* trees. The *kagdi-limbu* trees as a rule do not require special rest; they generally flower in the months of February and ripen their fruit in July and August. Occasionally they produce flowers in the month of October in addition to flowers which appear at any time of the year. The trees are manured with town sweepings without exposing the roots. But cases do occur where trees do not produce the normal crop of flowers, or where the fruit does not develop to its normal size and drops prematurely. This is generally associated with defecting the soil or over-irrigation. Scab both on the fruit and branches is also a fruitful source of this trouble. It is better to treat such plantations by cutting off water for one month and root exposure followed by manuring with town sweepings. If the trees are infested with scab they should be pruned of their diseased branches and should be immediately sprayed with Bordeaux mixture [see Bulletin No. 71 (1915) of the Bombay Agricultural Department]. The spraying will give tone to the trees. If aphid is very bad the trees should be sprayed with Incosopol* (1 lb. of Incosopol to be mixed with 8 gallons of water).

Pomelo trees when they are planted in a regular garden must be treated in December with old sheep manure about three baskets (60 lbs.) to each tree. The trees do not require a severe rest or root exposure. About two weeks' rest at Christmas time will quite suffice. Flowers generally appear in January and fruits ripen in November and December.

CHAPTER VII, A FEW SUGGESTIONS,

Occasionally one meets with orange gardens which present peculiar difficulties and must be treated according to the nature of the individual case. A *Santra* plantation in Junnar Taluka, for instance, showed signs of the yellowing of leaves and dying of branches of groups of trees here and there. The fruits of the trees remained small, prematurely turned yellow and dropped. Analysis of the soil showed large amounts of salts (see soil analyses given at the end). The well water which was used to irrigate the plantation was not salty. In the soil around the sickly trees succulent weeds such as are usually found on salty soils were noticed. This was a clear case of accumulation of salt in the soil. Owing to defective drainage in the soil an extra amount of salt was brought to the surface after every irrigation. Water evaporated from the surface leaving salts behind. Now to correct the defect in the soil, resort must be had to through drainage. To effect this trenches must be dug out round about the diseased trees at short intervals say at fifteen to twenty feet. Each trench must be three feet deep and eighteen inches wide. The trenches from the diseased trees should be connected to one common trench finally leading to the nearest stream or *nala*. (One has to see that irrigation or rain water will actually flow from the plot to the *nala*. If water remains stagnant in the trenches it will possibly make the case worse. Heavy rains in the monsoons are likely to wash away soils from the sides of the trenches. This can be prevented by putting brush-wood in the trenches at short intervals. The difficulty of irrigating the trees may be overcome by using small pipes or pieces of corrugated iron sheets through which water can be carried over the trenches. By this method the land can be improved in the course of about two years.

It occasionally happens that trees are planted in a very clayey soil; the subsoil, which is in ordinary cases lighter, more penetrable and more drainable, proves to be equally clayey. The trees grow all right for a few years and give a very good outturn. But soon after they begin to decline in their vigour, young twigs begin to turn yellow and die; the plants make a feeble attempt to form new shoots lower down but these never make any progress and finally the trees die a slow death. In this case also trenches made in the manner described above will improve the case.

When the soil is not so bad as described above nor is it as good as it should be, the plantation may be treated in a little different manner. Instead of making water channels in the usual manner, long furrows may be made between two rows of trees. At every watering turn alternate lines may be used and the remaining ones may be cultivated with a harrow. At the second watering the dry part may be irrigated and the wet part of the previous turn cultivated. In this way the soil will receive less water the dry part will act as a lung and the disadvantages of the clayey soil will be greatly minimised. The soil will be further improved if a green manure like sann-hemp is ploughed into the soil in the rainy season.

It is a common phenomenon that *Santra* fruits in certain places do not develop an attractive colour nor does the fruit develop to its normal size. Again the fruits of the *mrig-bahar* (ripening in February-March) in certain localities are scorched on the side exposed to the sun. The cause of this is generally to be found in soil conditions, especially imperfect drainage and aeration. Attention should be given to these points.

As regards the use of special manures for orange trees little attention has been paid so far; the following manures are recommended:—

20 lbs. farm yard manure	} per tree after one year,
10 " wood ashes	
5 " bone meal	

This manure may be increased by—

10 lbs. farm yard manure	} per tree per year for 8 years
2 " ash	
1 " bone meal.	

when it may be kept at that rate. This manure may best be given at the beginning of the rains if not heavy or in August if they are heavy. It should be mixed with soil and spread over the bed.

In famine years such as that of the year 1918-19 it is very difficult to keep the trees living. Water in the wells is very low and insufficient, and bullocks become too emaciated to lift it up. The best way to save the trees would be to irrigate the bearing trees first at ten to twelve days interval and then to irrigate the remaining ones which carry no fruit if the well allows it. In extreme cases if the trees could be irrigated by the end of February they at least could be saved. After the last watering the whole ground should be lightly harrowed once in a fortnight removing all weeds. In the second week of June the trees if they have gone very bad should be pruned with a saw leaving stumps of about three feet in height. In the rains just following this operation the stumps will sprout very profusely if the rains are favourable the new shoots may produce a few flowers but the trees will be benefited if these are removed as they appear. In the following year the trees may be allowed to develop a few fruits. Soon after pruning the stock produces suckers from below which must be carefully rubbed off to encourage shoots from the scion. In the first season after pruning any suitable intercrops may be taken between the trees.

One often meets with orange gardens which are nicely laid out in the beginning but come to be neglected through several causes. Advice is often sought as to the best method of renovating such old and neglected gardens. When dealing with such cases one has to see that the whole garden is first ploughed properly. The trees should then be pruned of all their dead shoots and dying branches, removing at the same time all diseased portions of the trees. The trees should be thoroughly examined for borers and grubs which if found should be destroyed. Perhaps it may be necessary to spray the trees with some insecticide or fungicide which may act as a deterrent such as incosopol or Bordeaux mixture. The worst trees may perhaps die under this treatment. The trees should be treated with a liberal dose of farm yard manure. They will on the whole certainly show improvement by producing fresh and healthy shoots.

Kagdi Limbu trees are hardy and as a rule yield a fair crop without any special care. This fact generally accounts for the neglected appearance of gardens. The trees of about ten years old are very often seen loaded with a considerable quantity of dead material. In all cases such trees should be pruned every year of their dead branches when the crop is harvested in September or at any time convenient to the owner. But this work must not be neglected on any account. Timely attention to the hygienic conditions of the garden always repays its costs many times over. The garden is rarely infested with diseases. It yields a better and increased crop and its life is considerably increased.

CHAPTER VIII.

DISEASES OF CITRUS TREES.

Aphides.—The Green Fly (*muva* in Marathi). All kinds of Citrus plants are liable to the severe attack of this pest. Young branches as they develop are often infested with colonies of tiny black or yellow insects. Such plants as a rule have an unhealthy appearance and the lower leaves are covered with a sticky secretion. At first the insects are wingless and have two short tubes projecting from the abdomen. Later on winged individuals appear. These little insects do a considerable damage to citrus plants by sucking juice from young branches and leaves; "they also excrete a sweet liquid which falling on the leaves below makes them sticky and shiny and gives a footing to a black fungus; this appearance on the plant is generally familiar in India. Ants and other insects are fond of this liquid and come to the plants to obtain it. Ants obtain it direct from the plant lice and it is well known that some ants use plant lice as we do cows, not only 'milking' them but preparing shelters for them and caring for them" (Lefroy: Indian Insect Pests, page 138).

The aphides are generally worse in the cold season, particularly in the months of October to February. They have a natural enemy which keeps them in check, namely, the lady-bird-beetle which is a small rounded beetle about the size of a split pea, coloured in red and yellow with black spots. The grub and beetle feed very actively upon aphides. The best remedy is to spray the plants particularly young parts with Incosopol, a product manufactured from cotton seed by the Indian Cotton Seed Oil Company of Navasari, District Surat. This substance is mixed with cold water in the proportion of 1 lb. to 8 gallons of water. The disease will be checked with two sprayings given at the right time; otherwise more sprayings at an interval of one week will be necessary.

Aphides can also be checked by spraying tobacco solution. "Soak 2 lbs. of tobacco in 2 gallons of water for 24 hours or boil for half an hour. Dissolve $\frac{1}{2}$ lb. bar soap or 1 point of soft soap in the mixture. This is the stock solution. Dilute with 7 parts of cold water."

The Lemon caterpillar (Papilio demoleus).—All kinds of Citrus trees and particularly *Kagdi Limbu* are defoliated by curiously marked caterpillars which feed openly upon the leaves of the plant. These caterpillars hatch from small round yellow eggs laid a few at a time upon the topmost shoots of the plants where the young caterpillars will find tender leaves upon which to feed. They are at first brown with white markings closely resembling the droppings of birds, and doubtless feed on the leaf in an exposed position to assist the resemblance. When nearly full grown the colour changes to a vivid green, with lateral brown markings and the caterpillars now leave their exposed position on the leaf. When young they feed on the quite small leaves, attacking larger leaves as they grow older. As a rule only a few are found on each plant but they do much mischief to small plants and, if abundant, entirely strip them. The caterpillar pupates on the plant, fixing itself by the tail and by a thread round the body which is fastened on each side to the plant. The butterfly is large and conspicuous, common throughout the plains. It lays its eggs also on the *Ber (Zisypus jujuba)* and other wild plants.

There are several broods in the year the first in April, the second in June, the last in November, but there is also a brood in December in places where the cold is not too great. The simplest method of dealing with this pest is to pick off the caterpillars and destroy them. The application of lead arsenate is effectual, but as there is usually a succession of egg laying females, one application is not sufficient, and it is simpler to pick them by hand.

A boring insect is sometimes found penetrating the trunk of trees especially in old and neglected gardens. This is not yet identified. It can be killed by a stiff iron wire in its hole and the hole then filled with wax.

White ants are sometimes very troublesome. In such cases the nest must be searched for and dug out and the queen ant killed.

The most important pest on orange fruits is the moth (*Ophideres*) which does considerable damage to fruits at night time. The fruit when almost ripe is punctured and its juice is sucked up by the moth. The fruit then falls to the ground. There are several species of this of which *Ophideres fullonica* is the commonest one. "It pierces the rind of the fruit with its powerful proboscis in order to extract the sap. The insect is a handsome one, the upper wings coloured in tone of gray to resemble tree bark, the lower bright orange and black. By day this insect hides on bark of trees with the wings folded, coming out at dusk to fly about. It is attracted to fruit, feeding on the juices."

Another moth which also does considerable damage to orange fruits at night time is *Nyctipao hieroglyphica*. "This is a large deep coloured moth up to five inches in wing expanse. The large ocellus-like markings on the forewing are very striking."

The larvæ of these insects have not been found, nor are their food plants known. It is, therefore, difficult to control these two pests except by catching them with a hand net at night. The insect is not very active; it does not therefore require considerable skill in catching them with a net and lantern.

Arbela tetraonis is found in old and neglected gardens and also feeding on the bark of a great many fruit trees, such as guava, mango, orange. The larva may be known by the peculiar patches of excrement and silk found on the bark of trees near the bore of the caterpillar which comes out at night, feeds on the bark and makes this peculiar covering on the part it eats.

The larval galleries and freshly eaten bark around them are evidence of the presence of the caterpillar which is readily destroyed by syringing into its burrow a mixture of two parts of chloroform and one part creosote.

The pest can also be controlled by the following method. First remove all excreta and webby material from the trunks of affected trees and spray the trunks thoroughly with Paris Green (proportion 1 lb. Paris Green, 1 lb. soft soap and 8 gallons water). Two sprayings in a week will completely check the pest.

Aspidiotus aurantii is a scale insect that produces scale like spots on the fruit. The remedy for this is spraying with rosin wash prepared by boiling 2 lbs. of rosin and 1 lb. of washing soda together in water till dissolved and mixing with water up to 8 gallons.

Aleurodes eugeniae var. *aurantii* is a small scale insect which attaches itself to leaves. It has the appearance of small black scale with a white border. Remedy: rosin wash as described above. These two pests are very minor ones in the Bombay Presidency.

So far we have been troubled with no serious fungus diseases of Citrus in the Bombay Presidency. There are however two diseases to which attention is drawn here. Scab is common on many kinds of Citrus fruits especially *santra*, *mosambi* and *kagdi limbu*. Young branches of *kagdi limbu* are also spotted with scab. The origin and exact nature of scab is not properly understood. Some fungi are usually associated with scab, but they are by no means proved to be the primary cause of the disease. Some kinds of bacteria are also found with scab.

Another obscure disease is a browning of the *mosambi* fruit called *tambora*. The cause of this disease is not known, but it appears that it is generally found in gardens which are perpetually moist as in sugarcane tracts.

At Wawoshi in the Kolaba District, orange trees were affected with a disease in which the branches died one after another. The cause of the disease is not definitely understood, but cultures from the affected branches showed several fungi of which *Nectria*, *Diplodia* and *Fusarium* were prominent. It is not clear if any of these fungi is the real cause of the disease, for inoculation experiments of these fungi did not produce the disease. Fortunately this disease is confined to only one garden in the Bombay Presidency; it appears in the rainy season and it is kept well under control by pruning and burning the affected branches and by thoroughly spraying the trees with Bordeaux mixture.

Fusarium limonis sometimes attacks plants at the collar. The usual remedy recommended is to cut out diseased parts and paint with 50 per cent. carbolic acid.

APPENDIX.

Analyses of Soils.

Name of place from which soil was analysed.	Surface and Sand.	Limo.	Nitrogen.	Potash.	Phosphoric acid.	Organic matter.	Stones.	Magnesia.	Salts.	Remarks.
Wawoshi, District Kolaba	Surface soil	60.14	0.081	0.31	0.16	0.85				Santra garden.
	Sub-soil	60.92	0.081	0.85	0.23	2.22				
Ganeshkhind Botanical Garden, Kirkee, plot No. 6.	Surface soil	49.00	0.051	0.97	0.13	1.57	2.60			
	Sub-soil	50.00	0.071	0.85	0.11	1.54	5.00			
Ganeshkhind Botanical Garden, plot No. 15.	Surface soil	49.36	0.078	0.61	0.17	1.83	NIL			
	Sub-soil	46.38	0.061	0.41	0.10	2.28	12.50			
Mr. Vaidya's Garden at Nirguda, Junnar.	Surface soil	54.84	0.070	0.39	0.11	1.38	2.00			Santra garden not yielding good fruit.
Mosambi Garden at Arvi, Junnar.	Surface soil	56.58	0.081	0.47	0.22	1.43	3.40			
Marwadi's Garden at Arvi, Junnar	Surface soil	55.24	0.073	0.78	0.16	1.20	NIL			Mosambi garden.
Ramchand Mainkhand's Garden at Baranati.	Surface soil	51.90	0.045	0.39	0.16	0.99	12.90			
A garden at Baranati	Sub-soil	49.38	0.054	0.27	0.13	1.53	14.40			A diseased garden of Santra trees.
	Surface soil	47.66	0.043	0.50	0.08	2.26	8.2	1.45	0.34	
Dongre's garden at Arvi, Junnar	Sub-soil	46.60	0.042	0.58	0.08	2.37	10.40	1.77	0.52	Santra trees were fairly good.
	Surface soil	6.09				2.16		0.25	0.11	
Dongre's garden at Arvi, Junnar	Sub-soil	5.86				1.07		0.32	0.09	
	Surface soil	5.00				1.58				
Dongre's garden at Arvi, Junnar	Sub-soil	4.45				1.01				
	Surface soil									

Analyses of Waters unfit for Citrus trees.

[Parts per 100,000.]

	Wells at Sabarmati in Gujarat.					A well at Akalkot.
	Water Samples.			Nos.		
	523	522	523	362A	362B	
Total salts contained ...	80.00	224.00	184.00	464.00	360.00	280.00
Calcium carbonate ...	12.00	22.80	10.00	8.00	20.00	28.42
Magnesium carbonate ...	6.09	12.17	15.22	36.53	51.59	
Magnesium sulphate ...					9.15	
Sodium carbonate ...		6.24	6.24	10.40	12.48	
Sodium bicarbonate ...	19.55	11.63	16.05	23.50		
Sodium sulphate ...	4.88	19.52	21.96	51.24	20.74	
Sodium chloride ...	32.34	136.29	99.33	302.94	231.00	
Calcium sulphate ...						74.5
Calcium chloride ...						30.36
Magnesium chloride ...						45.72

Water No. 523 is good but all others are unfit for irrigation.

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