PRUNING COFFEE TREES*

BEFORE describing the system of pruning which has been practised for three years running on the coffee plots at the Experimental Station of this Centre (a system which has given very satisfactory results, and which we therefore wish were understood and practised in this country), it is convenient, for the sake of clarity, to give a few lines to describing the development of the coffee tree and to consider the principles which are to be followed in the practice of pruning.

The coffee tree may be considered as consisting of two parts; a subterranean one which bears the organs of absorption known as roots, and a second, bearing those organs whose main function is the manufacture of the food supplies of the plant, which is called the stem.

Pruning is practised on the stem, and we are therefore concerned with its development.

The stem of the coffee tree grows vertically, becoming thinner and thinner until it terminates in a bud which is found at the junction of two opposite leaves and is protected by two membranous structures called stipules, which are formed at the base of the leaf stalks. The stipules protect the bud by means of their covering of waxy substance. The development of the terminal bud results in the indefinite prolongation of the stem, unless it is for any reason arrested.

As the bud develops, the stipules separate, and two small leaves appear, of a yellow-bronze colour, which later become green. These two small leaves are attached to a node of the shoot. The internode below this point increases in length and this lengthening is continued above the leaves.

Accompanying the terminal bud and covered by the same pair of stipules are two lateral buds, which give rise to the primary branches, commonly known as *bandolas*. The primary always grows from the angle of a leaf with the main stem, and its growth depends on the development of the terminal bud. In its earliest stage of development, the primary makes an angle of some 15° to 20° with the main stem, but, as it grows, the angle becomes wider and wider, until it lies in a nearly horizontal position. The first lateral buds, those which are formed in the axils of perhaps the first five pairs of leaves of the young coffee plant, do not develop unless the terminal bud has been destroyed below the fifth node, in which case they always take a vertical position and function as secondary shoots which will later produce secondary branches. Since in this case the shoots have sprung from the axils of the

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leaves, they form at the point of junction an acute angle, which makes them easily distinguishable from secondary shoots formed by the development of adventitious buds.

The primary branch has at its tip a terminal bud, together with two tiny lateral buds which may or may not develop.

The terminal bud is the one which increases the length of the branch ; but if for any reason this bud is destroyed, then the lateral buds come into play, forming secondary branches or *palmillas*, which, in their turn, should the terminal bud be destroyed, may form tertiary branches.

The ramification of the primary branch may occur without the elimination of the terminal bud if the plant encounters particularly favourable conditions for its vegetative growth. In some cases it has been observed that adverse conditions may produce the same effect.

If the terminal bud of the main stem be destroyed at about the fifth node, above a pair of already formed primary branches or if for any other reason the flow of sap in the upward direction is interrupted, secondary shoots appear, growing from adventitious buds which are formed below the junction of the secondary branches with the stem. These new shoots are generally formed in pairs at the last node of the stem. If the last two primary branches are cut away, these shoots develop rapidly, otherwise the sap goes on nourishing the primary branches and consequently the appearance of the shoots is retarded.

Under certain circumstances—for instance, after a heavy crop—if circumstances have not been sufficiently favourable to allow of the development of new wood at the same time as the production of fruit, the main stem, as well as the secondaries if there are such, will become covered for nearly the whole of their length with adventitious shoots or *hijos* (literally " sons ") one, two, or more at each node. The same phenomenon is seen when the shoots are bent, whether accidentally or by the weight of the fruit, in which case the adventitious shoots are formed only on one side of the shoot.

The primary branches of the coffee tree are arranged in a phyllotaxic order of three-six; that is to say that if, starting at the junction of one of the branches, a line be drawn parallel to the main stem until the junction of another branch be reached, there will be five intermediary branches in a spiral around the stem.

The branches serve to support the leaves, which in the coffee tree are borne in pairs above the nodes and in two different planes, perpendicular to one another. This peculiarity can only be seen by observing the arrangement of the new leaves at the tip of the branch, because as this develops it undergoes a twisting movement which brings all the leaves into the same plane, so that they shall have equal access to the sunlight. Careful observation of the herbaceous part of the branch reveals a longitudinal spiral groove which indicates the twisting which the branch has undergone in the course of its development.

When the coffee tree is subjected to changes of temperature and of precipitation, growth of the branches is not uniform but corresponds to changes in conditions. At the beginning of spring the plant enters upon intense vegetative activity, which is shown in the rapid prolongation of the branch, continuing until the exigencies of nourishment for the fruit divert, to a certain extent, the flow of the sap. The ripening of the fruit, followed on the Pacific side of the country by a pronounced drought and by a fall in temperature, causes an almost complete suspension of vegetative activity, which is seen in the small number of leaves, small also in size, produced during this period. As the branch lengthens, increasing the distance of the terminal bud from the main axis, the zone which represents the period of vegetative activity is correspondingly smaller.

It may be said that the increase in length of the branch during this season of activity will always be approximately half the growth of the previous year ; that is to say, if the branch has grown 50 centimetres in its first year of development, in the second it will reach a total length of 75 centimetres, and in the third barely 87·5. As the fruit of the coffee is only produced along the wood of the previous year, this relationship between the age and the length of the zone of production of the branch must be carefully considered in the practice of pruning.

When the principal axis of the coffee tree develops freely, the tendency is for the sap to nourish chiefly the main bud and the new branches, so that the lower primary branches gradually weaken, and die after two or three crops. The loss of these primaries means a reduction in the productive capacity of the plant ; if, however, the natural course of the sap, which is in an upward direction, be altered, they are provided with better nutrition, and the production of new wood in these branches is greater than that of branches further away from the root system of the plant. In this case the primary thickens considerably, sometimes reaching a diameter of 5 centimetres, and at the same time shows great ramification, forming secondary and tertiary branches, which together form a structure which our farmers call a " crinoline".

PRUNING

The object of the art of pruning is to modify the natural manner of development of a plant so as to obtain a greater abundance of fruit, more regularly, and of better quality, than when it is allowed to develop freely. Pruning modifies both the form and the function of the plant.

The practice of pruning has five main objects, *viz.*—

(1) The production of vigorous trees, strong, healthy, and capable of producing a good crop over a period of several years.

(2) Making the trees a convenient shape for the economic management of the plantation.

(3) Uniform distribution of fruiting.

(4) The production of fruit of good size and quality.

In the coffee tree these objects are pursued by the employment of five different methods of pruning, each with its own special aim. Each of these systems may be conveniently treated according to its necessity for the development of the tree.

PRUNING BY FORMATION

Pruning by formation is practised on the main axis of the plant with the object of producing secondary and tertiary shoots. This operation must be begun when the plant is in the nursery and before it has formed its first primary branches.

The axis is pruned above the third or fourth pair of leaves, in order that the first secondary shoots shall develop, through the activity of the rudimentary buds which are found in the axils of the leaf. These shoots, on account of the position of the buds from which they sprang, will grow forming an acute angle. In order to separate them at the bottom, and to give a better shape to the plant, a small stake or piece of bamboo, about five to ten centimetres long, is inserted between the two young stems, perpendicularly to them. This is done immediately the young shoots have attained sufficient firmness to hold the stick. When the secondary stems have developed more than five nodes, they are again topped above the fifth node, to increase the activity of the adventitious buds and the formation of tertiary shoots. The growth of these last is more rapid if at the time of pruning the primary branches corresponding to the fifth node are also cut away. The desired symmetry in the shape of the tree depends on the formation only of the tertiary stems on each secondary, so that one should eliminate any other stem springing from an abnormal position, as sometimes occurs. At this stage of its development, the plant will have four tertiary stems, and as pruning by substitution will be performed on all of them, we have called them " shoots for substitution pruning".

The tertiaries, like the secondaries, are pruned above the fifth node, giving rise to eight quarternary stems or fruiting shoots. It is desirable that these shoots should grow as slowly as possible, in order that the whole skeleton of the plant below them shall become strong and develop vigorously. This is achieved by not cutting the primaries which correspond to the node above which the tree has been capped. The fruiting shoots, whose life, because of pruning by substitution, will not be more than two years, will be pruned as necessary above the fifth node.

PRUNING BY RESTORATION

This system of pruning is practised on primaries which have borne fruit for two successive years. The practice in Costa Rica is to remove these branches completely as soon as they are no longer capable of bearing fruit, and the result is the formation of haphazard branches of every sort, very thick and rising to a considerable height. The tendency of our system is nevertheless to maintain the zone of fruiting of the plant as near as possible to the

roots, for the reason that, the further away from the roots the fruiting branches are, the longer will the primary grow during an active season, and consequently the smaller will be the crop which the branch can produce. The system of pruning by restoration is applied therefore to all the primaries above a height of about fifty centimetres from the ground ; that is, the branches are cut, when they show signs of weakening after bearing fruit for two years running, at the first and second node from their junction with the stem. Unless the primary has for some reason or other lost its vitality, this pruning produces the development of secondaries, usually one, sometimes two or more, which, during a season of activity, will lengthen almost as much as a primary, and produce a very heavy crop the following year. When this new branch has borne one large or two small crops, it will be restored by the same system, that is to say, it will be cut above the first node from its junction with the primary. It is not always desirable to apply pruning by restoration to all the primaries, as, if these are very numerous one runs the risk of producing very dense foliage, which may make for an unhealthy state.

After three or four years from the commencement of pruning by restoration on a plant, its branches will have become considerably thicker and capable of producing and carrying heavy crops. Since the primaries of a plant do not all appear at the same time, but in succession from below upwards, when the first primaries are restored the second are bearing fruit and the third are preparing for the following crop ; at any given time the tree will be in a good condition of productivity.

PRUNING BY SUBSTITUTION

The skeleton of the tree having been already formed by the method described in the section on pruning by formation, if the tree is left to continue its development freely, the eight quarternary shoots will lengthen indefinitely, each year increasing less than the year before, on account of the greater distance from the root system, and as a result the lower parts of the tree will weaken to a certain extent, these being the parts which are capable of the greatest productivity and which we wish to maintain in as vigorous a state as possible. If these shoots were pruned as they grew longer, the result would be an excessive multiplication which would also tend towards debility in the lower parts and, at the same time, undernourishment in the terminal shoots. To avoid this, the system which we have named " pruning by substitution " should be practised. This consists in pruning, after the first fruiting of the primary branches corresponding to the quarternary shoots, two of the tertiaries above the fourth node, or the one inferior to the fork formed by the two quarternaries. The result is the formation of two new quarternary shoots above the fourth node of the tertiary. This pruning should be carried out on the Pacific side, at the end of the dry season, and on the Atlantic side when the tree shows least activity. The following year the same operation is performed on the two tertiaries which were not pruned the previous year. The third year from the beginning of this pruning, two of the substitution

shoots are cut above the third node, and the fourth year the operation is repeated on the remaining two. This pruning is continued in successive years until the substitution shoots are completely worn out, after which the secondary is pruned above its fourth node, in order to restore the two tertiaries, which, pruned at the fifth node, will serve in subsequent years as substitution shoots. When these latter are worn out, their place will be taken by the branches arising from the tertiaries pruned above the third note.

Theoretically, pruning by substitution would keep the tree young for 104 years, but since, on account of the accidental destruction of the adventitious buds, the new shoots do not always appear at the node above which the branch has been pruned, this result is not obtainable in practice.

PRUNING OF SUCKERS AND ADVENTITIOUS SHOOTS

The *hijos* are shoots growing from the nodes of the vertical stems, below the junction of the primary branches. These shoots are the result of the development of adventitious buds, generally produced by excessive defoliation of the tree, either by diseases in which the leaf is the organ affected, as a consequence of a heavy crop when the tree could not produce new wood, or after a prolonged drought accompanied by strong winds. The usual pruning practice of our farmers consists in destroying these shoots, tearing them out from the base so as to avoid the debilitating effect which they might have on the tree. One should remember that these shoots rise from adventitious buds, and that by destroying them one removes the possibility of their developing if it should be necessary for uniformity of results in pruning by substitution. This danger can be avoided by pruning the shoot above the first node from its junction with the stem. If it is surrounded and covered by the foliage of the plant, its development will be arrested ; but if pruning by substitution reaches the node from which it springs, the adventitious buds beneath its only pair of primaries come into activity and give rise to two vertical stems, one of which is left to take the place of a quarternary.

The suckers (*mamones*) are those which grow from the main stem below its first bifurcation. Since they are near to the roots, their development is rapid and they should be eliminated, for otherwise, they will weaken the whole of the structure above themselves. In a case in which the plant has, for any reason, lost its vigour, the suckers may serve to develop a new and vigorous framework.

PRUNING BY ELIMINATION

This class of pruning consists in the elimination of a complete organ which has permanently lost its vigour, or which has for any reason died and constitutes a menace to the health and life of the tree.

The farmer should keep his trees under constant observation to prevent withered stems or branches from remaining any length of time on the plant and endangering the development of luxuriant growth.

GENERAL PRUNING PRACTICES

Every stem or branch consists of nodes and internodes ; new shoots grow only from the nodes. If when a branch or stem is cut a part of the internode remains, the sap will not rise beyond the node, and all the wood above will die from lack of nutrition. As soon as the material dies, fungi and other saprophytic organisms begin their work of destruction, giving rise to the phenomenon commonly known as decay. The decay extends to the healthy material, and may affect it and endanger the health of the whole plant. It is therefore of the utmost importance that in pruning the cut should be made as near as possible to the node. In this case the cells of the bark continue their work, and rapidly form a covering for the wound, preventing any danger of infection. When the stem which has been cut has a diameter greater than 3 or 4 centimetres, the cut should be painted with oil or tar to exclude all possibility of infection until it is covered by bark.

In pruning primaries and capping tertiaries, it is convenient to use secateurs, as being quicker.

For pruning thick branches, a pruning saw is more efficient and economical than the knife usually employed. If the surface of the cut is large, it is well to use a sharp knife after the saw, in order to leave it completely smooth, which greatly reduces the chances of infection.