VEGETATIVE PROPAGATION OF COFFEE*

THE reproduction of coffee by asexual methods has attracted attention in other countries, notably Java, for many years. Unforeseen difficulties have occurred, and although experimentation has been in progress for over fifty years, it cannot be claimed that the practical advantages of this method of reproduction have been fully appreciated until recent years. It is only to-day that some of the earlier problems are being elucidated, and it is obvious that a large field of work lies ahead of the research worker before many of the practical difficulties are solved and definite recommendations can be made.

In Kenya, a relatively recent coffee-producing country, it is quite natural that the subject has not been given earlier consideration. The possibility that many of our cultural problems might be more easily solved by breeding or selecting suitable trees and reproducing their offspring asexually is now realised, and, with this end in view, work on these lines was commenced three years ago.

ADVANTAGES AND DISADVANTAGES OF VEGETATIVE PROPAGATION

Before discussing the results obtained from the preliminary researches, it would be well to state the advantages and disadvantages of this method of reproduction. It will, it is felt sure, be obvious that the advantages are so great that the work is deserving of the fullest support.

The main factor upon which all other advantages depend is ably stated by F. B. Ferwerda, who writes as follows: "The most important advantage is undoubtedly that the daughter-individuals produced exactly resemble in outward appearance both one another and the mother-plant." Enlarging on this point, he shows how by means of vegetative propagation populations of coffees may be established which possess uniformity of habit, uniformity in size of berry and bean, simultaneous cropping and resistance to pests and diseases.

The disadvantages are merely of a technical nature. Whilst it is obvious that more skill and attention will be required with this method of reproduction, the difficulties can be overcome and the advantages gained will more than compensate the additional attention necessary.

METHODS OF VEGETATIVE PROPAGATION

The most common methods employed in reproducing plants asexually include propagation by cuttings (root, stem and leaf), layering, inarching,

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*By S. Gillett (Dip. Agric. Wye), Agricultural Officer and Experimentalist, Kenya Colony in *The East African Agricultural Journal of Kenya, Uganda and Zanzibar*, Vol. 1, No. 1, July, 1935.

and budding and grafting. The object of the experimental work in progress is to ascertain which of these different methods are applicable to coffee.

It should be noted that, owing to the marked polarity of coffee, all material used for cuttings or grafting is taken from vertical growth. Lateral wood only produces low-growing, flattened trees.

The results obtained will be dealt with under their separate headings:

CUTTINGS

It is remarkable that so little work has been conducted on these lines in other countries. It may be due to the belief that cuttings do not produce good root systems or that they do not have the traditional tap-root of the seedling. That the seedling seldom produces a true tap-root and relies on a number of deep-rooting verticals is now proved, so no importance can be attached to this latter theory. The former suggestion is a possibility which cannot be overlooked, and merits further investigation. Experiments conducted to date nevertheless indicate that the root system of a cutting compares very favourably with that of a seedling tree and that trees 2-3 years old raised from cuttings are comparable with seedlings of the same age. The behaviour of these trees when bearing a crop and a comparison of their yield with seedling trees must be ascertained before it will be possible to make definite recommendations.

(b) *Hardwood.*—At the Scott Agricultural Laboratories, where most of the early work has been carried out, many hundreds of different types of hardwood cuttings have been planted out in open nurseries without success. In the Nandi District a coffee planter has been highly successful with this type of cutting, the material used being prunings from trees grown on the multiple stem system. Each cutting was approximately 2 ft. long and about 1-1½ ins. in diameter. How these cuttings will behave when they become mature trees must await further investigation, but it is interesting to note that they are already producing a prolific root system.

(b) *Softwood.*—The propagation of this type of cutting entails the use of a closed frame or propagator. Several different propagators have been tested. That which is most suitable to local conditions consists of frames artificially heated by ordinary hurricane lamps in chambers beneath with an overhead canopy. Sand, thoroughly washed and steam sterilized, is used as the rooting medium.

The type of cutting is of the utmost importance. That which has given the greatest success, although termed softwood, really consists of a tip, having semi-hardwood at the base, and allowed to retain its young tip leaves. The cutting used is 6—9 ins. long, and not more than a ¼ in. in diameter. Very suitable material will often be found growing as a bunch of suckers on a stumped tree, generally in the centre under dense shade. Attempts are now being made to induce this type of growth on a larger scale by various methods—shading, etc. Since the tip leaves must be

retained, a high humidity must be maintained in the propagator, and thus the frames are opened up for a few minutes only each morning. The rooting medium, which is kept at a temperature between 68° and 72°F., requires watering about twice a week; on the other mornings the leaves of the cuttings are subjected to a fine spray of water in order to keep them fresh. Rooting may be expected in 3-4 months. Attempts have been made to stimulate the initiation of root growth by treating the cuttings with certain gases prior to placing them in the propagators, but so far no success has been recorded.

(c) *Root and Leaf Cuttings.*—All attempts to propagate these types of cuttings have failed.

(*d*) *A Modified Form of Layering.*—Both correct layering and marcotting gave success during the first experiments conducted, but due to the tedious nature of the work and the slow rate at which it would be possible to raise large clonal populations, other methods were sought. Early work proved that if suckers, growing from an old stumped tree, were ring-barked near the parent stump, and then etiolated, they would root with comparative ease provided suitable weather conditions prevailed. This indicated that if some method could be found whereby the parent material could be made to produce a larger area for the production of sucker growth, little difficulty would be experienced in raising large clonal populations. Thus a technique has been evolved, and whilst, due to drought conditions, it is impossible to give more than early observations, it is satisfactory to note that these are most hopeful. The following is the method adopted: A rooted cutting from a selected tree is planted out in a nursery at an angle of approximately 25° from the horizontal. By keeping it pegged down, it will continue to grow in this plane. As this plant grows, suckers come away from the axillary buds. When about 12 ins. high they are ring-barked at the base, and soil banked round them. When rooted, the soil is removed and the sucker cut away from the parent plant, which again will produce further cycles of suckers for similar treatment. In the first cycle only a few of the rooted suckers should be removed, the remainder being pegged over at right angles to the original plant to provide a larger area for the production of rooting material in the second and subsequent cycles. Experimentation has shown that earthing up must not be carried out until the suckers are ready for rooting, and even then it is necessary to ring-bark each sucker.

BUDDING

When the study of the vegetative propagation of coffee was commenced, considerable attention was given to the possibilities of budding, but it has been found that the technique presents several difficulties, so the method has been abandoned in favour of grafting. It is of interest to note that in referring to budding, Marshall says: "The union of stock and scion is much weaker than when grafting is used. In heavy wind the entire growth is liable to break back to where the original bud was inserted."

GRAFTING

Inarching.—Methods of inarching young seedlings in the nursery and of inarching one-year-old plants on to old stumped trees in the field were first attempted with considerable success by Rogers, Superintendent of Plantations at Amani. Adopting his methods, success has also been obtained here, and it would appear that either system is an easy way of grafting one variety of coffee on to another (*Arabia* on to *Robusta*). Unfortunately, with this method, both stock and scion must be seedling material, an arrangement by which little ultimate gain can be obtained.

Cleft Grafting in the Nursery.—Most attention has been paid to this form of grafting, as by this method it is possible to graft clonal scion material on to seedling stocks. Many hundreds of grafts have been made during the past two years in order to establish a technique which would give a high percentage of successful unions. As a result of this experimentation it would appear that the following points should be observed:

(a) *Size of Stock and Scion.*—The larger the stock and scion the easier it is to obtain success. Seedling stocks about 18-24 months old are much easier to graft on to than younger material. If possible, the scion wood should be the same size as the stock, but this is not essential. With smaller scion material great care must of course be exercised to ensure that one cambium region is in contact with one cambium region of the stock.

(b) *Method of Making the Graft.*—The stock should be cut just above or across a node, and a cleft about 2 ins. deep made between the buds. The scion, which must bear at least one bud (and, if material is plentiful, two or three are preferable), is cut in the form of a wedge, beginning on either side of a bud. If the scion material is the same size as the stock, both edges of the wedge should be cut the same. If, on the other hand, the former material is smaller, one edge of the wedge should be slightly narrower than the other, and when inserted into the cleft the narrower side is placed toward the centre of the stock. This ensures perfect contact of the cambium regions. The scion wood should be active at the time of grafting.

(c) *Binding and Waxing.*—Having inserted the wedge of the scion into the cleft, it must be protected to prevent movement until a union has been obtained. Observations show that the nature of the protection should vary according to the time of the year at which the graft is made. It has been found that the best time of the year for grafting at the Scott Agricultural Laboratories is during the cool, dry weather (June-October). Grafting in June, when sap flows freely from the stock, it will only be necessary to bind the graft with gunny string. Grafting later in the season (September), at a time when there is little sap flow and the weather is warmer, it is advisable to protect all the cut surfaces, including the tip of the scion, with grafting wax. In all cases the whole should be protected for a period of about three weeks by covering it with a loose waxed paper cover.

Provided these methods are followed a high percentage of success may be expected.

Cleft Grafting in the Field on to Old Stocks.—The obvious method to adopt in grafting on to old stocks in the field would be that of "rind" grafting, a method by which the scion wood is inserted between the bark and the cambium layer of the actual stock itself. Unfortunately, the method has proved entirely unsuccessful to date, so that other ways have had to be exploited. The method adopted, and which is proving successful, is that of grafting on to sucker growth encouraged from the base of the tree. When the sucker has obtained sufficient size and maturity it is treated in precisely the same manner as the seedling stocks are in the nursery. The ordinary cleft graft is made as described above, and is waxed and covered with a paper cover as before. The tree may be stumped back to the sucker, either before grafting or afterwards. If it is left until after grafting the natural shade thus formed will assist the newly made graft in its early days. Care must nevertheless be taken to stump before the graft makes too much growth, or it will be drawn up and tend to become whippy. The growth of a graft on an old established root-stock will be remarkably rapid.

RECOMMENDATIONS

It is known that many planters are becoming increasingly interested in this method of reproduction, and it is felt that it is here advisable to warn them against embarking on any large scheme of vegetative propagation work until such time as the Department is in a position to make definite recommendations, which can only be made after several years of careful observations and recordings.

Possibly one of the first great advantages to be obtained will be the improvement of established plantations by top grafting. It is to this aspect of the work that the planter should commence giving serious thought. The variation in yield and quality of bean existing between individual trees in a plantation is great. Whilst all trees may appear to the casual eye to be uniform, on closer examination it will be found that the percentage of "passengers" or unprofitable trees in most plantations is high. This variation could be considerably decreased if all the low-yielding trees were top-grafted with scion material from a known heavy-yielding parent tree. It is worthy of note that in East Java, where the method has been used on a large scale on some estates, the resulting yield has been increased in some cases by as much as 60 per cent. Mention has already been made of the method employed for top-grafting in the field on to old stocks. Before commencing actual grafting the planter should make a careful study of his plantation in order to pick out trees which produce a high yield of good quality coffee annually. These will subsequently be required as parent trees for the supply of scion material. It is not sufficient to work on one tree only, as it is quite possible that a high-yielding tree growing on its own stock may behave differently when grafted. Therefore a number of trees should be available for early investigation of their behaviour when used for this purpose. Individual trees throughout the plantation should also be subjected to close examination for a period of at least two years. If during this time little or no crop is harvested from them, they are obviously uneconomic units and should be prepared for grafting scion wood of the selected parent trees on to them at a later date.

STUDIES

Experimental work being conducted by the Coffee Section of the Department on this subject covers a wide sphere of work. This includes:

(a) Studies on the technique of rooting cuttings and their subsequent behaviour.

(b) Methods of grafting.

(c) Relation between stock and scion.

(d) The possibilities of grafting as a means of combating disease.

(e) A comparison of the behaviour of *Arabica* coffee when growing on different root-stocks. These include *Arabica* types, other varieties and hybrids.

(f) Selection of high-yielding trees for future use as parents for scion material.

(g) A comparison of growth and yield between seedling, grafted and cutting material.

(h) A study of the variation occurring between individuals in populations of trees propagated from seed, from grafts and vegetatively on their own roots.

(i) The raising of monoclonal populations of selected trees by grafting.

(j) The possibilities of hybrids are of the utmost importance. Breeding work has been commenced, and it is hoped that soon useful material will be obtained from crosses which are being made.

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