Notes on the Vegetative Propagation of Greenwood Cuttings with Reference to Tea.

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ABSTRACT.

Vegetative propagation by means of leafy softwood cuttings in general and techniques used in the propagation of tea nodal cuttings in particular, are discussed.

Principles of mist propagation are briefly described and a report on mist-propagated, pre-callused tea cuttings is given.

INTRODUCTION.

Before describing the propagation of tea cuttings, it is thought that an outline of the principal techniques and factors connected with the vegetative propagation of greenwood cuttings generally, will be helpful to introduce the techniques used in the propagation of tea cuttings.

These notes on the vegetative propagation of greenwood cuttings, with particular reference to tea cuttings, are based on more than twenty years of practical experience as an experimentalist and a nurseryman in the field of vegetative propagation, supplemented by information gained from experiments conducted by other research workers.

The notes are intended as a guide to the plant breeder-experimentalist, as well as the tea planter in Papua and New Guinea.

PROPAGATION OF GREENWOOD CUTTINGS IN GENERAL.

Of the various types of cuttings used in the vegetative propagation of plants, e.g., hardwood, softwood, leaf and root cuttings, each of which requires the use of a different technique, this paper will discuss only softwood cuttings, because this is the type of cutting used in the vegetative propagation of tea.

The propagation of leafy softwood cuttings has become increasingly important in the past decade. It is now a practical, safe and quick method in the vegetative multiplication of many plant species. This is mainly due to the results of plant research work, particularly the investigations into environmental conditions influencing success in striking cuttings and the development of advanced techniques, which has enabled vegetative propagation to take great steps forward. Modern mist propagation, for instance, has revolutionized nursery management by making large scale multiplication of leafy softwood cuttings a practical and economical method in vegetative propagation.

There are a number of internal as well as external factors which influence success in the striking of cuttings. Among the internal factors are the condition and age of the mother plants as well as the physiological condition of the cutting itself.

Of the external factors, the more important ones are light, humidity and temperature, while the rooting medium used can greatly influence results in the propagation of cuttings.

INTERNAL FACTORS.

Condition and Age of the Mother Plant.

It goes without saying that the parent material from which the cutting is taken must be in a healthy and vigorous condition. The practical nurseryman usually selects his original parent material on general appearance and on desirable characteristics. He often sets aside a special area for these mother plants where they receive special attention with regard to watering, positioning, pruning, etc., to enable him to obtain the maximum amount of healthy, vigorous cutting material.

As far as the condition of the mother plant in relation to position is concerned, it is of interest to note that Harris (1953) experienced considerable trouble in rooting cacao softwood cuttings when taken from plants in an exposed position. He found that a much better root strike was obtained if the cuttings were taken from plants

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which had received 40-50 per cent. of the full light intensity. Garner (1944), quoting Feilden and Garner on the other hand, stated that in coffee softwood cuttings the best results were obtained if the cuttings were taken from plants grown in full light.

Garner (1944) also said that Starring found that a high carbohydrate content of softwood cuttings with low soluble nitrogen, favoured rooting.

As far as the age of the mother plant is concerned, it is common knowledge among nurserymen that cuttings taken from young plants produce quicker and better roots than cuttings from old plants. Eden (1965) reported that :

"New light on the kind of shoot that provides the most vigorous cuttings comes from work at the East Malling Research Station on the propagation of apple root stocks. Rooting capacity is inversely related to maturity. This applies not only to the individual shoots on a mother plant but to the mother plant itself. Applied practically, this means that shoots used for cuttings should be those arising from a hard pruning, which stimulates rapid growth. Moreover, it is better to use relatively young bushes as a source of material."

With regard to *the physiological condition of the cutting itself*, it is known to most nurserymen that a dormant shoot often produces better and quicker roots than an actively growing shoot. This is probably caused by the amount of carbohydrates available. It may be expected that dormant shoots have a higher carbohydrate content than the actively growing shoot.

It is also a recognised fact that the presence of flowers or flower buds on the cutting has a depressing effect on root formation. Garner (1944) reported that the experiments by O'Rourke with blueberry hardwood cuttings indicated that it is not the presence of flower buds that depresses rooting but rather the conditions that lead to the formation of flower buds.

The time of year that cuttings are taken seems to have an influence on rooting and growth, but this is probably more related to climatic conditions and the resulting condition of the parent plant than to the actual time of the calendar year.

Summarizing the *internal factors* influencing root formation in cuttings it could be stated that :—

(1) parent plants must be healthy and vigorous ;

(2) food reserves (carbohydrates) in the cutting are an important factor in root formation ;

(3) cuttings from young plants produce better and quicker roots than cuttings from older plants ; and

(4) taking cuttings from dormant shoots without flower buds promotes root formation.

EXTERNAL FACTORS.

Light.

The amount of light a leafy softwood cutting receives is of vital importance in root formation, growth and general health of the cutting. Van Haaren (1955) working with coffee cuttings reported 12 per cent. rooted cuttings and 54 per cent. dead under a light intensity of 30 to 40 per cent. of daylight against 59 per cent. rooted cuttings and 8 per cent. dead when grown under 80 to 85 per cent. of daylight.

Most softwood cuttings when made have low reserves of carbohydrates and these may be depleted within a week unless the photosynthesis process can continue to produce food for root formation and growth. Without sunlight and the chlorophyll tissues of the leaf, the photosynthesis process cannot continue and the cutting will die. Thus, the bigger the leaf area and the more sunlight available, the greater are the chances of success.

Temperature.

Temperature is often the limiting factor in the possible amount of light and leaf area, particularly under tropical conditions where greater amounts of sunlight increase the temperature of the air. This results in excess transpiration through the leaf and subsequent wilting of the cutting and finally death. To control transpiration, the shading and reduction of the leaf area were common practices in the propagation of softwood cuttings before the advent of mist propagation techniques.

Humidity.

A humid atmosphere surrounding the leaf area is necessary for the leaf to keep its turgor, to stay alive and to function to produce the required substances for root formation.

Light, temperature and humidity are closely inter-related factors ; indeed, one influences the other.

The maximum possible amount of sunlight and high humidity coupled with a warm atmosphere are the external conditions required to keep the leafy softwood cutting alive and healthy. Root formation and growth will subsequently follow.

Mist propagation has provided the tool to create and control optimum external conditions to a much greater extent than ever before.

Rooting Medium.

The various types of cuttings, as well as cuttings from different species, require a different rooting medium. Softwood cuttings need a better aerated rooting medium than hardwood and root cuttings. To achieve this, coarse sand is usually incorporated in the top four to six inches of the medium. Various mixtures of coarse sand and peat moss, or coarse sand and soil of little clay content are the more popular rooting media. Fine sands are not suitable as they tend to pack quickly and become waterlogged resulting in rotting and death of the cutting. Although coarse sands are usually essential in a good rooting medium, even the best of sands has its drawbacks. Sand not only contains very little in plant nutrients, but also, because of the greater aeration, there is the danger of excessive callus growth, resulting in slow root formation.

Mixtures of coarse sand and soil and peat moss are preferred by most nurserymen.

Well-leached sawdust is another rooting medium. Excellent rooting results are obtained with softwood cuttings of cacao in a 100 per cent. sawdust medium under mist propagation at the Keravat Lowlands Experiment Station, New Britain. However, the author experienced very disappointing results with coffee cuttings in a sawdust medium at the Aiyura Highlands Experiment Station, New Guinea, when, for instance, only 37 per cent. of the cuttings in sawdust rooted (5 per cent. dead) against 80 per cent. rooted cuttings (nil dead) in a coarse sand medium (van Haaren 1955).

A disadvantage of either a 100 per cent. sawdust or a 100 per cent. sand medium is the difficulty usually experienced in transplanting the initially rooted cuttings to normal soil or potting mixtures. The changed conditions often cause setbacks and heavy losses.

The use of peat moss in a rooting medium has in recent years become more popular. One of the main features of peat is its excellent moisture retaining capacity combined with an efficient aeration ; its acid reaction is a desired characteristic in the propagation of *Azalea* and *Rhododendron* cuttings.

Sterilization (by heat treatment) of the rooting medium is usually beneficial to root growth. The *temperature of the rooting medium* is probably of more importance in the colder regions than in the tropics. Generally speaking, the temperature of the soil should be the same as, or slightly warmer than, the temperature of the air surrounding the cuttings. Garner (1944) stated that the temperature at the basal end of the cutting should be somewhat higher than at the apex, hence the beneficial effect of bottom heat.

Hormone Treatment.

There are numerous hormone preparations on the market. Applications and results of these root-promoting substances vary according to the plant species treated. The subject is, however, too complex to deal with in the context of this paper. It suffices to state that hormone treatment has its practical applications in the propagation of cuttings and that it can be a great help in root promotion of the more difficult and slow-rooting species of cuttings. The indolyl-butyric acid-based hormones appear to be the most effective of these synthetic growth-promoting substances for stimulation and root development in softwood cuttings.

Summarizing the *external factors* in influencing successful propagation of cuttings, it is stated that :—

(1) light, humidity and temperature are the most important correlated factors ; maximum amount of sunlight, a high humidity, a warm atmosphere and the greatest possible leaf area are the keys to success in the striking of softwood cuttings ;

(2) a good aerated but moisture-holding rooting medium is essential ; and

(3) sterilization of the rooting medium, the use of bottom heat and hormone treatment of the cuttings may give added success in the propagation of softwood cuttings.

After the above general discussion on factors influencing vegetative propagation by softwood cuttings, and before dealing with tea cuttings in particular, a few words have to be said about

the present day most popular and successful method of striking softwood cuttings, i.e., mist propagation.

MIST PROPAGATION.

In mist propagation, the cuttings are grown in a humid atmosphere obtained by spraying a fine mist of water over the cuttings at regular intervals. Thus, the relative humidity is kept high, transpiration through the leaf is greatly reduced and the cuttings may be exposed to the benefits of sunlight without harmful effects. Only a very light shade is used and even the propagation of softwood cuttings in full sunlight has become possible.

In the early days of mist propagation, some 20 to 25 years ago, the cuttings were grown under a continuous spray of water. It soon became apparent, however, that too much water caused excessive nutrient leaching of the leaves and kept the rooting medium rather cold. Experiments indicated that a mist spray turned on at intervals, so-called intermittent mist, was sufficient to keep the leaves moist and in a turgid condition. An intermittent mist application in full daylight enables the photosynthesis process to continue. Thus, food reserves are accumulated and this results in a higher survival rate and earlier rooting of the cuttings than was ever before possible with the conventional methods of cutting propagation.

Intermittent mist, often combined with electrically-supplied bottom heat to keep the rooting medium around the optimum temperature of about 75 degrees F., is producing excellent results and has become the standard method of propagation of many plant species in present day nurseries. For a detailed description of mist propagation techniques, it is highly recommended to study the booklet *Mist Propagation of Cuttings* by Patricia Rowe-Dutton, published by Commonwealth Agricultural Bureaux, Farnham Royal, Bucks, England.

TEA CUTTINGS.

History.

The earliest work on vegetative propagation of tea has been recorded in Formosa and Japan where layering and marcotting was practised as early as 1887. In Java, the vegetative propagation of tea began to be studied seriously in 1912, by Dr. J. P. Cohen Stuart. Wellensiek, who continued this work described a propagation method of tea cuttings in 1931. Budding and grafting of tea was practised in West Java in the years before World War II but the technique never gained much popularity. The work of van Emden (1950), just before the second World War, and in the years immediately after, laid the basis for tea propagation by cuttings in Java. In Ceylon, Kehl, Visser and Eden, and in Kenya, Green, have given detailed accounts of their experimental work in tea cuttings (Eden 1965).

Van Emden (1950) in Java, used a continuous mist propagation method for tea cuttings as early as 1949.

During the last decade the propagation of tea by single internode cuttings either under mist or without use of mist, has by far become the more popular method in any breeding and selection programme of tea. The technique is a dependable and an economical method for the rapid multiplication of selected clonal planting material.

In the propagation of tea cuttings the same general principles and factors apply as described in the earlier chapter. Further discussion will therefore deal with those techniques and factors which relate to the striking of tea cuttings in particular.

Mother Plants.

Mother plants are bushes selected because of high yield and good quality and which preferably have a wide plucking table. Mother bushes are allowed to grow unpruned for about four to six months, producing in that period many shoots. Hundreds of single internode cuttings can be taken twice a year from one mother plant.

Mother bushes are specially cared for in order to keep them healthy and vigorous. A nitrogenous fertilizer is usually applied twice a year at three months before taking the cuttings,

As described earlier, the age of the mother plants influences rooting ability. This principle applies also to tea. In this regard, van Emden (1950) reported that cuttings taken from one-year-old seedlings showed 80 per cent. rooting in four weeks' time, whereas in the control series taken from ten-year-old plants, not a single cutting had rooted. The impression was also gained that cuttings taken from a budded plant do not root as readily as do those taken

from a seedling of the same age. Van Emden (1950) furthermore stated that there is no difference in rooting performance between cuttings taken from shoots with flowers and cuttings from shoots without flowers. He added however that if cuttings produced flowers while in the propagation beds, root as well as shoot growth stagnated.

Generally speaking, the making of cuttings from shoots that are in flower should be avoided as these cuttings often produce flowers and little or no growth.

Kehl (1950) reports that it is no disadvantage if the cuttings are made from shoots with growing buds, but if much growth has been produced, the shoot is cut back to the so-called ' fish-leaf '.

Green (1964) on the other hand stated that the axillary buds should be dormant.

It is the author's opinion that cuttings with active axillary buds up to a length of say one-half of an inch are quite acceptable, but that cuttings with one inch and over in axillary bud growth may present difficulties because of excess transpiration (not under mist, of course) while they also appear to be slow in rooting.

Making the Cuttings.

The shoots are cut from the mother bush at about one inch above the old pruning cut, are placed in a bucket of water and are carried to the propagation bed.

Making of cuttings is always done under shade and many nurserymen prefer the cuttings to drop into a bucket or a dish of water to prevent drying out. The author prefers the late afternoon and evening hours to the early morning hours in making the tea cuttings, and also immediately planting out without dropping them in water first ; the cool hours of the night seem to " settle them in " better.

Time of the year in making the cuttings appeared to be rather immaterial in West Java, but Harler (1966) states that in north-east India, the best time of the year to take cuttings is between mid-April and early May and from mid-September to early October. The cut is made just above the leaf with a sharp knife or a good pair of secateurs, taking care not to damage the axillary bud and the leaf. The cut is often made at a 45 degree angle, sloping away from the bud. It is the author's opinion that it does not matter whether the cut is made on an angle or straight across the stem, and he has mostly used the secateurs instead of a knife in making tea cuttings. The indications were that making the cut with secateurs and thus slightly bruising tissues had a stimulating effect on root formation. Using secateurs and cutting straight through the stem just above the leaf is a simple and a quick method which became the author's standard technique in making tea cuttings.

Length of the cutting is governed by the length of the internodes and although short as well as long internode cuttings can be successfully used, the ideal length of a tea cutting is $1\frac{1}{4}$ to $1\frac{3}{4}$ in. Long internodes (over 2 in.) may of course, be shortened to about $1\frac{1}{2}$ in., but cuttings shorter than $\frac{3}{4}$ in. are usually discarded unless it is very valuable material and in short supply. Shoots with rather short internodes may be used in making two internode (or more) cuttings by removing the lower leaf or leaves.

The full length of the shoot can be made into cuttings although cuttings made from the lower, woody part take longer to root and in practice are mostly discarded if sufficient material is available. Without mist propagation, the two to three top internodes cannot be used, as stem tissues are too soft causing the cutting to wilt and die. Their rooting potential however, is as good as or even better than in cuttings made from the greenwood middle section of the shoot.

Planting the Cuttings.

Planting during the late morning hours, midday and early afternoon must be avoided for obvious reasons. Planting is best carried out in the late afternoon and evening hours. Spacing of the cuttings depends on leaf size. The author has always planted tea cuttings as closely together as possible without leaves touching or overlapping others. The planting technique consists merely of taking the upper part of the stem between thumb and index finger, leaf pointing outwards, and pushing the cutting vertically into the earlier prepared soil or special rooting medium, so that the base of the leaf is just touching soil level ; the leaf itself is then usually off the ground and pointing slightly upwards. A planting stick, or dibbler, was never used because of the danger of leaving an air pocket under the base of the cutting. The soil in the propagation bed is firmed just before planting. Naturally, planted

cuttings are immediately 'watered-in'. The ordinary knapsack-sprayer was found to be satisfactory for this purpose. Light spraying is done after each batch of approximately one hundred cuttings is planted; cuttings are kept moist as planting progresses. Needless to say, that planting is done under shade or at least away from direct sunlight.

Rooting Medium for Tea Cuttings.

It is generally recognized that tea cuttings planted in humus-rich soils show poor rooting performance. Whether this is related to the fact that the tea plant, in most countries, grows best in a soil with a pH value of around 5.0—an acid-type soil which is often poorly textured—is unknown. However, it seems generally agreed that the tea cutting roots best in a soil of a low organic matter content with a pH ranging from 4.5 to 5.5 (Green 1964). The author believes that the pH has little or no influence upon root formation, but may well have an influence after the initial root development when the young rootlets begin to function. Not enough is known about the factors influencing rooting in cuttings; it is quite possible that a combination of factors in the rooting medium, such as aeration, water-holding capacity, nutrient status as well as pH, govern the rooting process.

The repeated poor rooting ability of some tea clones is, of course, a genetic factor and a clonal characteristic which should not be confused with results influenced by environmental conditions.

The main requirement of a rooting medium for tea cuttings (and greenwood cuttings in general), is that it drains well and is adequately aerated, particularly in the top three to four inches of the medium. Coarse sands meet these requirements. However, sands usually have a high pH value. If it is desired to bring the pH value down, the sand could be mixed with soils of low pH, or could be treated with sulphur powder (or ammonium sulphate) as an acidifying agent. Any soil not too rich in organic matter and with little or no clay content and an open texture will be suitable in itself or in mixtures with coarse sands as a rooting medium for tea cuttings, provided that drainage and aeration are adequately taken care of. Sterilizing the medium is usually beneficial to rooting. If the cuttings are to be left in the medium for some time after initial rooting, it is a good practice to fertilize the subsoil before planting the cuttings. In most instances, however, cuttings are left in the rooting medium for six to twelve weeks—depending on root development—and are transplanted to nursery beds as soon as possible.

A more recent method is to propagate the cuttings in polythene bags under the same conditions as in the propagation beds. The cuttings are left in the bags to root and grow, and after a hardening-off period, are normally ready for transplanting to the field in about six months' time; they could be left in the polythene bags for up to 12 months if necessary. In the polythene bag technique, using bags of ten inches in length, the bottom six to seven inches are filled with a suitable subsoil, which is often mixed with fertilizer. The top three to four inches consist of the desired rooting medium.

Light, Humidity and Temperature.

The same principles apply for tea cuttings as described in the propagation of greenwood cuttings, these being as much daylight as possible, combined with a high relative humidity and an air and soil temperature of around 75 degrees F.

REMARKS ON PROPAGATION OF TEA CUTTINGS IN PAPUA AND NEW GUINEA.

Although the author believes that modern mist propagation techniques are the answer to large-scale and rapid propagation of tea cuttings, it is realized that under Papua and New Guinea conditions, this technique is often impracticable. Provided that the general principles for striking greenwood cuttings are adhered to, a relatively simple and economical method of propagating tea cuttings is feasible.

The imaginative planter-propagationist will be able to adapt the above-outlined principles and techniques to suit local conditions. The method as described by van Haaren (1955) for coffee cuttings in the New Guinea Highlands could easily be modernized and adapted to the propagation of tea cuttings. The author will be interested to learn of locally developed techniques in tea cutting propagation and will be pleased to advise in such developments.

As a general guide to root and shoot growth, it can be stated that tea cuttings under suitable conditions produce the first callus growth in two to six weeks after planting, root growth follows in

four to eight weeks after planting, and growth of the axillary bud commences after five to twelve weeks. Using mist propagation, rooting and shoot growth are accelerated.

It must be emphasized, however, that rooting and growth are greatly influenced by environmental conditions and that rooting ability of the cuttings is a clonal characteristic, which can vary greatly within clones.

In 'shy rooting' clones, the use of root-promoting hormones is often beneficial.

REPORT ON CALLUSED TEA CUTTINGS.

In conclusion, the propagation of pre-callused tea cuttings is discussed.

It is sometimes necessary to send tea cuttings over long distances to other areas for propagation and planting. Freshly-made cuttings dry out very quickly and cannot be transported over long distances. However, when callus has formed at the base of the cuttings. they stand travelling much better. The technique developed in East Africa is to callus the cuttings first in the propagation bed. This takes about three to four weeks. Cuttings are then lifted, washed in water, inspected for callus formation, packed in polythene bags (200-gauge), and then loosely packed into cardboard boxes for transportation. On arrival at their destination, these pre-callused cuttings are immediately planted into their propagation beds in the same way and under the same conditions as freshly-made cuttings.

Although this method seems to work satisfactorily, the author does not favour it and believes that there must be better ways of striking cuttings at long distances away from their source. It is evident that lifting the callused cuttings after some two to four weeks in the rooting medium, at a time when these cuttings are at the most critical period of the rooting process is a disturbing and severe operation, which it is thought, must be detrimental to the cuttings. As every nurseryman knows, one of the principle rules for the successful propagation of cuttings is not to touch them during the first eight weeks when initial root development takes places. This lifting operation of two to four week old tea cuttings, followed by transportation and replanting, into what is often a changed environmental condition, must give the cuttings a severe physiological shock which cannot be anything else but detrimental to final success.

As an alternative method of striking cuttings at some distance away from their source, it is suggested that the complete shoot, less the two top internodes, as taken from the mother plant, is moisture-sprayed and packed in polythene. Some four to six, or more, shoots may be packed together, in rather the same way as bunches of flowers are packed and dispatched all over the world. Upon arrival at their destination, the shoots should then immediately be made into single internode cuttings and propagated in the usual manner.

In view of the above, it is perhaps interesting to examine the planting and treatment of pre-callused tea cuttings grown at the Plant Quarantine Laboratory, Yarralumla Nurseries, Canberra, A.C.T.

In October, 1966, a consignment of pre-callused tea cuttings for a Territory trading and planting firm were sent from Kenya (East Africa) to Canberra (Australia), where these cuttings had to undergo intermediate quarantine in accordance with plant quarantine regulations, before they could be forwarded to New Guinea.

The author, assisted by Officers of the Plant Quarantine Section, Department of Health Canberra, took delivery of these cuttings and attended to planting and further treatment.

The cuttings arrived at Canberra after some 40 hours of travel and perhaps as long as three days after lifting from the propagation nurseries in Kenya. The cuttings were well packed in polythene sleeves and generally appeared to be in remarkably good condition, except for a number of cuttings from one or two clones which showed a copper-brownish discolouration of leaves and stems, reminiscent of fermented tea leaf. Three clones—K5/179, K1/4/12 and 12/90 in this order—showed excessive callus development, while it was also noticed that clone 12/90 had produced rather lengthy shoots from the axillary bud.

Before planting, all cuttings were dipped in a malathion 0.2 per cent. solution to comply with Australian plant quarantine regulations, after which the basal ends (callus tissues in this case) were dipped in 'Seradix' B, No. 2 powder, an indolyl-butyric acid-based hormone preparation. It may be noted that *Camellia* cuttings in particular have responded well to treatment with 'Seradix' when removed from the rooting medium and not having produced roots as yet.

A total of 322 cuttings from 13 different clones were planted in four rooting media as follows * :—

(A) sand + peat 1 : 1, pH 5.0, 112 cuttings in 20 pots ;

(B) sand + peat 2 : 1, pH 5.5, 78 cuttings in 15 pots ;

(C) sand + peat 1 : 2, pH 5.0, 78 cuttings in 15 pots ; and

(D) perlite 100 per cent., pH 7.5, 54 cuttings in 10 pots.

* *Plates* I and II.

Plate I.—Tea cuttings one day after planting perlite (rooting medium D) in foreground.

Plate II.—Tea cuttings one day after planting perlite (rooting medium D) in background.

The cuttings were planted in plastic pots of about ten inches deep and some eight inches wide at the top. The bottom six inches of every pot was filled with a sterilized mixture of river sand and peat 1 : 1 (pH 5.0) which included superphosphate at the rate of 2 oz. per 4½ cubic yards of this subsoil mixture. The top three to four inches consisted of the various rooting media (sterilized) as described above in A, B, C, and D.

Because of the rather high pH value (7.5) of it was decided to mix this sand with imported of the local (Canberra) type of coarse river sand, German peatmoss (pH 4.0) in a ratio of one to one and to make this mixture the main rooting medium (A). Media B and C were added to test drainage and moisture-holding capacities of the medium. Perlite was added as a rooting medium to check rooting in relation to pH value. Perlite is a coarse granular mineral used as a plaster aggregate in the building industry ; it has excellent drainage and aeration qualities and is well known to nurserymen as a good rooting medium for softwood cuttings. The perlite in this case had a pH value of 7.5.

The pots with the cuttings were placed in the brick-constructed propagator in the centre of the glasshouse under an intermittent mist spray of 15 seconds misting in every two minutes, aiming at a relative humidity of 70 per cent. The air temperature in the glasshouse was controlled by an automatic hot water heater, set at 70 degrees F., which would blow warm air into the glasshouse when the temperature dropped below 70 degrees F.

Results obtained as reported to the author by the Officer-in-Charge of the project, Mr. Lance Smee, Plant Quarantine Officer, Department of Health, Canberra, A.C.T., were briefly as follows :—

At seven weeks after planting, 14 per cent. of the cuttings had produced good shoots of four inches and over in length ; 43 per cent. of the cuttings had shoots of two to one inch in length, and 41 per cent. had shoots under one inch in length (*Plate* III). Only four cuttings had died by that time. On appearance, the medium had no significant influence upon growth of the cuttings. The best clone in vigour appeared to be 1097, while clones K4/45, K3/23 and 12/90 were far behind in vigour. At this stage, i.e., seven weeks after planting, nearly all of the shoots were rather pale in colour ; indicative it is thought, of nutrient leaching through excessive watering ;

Plate III.—Tea cuttings six weeks after planting. Note growth of axillary bud.

Hardening-off commenced at this time by reducing the mist frequency and gradually removing the pots with the more advanced cuttings to the humidity chamber in the screen-house where they were watered twice daily. The last, and least developed, lot of cuttings were removed from the mist 12 weeks after planting. During the hardening-off period, some losses occurred.

In late February, 1967, twenty weeks after planting, the majority of cuttings were ready for dispatch to New Guinea (*Plate* IV), but for various reasons, they were not air-transported to Port Moresby until early April, 1967, 25 weeks after planting.

At the time of dispatch to Port Moresby, all the cuttings, except in clone K4/45 and 12/90, had formed good quality roots of three to six inches in length with the best rooting clones K5/206 up to ten inches root length and K2/45 with roots up to eight inches in length.

There were no marked rooting differences in the cuttings from the sand + peat mixtures, media A, B and C, but the cuttings in medium D, perlite, had produced a stiffer and branched type of root. They were about one inch shorter than the average in the sand — peat mixtures, but were also of good quality.

It may be concluded that—

(1) the high pH value in the perlite had no influence upon initial root development;

(2) drainage and aeration are of greater importance in a rooting medium than the pH; and

(3) a sand — peat mixture 1 : 1 is the more practical rooting medium and would make an ideal medium for tea cuttings in polythene bags under intermittent mist propagation.

Cuttings in such a medium could stay in the polythene bags for uninterrupted growth until transplanting to the field.

Plate IV.—Tea cuttings 22 weeks after planting, just before dispatch to New Guinea.

The best all-round clone, for rooting as well as for vigour, of this consignment as Canberra, was undoubtedly K5/206.

It is interesting to note that—

(1) the best rooted clones, i.e., K5/206, 1097 and K2/454, showed a very light to light type of callus development and a medium to small axillary bud growth on arrival at Canberra ; and

(2) the poorest rooter, clone 12/90, had a relatively long axillary shoot and a medium to heavy callus development on arrival.

This bears out the author's opinion, as well as literature sighted, that excessive callusing and early shoot development are contrary to root formation.

Finally, it must be added that the striking of cuttings, including tea cuttings, requires the constant supervision of the propagationist. Without daily attention to environmental conditions and a keen eye for the general behaviour and health of the plants, any cuttings propagation programme will result in failure. It is usually the experienced nurseryman who will achieve best success.

ACKNOWLEDGEMENTS.

The author is indebted to the following persons :—

Mr. A. W. Charles, Assistant Director, Research and Surveys, Department of Agriculture, Stock and Fisheries, Territory of Papua and New Guinea, for critically reading the paper ;

Dr. J. R. Morschel, Assistant Director-General, Plant Quarantine, Department of Health, Canberra, A.C.T., for the co-operation and assistance in making available quarantine facilities at Canberra and for the detailed notes and observations made on the rooting of tea cuttings in intermediate quarantine at Canberra ;

Mr. W. L. Conroy, Director, Department of Agriculture, Stock and Fisheries, Territory of Papua and New Guinea, for assistance and advice in the Canberra tea cuttings assignment ; and

Mr. Lance Smee, Plant Quarantine Officer, Department of Health, Canberra, A.C.T., for assistance in planting, care and attention to the tea cuttings in Canberra, as well as for notes and observations on growth of these cuttings—and for *Plates* III and IV.

The author is particularly grateful to his former Director, of the Botanical Division, C.P.V. Research Station, Buitenzorg (Bogor), West Java, Ir. J. H. van Emden, whose advice and encouragement directed him in the field of vegetative propagation.

Their assistance, interest and efforts are gratefully acknowledged.

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Accepted for publication December, 1968.