SELECTION AND VEGETATIVE PROPAGATION OF TEA*

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1. Introduction

Tea raised from seed, in common with seedling trees of most crops shows considerable variation in type and yielding capacity. An illustration of the variability in yield was shown in a yield survey of individual bushes of two uniform areas consisting of 1000 and 1500 bushes respectively. The findings of this survey were that the majority of our tea bushes are low yielders and that about 1/3rd yields most of the total crop. Whilst some of this variability in yield is probably due to environmental causes, there is a large proportion of bushes of which the differences in yield must be attributed to inherent factors. Besides differences in cropping capacity there are significant variations in the quality of tea. Resistance to diseases and pests too vary markedly from bush to bush.

In many perennial crops of economic significance rapid progress has been made through the selection of outstanding mother bushes and by the multiplication of these by suitable vegetative methods to ensure the maintenance of their desirable characteristics. In planting tea it would naturally be a sound policy to use high yielding plants that produce good quality tea and possess other desirable characteristics. This can be achieved by propagating tea by cuttings, which is an easy process, cheap and capable of being done by any nurseryman with some experience.

2. Field selection

2.1 Yield

The first criterion to adopt in selecting mother bushes should be yield as it is one of the most important factors. The initial selection can be made by pluckers or pruners. The bushes which are labelled are then carefully examined by the Superintendent, who rejects any whose type renders them plainly unsuitable. He should pick out easy plucking types that branch freely, having a good spread with a dense plucking table and reject those with the following undesirable characters :

(1) an open plucking table, (2) carrying few plucking points, (3) an upright habit or poor spread, (4) having few maintenance leaves, (5) a free flowering habit, (6) a tendency to produce banji frequently, (7) very short internodes, and (8) a slow recovery from pruning.

The final selection can be done solely at the Superintendent's judgment by picking out by eye alone bushes likely to be heavy yielders. However, as appearances are apt to be deceptive, a more accurate selection is obtained by yield assessments—that is to say, the yields of all individual bushes retained (and labelled) must be recorded by weighing the flush. Yield determinations must be preferably carried out in the second year after pruning. The best method is to record the yield of 8 consecutive plucks 4 times in succession. On each occasion a number of the lowest yielders are discarded according to the following scheme :—

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(a) First 8 plucks: per 100 bushes chosen, reject the 50 lowest yielders
(b) Second 8 plucks : per 50 bushes left from (a) reject the 25 lowest yielders
(c) Third 8 plucks: per 25 bushes left from (b) reject the 8 lowest yielders
(d) Fourth 8 plucks : per 17 bushes left from (c) reject the 6 lowest yielders,
leaving the 11 highest yielders of each of 100 bushes initially selected by visual observation.

It is important that a preliminary test for *quality* is carried out on the bushes thus selected. For this purpose an ordinary small-sized household mincing machine with all its parts chromium plated is suitable for rolling the leaf of a single bush. Any non-fermenters or those with taint should be rejected.

2.2 Resistance

Where *blister blight* is prevalent, it will be necessary to look for bushes that are resistant. Bushes which continue to yield plenty of flush with little or no infection during a severe attack of blister should be selected. Accordingly, such selection should be carried out during a blister blight period and preferably from young fields, as these are more liable to damage. It should be noted that the selection of blister resistant clones may now be rather difficult as a result of the widespread adoption of successful crop protection measures.

On estates where *meadow* and *root-knot eelworm*, particularly the former, are a problem, bushes should be chosen which continue to grow vigorously in heavily infested areas.

Also bushes resistant to *mites*, *shot-hole borer*, *scales*, etc. merit consideration from the selection standpoint.

Drought resistant types should be selected in areas where frequent droughts occur, the selection being made during a drought.

As each estate will have its own problems, it is advisable that every estate not only relies on clones selected elsewhere, but also carries out the selection of its own mother bushes. It is known that good bushes do exist on all estates which, if propagated, will do as well or possibly better than imported clones.

3. Subsequent selection

3.1 Treatment of selected bushes

The bushes which have been screened in the field for yield, quality, resistance, etc., are subsequently vegetatively-propagated for purposes of multiplication and final selection. Their rooting ability will be found to differ to a greater or lesser extent. Mother bushes the cuttings of which fail to root or which give a low rooting percentage under optimal nursery conditions should be discarded, irrespective of their other characteristics.

The remaining bushes must be labelled and a rough plan made showing the position of the selected bushes. Cuttings can be taken for propagation from a bush at any stage of growth. However, it is advised that a light clean prune be given to a bush at the end of its cycle and it be allowed to grow until the base of the new shoots turn woody. At low elevations this would take between 2 and 4 months and, at higher elevations, between 4 and 6 months. Bushes selected at the beginning of the pruning cycle need not be pruned again, but can be allowed to grow unplucked until shoots can be obtained for the taking of cuttings.

The breaking of the tips of the shoots about 2 to 3 weeks before the cuttings are to be taken induces axillary bud development which has been found to be an advantage.

The selected bushes which are allowed to grow should be examined again for mites and scales as the presence of these can result in poor rooting and growth. It is a sound policy to eliminate such pests before one starts to propagate rather than adopt control measures in the nursery or at a later stage.

3.2 Test and multiplication plots

Although the laying out of test plots will not be necessary on all estates, their establishment may be very useful. The procedure followed at the Institute has been to plant 25 to 50 bushes of each selected clone in rows up and down the hill. The bushes in such plots are lightly forked and manured 3 to 4 times a year during suitable weather conditions, as follows :—

Years from planting	*Minimum rate per application*
Up to 1 year	½ to ¾ oz. Sterameal A
1 to 2 years	½ oz. T. 175 mixture
2 to 3 years	¾ oz. T. 175 mixture
3 to 4 years	1—2 oz. T. 175 mixture

In case the planter wants to rely on clones selected on his own estate for planting or replanting, it is advisable to have a larger number of bushes per clone in the test plot (*e.g.* in treble rows) than mentioned above. This has the advantage that by the time the plot is in plucking and the final selection made, the clones selected can be used as "multiplication bushes" thereafter. They will then be present in sufficient numbers to cover the needs of an envisaged planting programme. The number of bushes to be planted per clone depends on the acreage which one wants to plant yearly. An estimate can be made on the basis that a mature bush (4 to 5 years or older) will yield between 500 and 700 cuttings per year.

Although the initial outlay of larger test cum multiplication plots will be more expensive, the involved expenditure is justified. It means that not a further 3 to 5 years are lost which would otherwise be needed for multiplying again those clones finally selected. The area containing the rejected clones is likely to produce a much higher yield than seedling tea.

The bushes used for the production of cuttings should be manured liberally and attention must be paid to keep them free from diseases and pests. Manuring can be done according to the above table ; in the 5th and subsequent years the application rate can be stepped up to 2 to 3 oz. T. 175 applied every 3 months. It is advisable to give the bushes from which the cuttings are taken a light prune every 15 to 20 months, so that vigorous shoots may be obtained.

The establishment of clonal units as described above is very necessary, not only to provide enough planting material eventually, but also to provide more reliable data than are available on resistance to diseases and pests, growth habit, yield and quality of each clone.

The test of the *quality* of a clone is a matter that deserves more attention than it has received so far and should not be overlooked. The method to be adopted and the equipment required should present no difficulties. Details have been published in the *Tea Quarterly*, Vol. 24/4, 1953 : 82-89. It should be emphasized that since the characteristics of a tea are influenced to a marked extent by seasonal changes and the standard of plucking, the greatest care should be taken in assessing the potential qualities of a clone. The method of manufacture should also be taken into account.

An important aspect in clonal replanting is that a number of good clones should be planted out on an estate, and on no account should planting be restricted to one " ideal " clone even if such a one did exist. The large scale planting of only one clone is attendant with the danger that some unknown disease or pest may favour that particular clone and destroy the entire plantation. Accordingly, the

cultivation of a variety of clones is advocated and these are best planted out in separate blocks of at least ½ to 1 acre, or larger depending on the acreage to be replanted.

4. Propagation

4.1 Choice and treatment of cuttings

It is advisable not to start propagation during the latter part of the dry season or during a drought, as cuttings taken during these periods are often too mature, resulting in impeded rooting and growth. Otherwise, cuttings can be taken from any primary shoot that has reached sufficient maturity for that purpose.

I. Type of shoot.—The *age* of the bush from which the shoots are taken makes no difference in the rooting or growth of the cuttings; the condition of the bush naturally has an effect on the performance of the cuttings. The age of the *shoot*, within limits, has no great influence on the root initiation, but cuttings of shoots that have been allowed to grow for over 12 months are likely to show a marked tendency to produce flower buds which usually restricts growth. No differences have been observed in rooting between cuttings taken from shoots with a dormant or an active apical bud.

II. Type of cutting.—With regard to the type of cutting to be propagated it is advised to use "single-node" cuttings (consisting of 1 leaf and inter-node). "Half-leaf" cuttings—top half of nodal leaf cut off—allow a greater number of cuttings per unit area to be planted (Fig. 1). They root equally well, but their subsequent growth is less than that of cuttings with an intact leaf. "Double-node" cuttings (2 inter-nodes and 1 or 2 leaves), though potentially able to grow more vigorously do not usually give such good results as single-node cuttings, because they are more liable to be affected by adverse nursery conditions.

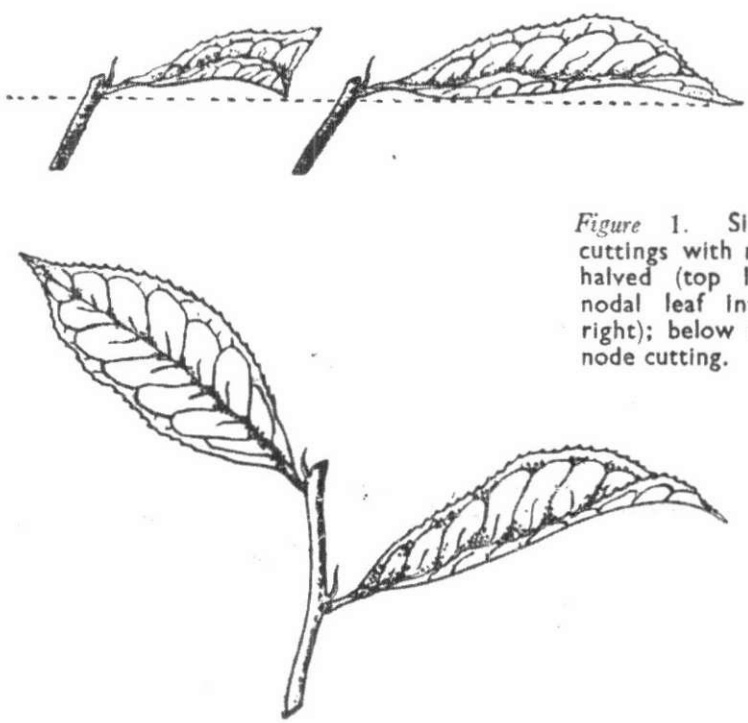


Figure 1. Single-node cuttings with nodal leaf halved (top left) and nodal leaf intact (top right); below a double-node cutting.

A cutting with the axillary bud starting to develop gives better results than one with a dormant bud. As regards cuttings the axillary bud of which has developed into a shoot with some leaves, the shoot must be cut back to the fish leaf as rooting may otherwise be hampered.

III. Preparation of cuttings.—The shoots are divided into cuttings with a very sharp knife, the tender apical portions together with the woody basal ends being discarded (Fig. 2).

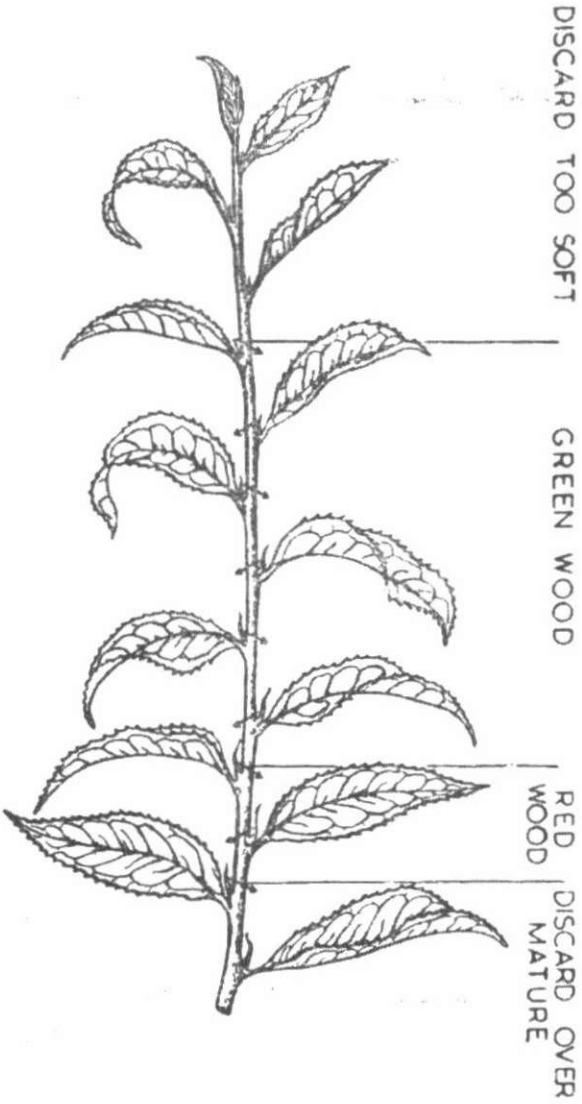


Figure 2. Cuttings to be used and discarded from a primary shoot.

It is important that this operation be done under shade and that the cuttings be left in water to prevent drying out. In making the cut, care should be exercised in not damaging the axillary bud, and anything in the nature of a ragged end or a bruised cut should be avoided.

Pre-treatment of cuttings of difficult rooting clones with several *growth hormones* both in their pure form and as commercial preparations has not given practical results so far.

For purposes of *transport* and *storage*, the shoots or the individual cuttings can be packed in bags of polythene tubular film. Stored thus under normal light conditions (not in sunshine) and at room temperatures they can be kept without harm for 1–2 weeks.

4.2 Nursery conditions

The essential requirements of a nursery site are :

(1) good drainage, (2) a good textured soil, (3) correct pH, (4) absence of parasitic eelworms, (5) closeness to a water supply, (6) protection from winds, (7) proximity to the area to be planted.

The costs involved in obtaining these conditions are, to a greater or lesser extent, determined by the choice of the site for the nursery.

I. Rooting media.—A good rooting medium must permit, on the one hand good drainage, while on the other it should have a good water-holding capacity. The medium should not be rich in nutrients or manured before propagation as this would decrease rooting. It must also be free of decay-producing fungi and bacteria and contain no parasitic eelworms. With regard to the latter, *fumigation*, should be carried out as a routine measure at the start and subsequently once every year, unless the soil is definitely known to be free from eelworms. Fumigation can be done with either Nematox, Nemagon or Shell DD at the rates recommended by the manufacturers. A period of 4 to 5 weeks must be allowed to lapse after fumigation before the beds are used for planting.

If the same nursery is used intensively, its soil should be renewed or rehabilitated at least once in 1 or 2 years or a new site should be chosen.

With regard to nursery soils the following observations can be made :—

(*a*) *Guatemala soil :* Outstanding results can be obtained by using soil where Guatemala grass has been grown for a period of about 3 to 6 years. Such soils, the structure of which is usually excellent, contain large quantities of undecomposed roots which provide suitable aeration and adequate drainage. On certain estates *Mana grass* (*patna*) *soils*, if not eroded, and *jungle soils* have also been found to give good results.

(*b*) *Sub-soil* from between 3–6 feet below the soil level, is suitable when passed through a coarse sieve (about No. 4 mesh) and mixed with *peat* or with peat and washed river sand. The mixtures found to give good rooting were : 1 to 2 parts of sub-soil + 1 part peat and 1 part sub-soil + 1 part peat + 1 part sand. Sub-soil has the advantage that it is free from harmful organisms. The proportion of sand added should never be too great as it increases the pH unfavourably.

(*c*) *Tea soils*, even though having a reasonable structure, do not give results as good as those obtained from Guatemala soil or the above mixtures.

(*d*) *Saw dust, coir dust* and *expanded mica* were found to be unsuitable.

(*e*) *Soil acidity :* For optimal results the pH should be in the neighbourhood of 5.0 and preferably lower ; a pH higher than 5.5 is definitely harmful. An adverse pH reaction of the soil may be rectified by mixing the soil with flowers of sulphur. The rate of application varies with different types of soil, but as a general rule between 1 to 3 oz. per square yard, or between 1/3 to 1 lb. per cubic yard of bulked soil, should be satisfactory. The sulphur should be thoroughly mixed with the soil and the treated soil well watered for about 6 weeks, when planting can be done. A pH which is not too high can be also reduced by the addition of peat which improves the condition of the soil at the same time.

II. PREPARATION OF THE BEDS.—The preparation of the beds consists of loosening the earth to about 15 inches deep, removing stones and roots and breaking down the lumps. Drainage may be effected by providing the base of the bed with 2 or 3 inches of small metal or gravel. The depth of this layer will depend on whether the bed is used for callusing or rooting only (6") or whether the rooted cuttings are to be left in the bed (12"–18"). The bed is then filled with the removed soil or with other suitable soil or soil mixture, to a height of about 6'-9" above path level. The provision of a drainage layer to soils (*e.g.* sandy soils) which already are well drained can be disadvantageous during dry weather.

After the prepared beds have been allowed to settle they must be pressed before planting. The degree of pressing depends on the soil and the weather conditions during propagation.

During dry weather propagation a loose friable soil needs more pressing than a heavy soil or when propagation is carried out during the wet season.

III. PLANTING.—The prepared cuttings are inserted into the soil up to the axils of the leaves in rows across the beds and at such an angle that the leaf lies flat on the surface of the soil. The leaves should point in the direction of the wind ; the soil around the stem should be pressed firmly.

It is important that the basal ends of the cuttings do not become damaged in the process of planting. This can be obviated by the use of a dibbler to make holes prior to planting, but care should be taken to avoid leaving air pockets at the base of the cuttings by pressing firmly. When planting is done in dry weather the beds must be lightly watered beforehand, and planting must be carried out under shade.

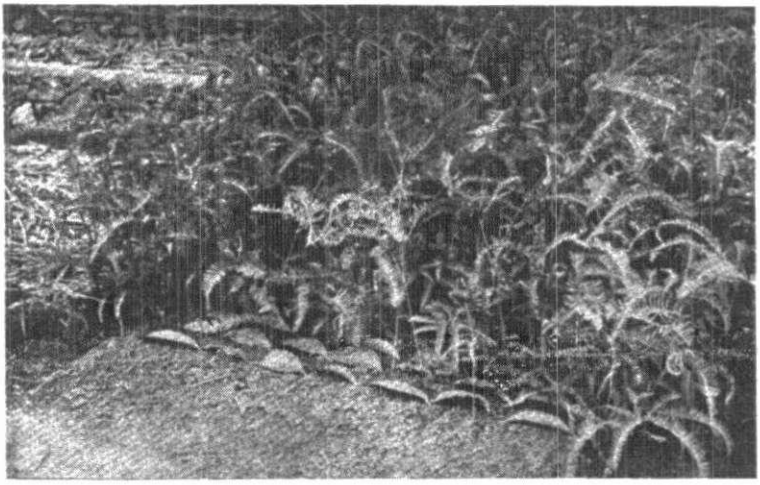
The cuttings can be spaced closely about $3\frac{1}{2}$" between rows and about 2"–$2\frac{1}{2}$" in the rows, if they are to be transferred into baskets after they have rooted. However, if they are to be left longer in the beds and transplanters are to be used, it is then necessary to space the cuttings at least 5 to 7" apart.

4.3 Shading and watering

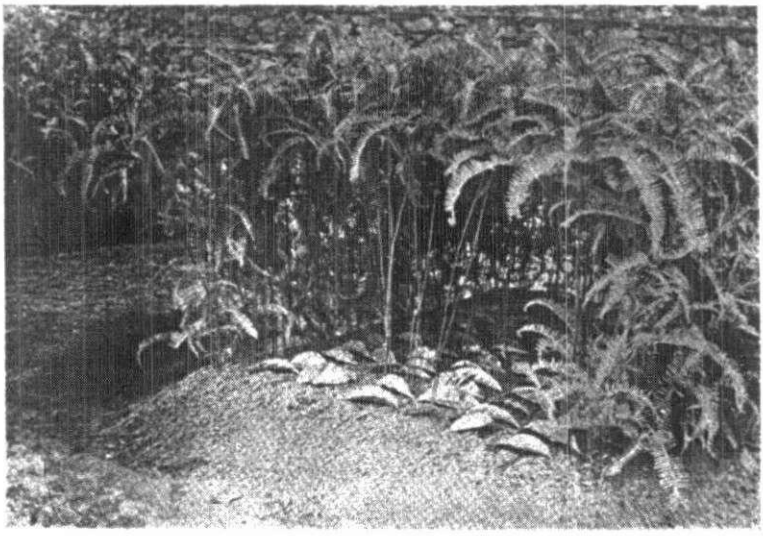
It should be realised that shading and watering are interdependent ; a densely shaded bed requires less water than one which is not so heavily shaded. Over-watering and over-shading are equally harmful. The former will impede aeration causing poor rooting and rotting ; the latter will hamper the photosynthetic processes of the leaf leading to decreased growth and possibly the death of the cutting. One should not forget that both shading and watering are only required to keep the soil and the atmosphere under the shade reasonably humid and cool in order to prevent wilting and sun scorch.

With regard to weather conditions, it may be remarked that propagation during monsoonal weather is usually less successful than during dry weather because of excessive rain and unfavourable light and temperature conditions.

The *shading* of the cuttings must be done almost immediately after planting, as a few minutes' exposure to intense sunlight can cause damage. One method of providing shade is with bracken fern (*Gleichenia linearis*) which is inserted in clusters into the bed between the leaves and along the sides of the bed. The shade should be fairly dense, so that the cuttings are hardly visible from above. (See Fig. 3).



Improper way of shading



Proper way of shading

Figure 3. Shading of cuttings with fern.

A more efficient, though more expensive system of shading cuttings is the use of iron or bamboo hoops covered with open-weaved coir matting. (See Fig. 4). Mesh widths ranging from about 1/8" to about 1/2" provide adequate shade (15-25% light intensity), the mesh width depends on local climatic conditions. Some of the advantages of using coir are that it can be used repeatedly and that it provides known and equal light conditions over the whole bed, while facilitating nursery operations.

Under extreme conditions of temperature and humidity, the height of the shade above the cuttings should be increased or a "double shade" may be employed. The latter method involves the use of a semi-permanent "overhead" shade, 5 to 6 feet high, which must permit a fair amount of light (40-50%). The cuttings themselves can be lightly shaded with fern.

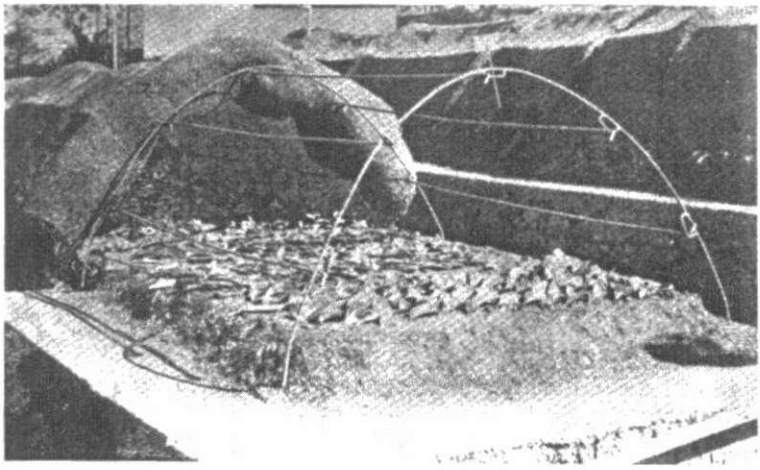


Figure 4. Shading of cuttings with coir matting.

With respect to *watering* it was found for coir shaded beds that a daily quantity of 0.25–0.40 inches of water given in two applications was sufficient during *dry weather*. The amount of water needed depends to some extent on the type of soil used for propagation, a heavy soil needing less water than a light soil. Watering, apart from being dependent on shading and soil conditions, also depends on the climatic conditions. During dull or rainy weather little or no watering should be carried out ; rainfall should be considered as water application. Generally, watering should be done before the soil under the shade shows indications of getting unduly dry.

For large nurseries a system of overhead sprinklers may be worthy of consideration as an efficient method of water application.

It should be mentioned that once the cutting has rooted, less water and more light are required. The latter can be provided by the thinning out of the fern. In case coir is used the sides of the beds can be left open or the original dense coir can be replaced by coir of a wider mesh (*e.g.* 3/4" or 1").

4.4 Pests and their control

As certain pests are liable to occur under nursery conditions, even though selection on resistance has been carried out, the control of the most common ones is given below.

Pests in nurseries and their control

Pest	*Control Measures*
Tea Aphids	Spray Nicotox " 20 "—1 oz. in 2 gallons water. One application.
Thrips	Spray 50% DDT—1 lb. in 25 gallons water. One to two weekly applications.
Scale Insects	Spray Nicotox " 20 "—1 oz. in 1½ gallons water. Three weekly applications.
Yellow & Purple Mites ...	Spray Thiovit or Spersul—1 lb. in 25 gallons water. Two weekly applications.
Scarlet Mite & Red Spider ...	Spray Thiovit or Spersul—1 lb. in 25 gallons water. Three weekly applications.
White Grubs & Cut Worms	Pour Intox " 8 " or Chlordox—6 pints per square yard, dilution 1 : 2000. One application.

5. Treatment of rooted plants

5.1 Soils and Manuring

I. Soils.—The use of baskets for rooted cuttings entails the choice of a soil suitable for growth. The choice is less limited than for propagation, as the soil may be rich in nutrients and the pH conditions may be less exacting.

Guatemala soil proved again to give excellent results when used for this purpose, while good *patna* or *jungle soil* are also suitable.

A suitable alternative in case the above soils are not available is provided by *sub-soil mixed* with well broken down compost or with peat and sand. Likewise, sub-soil mixed with tea fluff (5 : 1) provided a good mixture for basket plants, but the tea fluff should be allowed to decompose in the mixture before it is used.

The use of tea soil may not be advisable on account of the possibility that it contains toxic factors.

It is essential that basket soil be fumigated should parasitic eelworms be present in order to prevent their dissemination in the field.

II. Manuring.—In all the above instances the soils should be manured as soon as the cuttings have rooted, whether or not they are transferred into baskets. It is our experience that it makes a considerable difference to their subsequent growth. They can be manured with an organic mixture such as Sterameal A or other organic fertilisers of similar composition, at the rate of 2–4 oz. per square yard two-monthly. For young plants in baskets, a two-monthly application of 2 oz. Sterameal for about 20 plants is sufficient. The first application should be given soon after transferring into baskets.

Alternatively, manuring can be carried out with T. 175 mixture at the rate of 1 oz. per 20 plants every month. This has the advantage that it can be more quickly applied by using it mixed in water. Plenty of water should be used in order to prevent scorch ; the manuring rates can be increased with the age of the plant.

5.2 Transplanting

Once the cuttings have rooted two procedures can be followed : (*a*) they can be transferred into baskets, or (*b*) they can be left in the nursery (provided they were widely planted) until they are big enough for direct transfer to the field.

Whether "basket plants" or "ex-nursery plants" should be used depends largely on climatological conditions and the environment in which the plants have to grow in the field. The use of baskets is advisable if the transplanted plants are liable to be subjected to periods of drought, and also if they are used for resupplying or for planting in a rather poor soil. Plants directly transplanted from the nursery into the field particularly under circumstances described above have less chances of survival than basket plants.

Ex-nursery plants can be transplanted in two ways: (1) the plants can be removed with a suitable transplanter or, (2) they may be forked carefully out of the beds and then put out as stumps. These methods are cheaper than basketing and have the added advantage that less soil is required. It is often practised in areas where rainfall is well distributed, but it will be less successful in areas with adverse weather conditions.

As regards the time a plant is put out into the fields, the size rather than the age should be the main consideration in determining this. Generally, cuttings propagated under good conditions can be transferred into baskets 3 to 5 months after propagation started. Under suitable conditions both basket and ex-nursery

plants should be ready to go out into the field within 8 to 11 months after planting. If they are, however, to be grown under unfavourable conditions or at very high elevations where growth is slow, it is advisable to use somewhat older plants.

5.3 Bringing into bearing

It is important to start early on the shaping of the young plant to a suitable frame. Basket plants that carry about 10 leaves should be thumbnailed once, leaving 3 to 4 leaves on the plant. This cut will encourage early branch formation.

Ex-nursery plants can be treated likewise in the bed, but should receive a light cut—in order to reduce transpiration—before transplanting into the field.

Plants which are used for resupplying vacancies in old or nearly full grown tea must be allowed to grow without interference for several years after they have been put out, otherwise their chances of survival are remote.

Normally after the plants have been established in the field, either thumbnail pruning (in moderation) or layering should be resorted to. Centering should normally be avoided as it delays growth and, if done when the plant is still young, renders it more liable to succumb to adverse conditions.

5.4 Planting operations

The normal practice is to cut the holes or trenches in advance of planting. Consequently, they are often left open for one or more weeks before the plants are put in. This should be avoided as the holes or trenches may become filled with water and the walls "glazed." It is better to cut them in advance and fill them up with good soil, preferably mixed with compost or manure (*e.g.* 10 lb. per hole), immediately after or within a few days. The centre of the hole should be marked with a stick. This procedure has the advantage that the soil will have time for settling down and the compost or manure mixed with it will have decomposed to some extent. It also enables the plants to be put out at any suitable time, as the cutting of fresh holes, no larger than what is actually required, can then be easily carried out.

The planting must be done in *contour* hedges. The planting *distances* will depend on the growth habit of the clone, the condition of the soil and the steepness of the land. Spacing distances of between $1\frac{1}{2}$ and $2\frac{1}{2}$ feet in the row and from $4\frac{1}{2}$ to $5\frac{1}{2}$ ft. between rows are recommended. The aim should be to plant about 5000 bushes per acre.