

NURSERY MANAGEMENT

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Introduction

Many of us are about to undertake the replacement of old and uneconomic tea with high-yielding, vegetatively-propagated material. Therefore, costs and information on nursery management and new clearings and details of the various aspects of uprooting, rehabilitation, and replanting may be useful. A great deal of the information has already been published in the *Tea Quarterly* (Visser & Kehl, 1958) and as a separate bulletin (Visser *et al.*, 1959). In spite of this, many requests for information are received each week and it is therefore intended to cover as fully as possible details of each operation from the nursery stage until the replanted tea is finally in bearing.

Nursery—situation and extent

It is generally accepted that nursery organization is the most important operation, if final success is to be achieved in the field. It is therefore necessary to decide at the outset whether a large, permanent nursery, to last, say, 5–10 years, should be constructed in a central situation, not too distant from the area to be replanted, or whether a sufficiently large temporary nursery should be put up close to the area to be replanted each year, and abandoned or planted up after the necessary plants have been produced for each year's replanting.

A decision will depend on the availability of land for suitable sites to lay down a nursery. On some estates, ample space is readily available, whilst on others, space is very difficult to come by. But the economic aspect should be thoroughly investigated before a final decision is made.

A central permanent nursery of sound construction pays dividends. Soil can be brought in from outside for each year's plants and sufficient space for as many cuttings as are required each year will be all that is necessary. If this is not possible, perhaps subsidiary nurseries could be built to supply any shortfall.

Nurseries should be fenced round at the beginning, either with live fences (*Gliricidia* or dadap cuttings, closely planted) or with concrete posts and barbed wire, as considerable damage can be done by stray dogs, cattle and buffaloes, and theft is not unknown.

Nursery Conditions

A properly drained site is essential, as water-logging will have disastrous effects. The availability of water is also an important factor.

When these two requirements have been met, the soil should be tested (a) for pH and (b) for eelworm infestation. Soil samples should be taken from different parts of the site and submitted for testing. Messrs Colombo Commercial Co. Ltd., A Baur & Co. Ltd., or Fisons (Ceylon) Ltd., operate free services for testing soil. If the pH is between 4.5 and 5.0, then generally the soil can be considered suitable. A high pH can be corrected by applying Flowers of Sulphur at 1-3 ozs. per sq. yd., or 3rd lb to 1 lb. per cubic yard of bulked soil. The sulphur should be thoroughly mixed with the soil which is then watered daily for 6 weeks before planting operations commence. The addition of peat at 1:1 also reduces a high pH and improves the condition of the soil at the same time. Organic manure should *not* be mixed in the soil before planting cuttings.

Fumigation of nurseries on up-country estates is considered to be absolutely necessary and is desirable for mid-country estates (Hutchinson, 1969). The method currently used involves injecting the fumigant into the prepared soil, using an injector gun. Two guns are available: (1) Macleans "Fumigun" obtainable from Maclean Company, 1536 Industrial Way, Belmont, California, which costs Rs. 100/- F.O.B., and (2) the Shell Co. of Ceylon Ltd. market a gun called the SHELL D-D injector gun (MK 111 A) which has to be calibrated. An instruction leaflet giving complete details is available, but further advice regarding the use of this gun can be had from the T.R.I. The cost of the gun is Rs. 100/-. Using either Shell D-D soil fumigant, Shell Nemagon or Fison's Nematox at a dosage rate of between 25 and 30 Imperial gallons per acre, the soil must be injected to a depth of 6" every foot in each direction. This injector holds about 2 quarts of liquid and gives a standard injection of 2½ c.c. which is effective to a depth of 18". The cost of Shell D-D soil fumigant is Rs. 13/50 per Imperial gallon and Nemagon costs Rs. 100/- per Imperial gallon.

The operation should be carried out when the soil is moist and neither too wet nor too dry. Immediately following fumigation, the area should be heavily thatched with Guatemala grass, Mana grass, jute hessian, or empty manure sacks which have been washed. This is done to minimise loss of the fumigant which, being heavier than air, escapes by vaporisation because the soil is warm. The covering should be left on until three days before the land is thoroughly cultivated, and should then be removed to allow all the fumigant to escape from the soil. Planting operations can commence after three weeks during warm dry weather and after five weeks during wet weather. All soil used for basketing, regardless of its source, should be fumigated and this should be done under cover, preferably in a shed, to prevent the soil from drying out or getting too moist. It should be emphasized that sub-soil, jungle soil, or soil from Guatemala grass areas should be fumigated, since it is possible that soil brought into nurseries from areas which have not been weeded, or from areas which receive drainage water from infected areas above, may be heavily infested.

Note:—The use of Shell D-D or Fison's Nematox is recommended for up-country areas only. Nemagon should not be used at high elevations but is suitable for use in the low country.

Preparation of Beds and Cuttings

It is necessary to decide well in advance what cuttings are to be planted in the nursery. If mother bushes are available on the estate, a bud and two leaves should be removed from each shoot two to three weeks before the shoots are due to be taken for cuttings, in order to induce axillary bud development. A cutting with the axillary bud starting to develop gives better results than one with a dormant

bud. If possible, cuttings should not be taken during the latter part of the dry season or during a drought. If a particular clone is known to be a poor rooter, four to six applications of urea sprayed at weekly intervals (at an application rate of 1 lb. per 10 gallons of water, 6 lb. per acre), commencing immediately after the removal of the tips, will further assist axillary bud development. Spraying of urea must be done during reasonably dry weather.

Note:—Urea is an organic substance containing 46% nitrogen and is 2.2 times as concentrated a source of nitrogen as sulphate of ammonia. Being a neutral nitrogenous fertiliser both chemically and physiologically, it does not affect soil pH adversely and can be used as a foliar nutrient on mother bushes or for spraying plants in the nursery or in the new clearing.

When preparing nursery beds, it is recommended that beds be 3 ft. wide and 6-9 inches high. The earth should be loosened to a depth of 12-15 inches. All stones, roots and gravel must be removed to a depth of one foot and hard lumps of earth should be broken down or discarded. A good-textured soil is essential. It is generally desirable to use jungle soil as a top dressing. If tea fluff is used in any soil mixture, it should be added in the proportion of 1 part to 5 parts soil. The mixture should be allowed to decompose for about 3 weeks before use, being frequently turned over during this period and lightly watered. Imported peat moss, if available, can be mixed with the existing nursery soil and gives excellent results. The cost per bale of peat moss is approximately Rs. 40/-. Sub-soil (from 3 to 6 ft. below the soil level) has been found to be free from harmful organisms and, mixed with tea fluff 5: 1, makes an excellent top dressing. The mixture should be watered and turned over every week for six weeks before use.

Planting Cuttings

At St Coombs several methods have been adopted. The commonest methods are:

- (a) cuttings direct in beds with sub-soil and tea fluff 4-6" top layer;
- (b) cuttings direct in baskets with soil and tea fluff;
- (c) cuttings direct in polythene bags with soil and tea fluff;
- (d) cuttings direct in beds with nursery soil and peat moss 4-6" top layer.

Satisfactory results have been obtained from all four methods but costs vary considerably and the space factor has to be given serious consideration. These aspects will be dealt with later.

As soon as the beds are ready to receive cuttings, a light watering should be done. Single-node cuttings, consisting of one full leaf and an internode, should be taken, in the shade, with a very sharp knife (a bud-grafting knife is suitable) and immediately placed in a large galvanized bucket filled with water to prevent drying out. The lower end of the stem should be immersed in water immediately after cutting. Shoots should be divided into cuttings, the tender portion and the woody base of each shoot being discarded. Planting should commence as quickly as possible after cuttings have been taken.

Half-leaf cuttings, *i.e.* the top half of the nodal leaf cut off, allows for a greater number of cuttings to be planted. They root equally well, but subsequent growth is retarded by comparison with cuttings planted with the leaf intact.

The planting operation is an important one. The earth on the bed should be stamped down firmly with a plank immediately before planting. Light watering should precede planting and stamping down should be done before each section of approximately two to three feet is planted. Each cutting is held between the thumb and forefinger and inserted gently into the soil up to the axil of the leaf. Planting cuttings with ragged ends and bruised cuts should be avoided. The earth round each cutting must then be pressed down firmly to avoid leaving air pockets. Cuttings should be placed at an angle so that the leaves lie flat on the surface of the soil, in rows, and the apex of each leaf pointing into the direction of the wind. Further light watering should follow immediately after planting. It should be noted that planting in heavy rain should be avoided. In the case of baskets and polythene bags, the amount of earth required from outside is quite considerable. The mixture of sub-soil and tea stuff 5:1 is recommended. The polythene cylinder in various sizes can be purchased locally by the roll and cut into the required lengths with a sharp knife or blade. The most useful size for nurseries is 6" wide in the roll; when this is opened out into a cylinder, its diameter is nearly 4" (actually 3.82"). The bottom of the bag can be stapled or spot-welded with a candle flame in the centre to simplify filling and early handling. Two holes are punched on either side of the bag, about midway down. This allows for seepage of excess water and allows air to pass through the bag. It has been noticed that moss forms rapidly inside the polythene cylinder but this has no detrimental effect on the eventual success of cuttings planted in this manner. The bags are filled with earth and packed as tight as possible without causing damage to the bag. Bags are placed next to each other and held together by supports of either planks, round timber, or cement bricks.

Either one or two cuttings are planted in each bag. The dry weight of earth per small polythene bag, 4" in diameter and 9" long, is approximately 3 lb. The larger ones from a 10" roll are 6.35" in diameter; at 9" long, they hold about 9 lb of dry soil. These polythene cylinders will last for at least 14-15 months, perhaps longer, and they are unlikely to disintegrate in the way that baskets do. Various types of baskets can also be used but it is doubtful whether any bamboo basket will last longer than 8-9 months without disintegrating. The dry weight of earth per basket of 6" diameter at the top and 9" high is also 3-3½ lb.

Shade Requirements and Watering

It must be remembered that shading and watering are interdependent operations. If shade is dense, less watering is required but with less shade more water is needed. But over-watering and over-shading are equally harmful and will result in rotting, poor rooting, and decreased growth. The ideal should be to have medium shade, sufficient for the very light filtration of sunlight. In order to avoid wilting and sun-scorch immediately after planting, watering should be done in small quantities and often, so that the atmosphere under the shade is reasonably humid and cool. Various methods of shading can be adopted but the cheapest is bracken fern which is inserted in clusters between the cuttings and along the sides of the beds. This method depends entirely on the availability of fern. The taller the fern the better. Variations which have proved successful are as follows:—

- (a) using the taller fern in the middle of the bed and the shorter fern on the sides, tapering gradually from the middle towards the sides;
- (b) using fern of one height, at least 2 ft tall;
- (c) building a frame with stout poles round the bed with small cross poles sufficiently close on top to insert short fern over the top of the frame. Fern has to be inserted along the sides of the bed as well.

Other methods are:

- (d) bamboo slats;
- (e) iron or bamboo hoops with open-weaved coir matting, the size of mesh to range from $\frac{1}{8}$ " to $\frac{1}{4}$ ". The width of mesh will depend on local climatic conditions.

Of the above methods the most efficient system though not the least expensive is (e) because it provides equal light conditions over the whole bed, makes nursery operations such as weeding and manuring easier, and can easily be taken off to replace dead cuttings in the first few weeks after planting. The matting can be used over and over again. During warm weather, the sides can be lifted for a short period in the morning to allow for increased air circulation after the cuttings have rooted. At this stage less watering and more light are required.

For large nurseries the purchase of a sprinkler may be worthy of consideration, since watering can then be easily controlled. Watering should not be done at all during rainy weather and, even at other times, only if the soil shows signs of becoming too dry. Watering should be done intelligently, *i.e.* to keep the soil moist, and not too dry or soaking wet. A water-logged soil is very bad.

Transplanting

The ideal to be achieved in the nursery should be a high percentage of cuttings successfully rooted, healthy vigorous plants 10-12" high in 9-10 months, and a low cost of producing a plant. There are three methods of transplanting generally practised:

- (a) cuttings in callousing beds are transplanted into baskets and finally transplanted into the field;
- (b) cuttings are planted direct into baskets or polythene bags and these are transplanted into the field;
- (c) cuttings are planted direct into beds and transplanted directly from the nursery into the field (bed plants).

The use of callousing or rooting beds is a thing of the past; it is unnecessary, and costs and nursery space are all important. The use of baskets is expensive, but assuming that only small numbers of plants are handled each year, as in the case of multiplication plots and small clonal blocks, or if the plants are liable to be subjected to long periods of drought, or are planted in areas where the soil conditions are poor, then there is ample justification for the use of baskets. Direct planting in polythene cylinders, however, has so far given excellent results and costs are a good deal lower than when using baskets. These cylinders have many advantages over the basket, namely, disintegration is less, the soil is held together more compactly, moisture retention is greater and therefore watering is reduced from a daily to a bi-weekly operation, and manure is not leached out as easily.

When large areas are to be replanted, involving hundreds of thousands of plants, a realistic approach should be adopted. Bed plants have been grown with great success, but correct spacing initially in the nursery is essential. This brings us to the matter of nursery organization.

Nursery Organization (Land Requirements)

Three methods are postulated: A + B—rooting in beds, then transplanting into small polythene cylinders or baskets, which are later planted in the field; C—rooting direct into clipped polythene cylinders which are slit open when planting in the field; and D—rooting in beds followed by naked root (not balled) planting in the field. All beds should be 3 ft wide and paths are assumed to be 20 inches wide.

The distance between rows and the distance in the rows is generally 3" × 3" or 3" × 4" where rooting beds are concerned and 4" × 4" where direct bed plants are concerned. The cuttings are put at half of these distances from the edges of the bed and the numbers of cuttings per square yard are then as follows:—

- (a) 3" × 3" = 144 cuttings
- (b) 3" × 4" = 108 cuttings
- (c) 4" × 4" = 81 cuttings

The distance between rows and the distance in the rows for baskets and polythene cylinders depends on the size of basket or polythene cylinder; some examples of the number per square yard are as follows:—

- (d) small polythene cylinders 9" long, 4" diameter=90 bags per square yard.
- (e) large polythene cylinders 10" long, 6" diameter=30 bags per square yard.
- (f) baskets 7" long, 5" diameter (tapering)=about 60 baskets per square yard.

Therefore the bed space, without paths, required for one field acre, *i.e.* 6,000 cuttings or sufficient material to plant 5,000 on ONE acre is as follows:—

(a) Rooting beds 3" × 3"	=	42	square	yards	per	field	acre
(b) Rooting beds 3" × 4"	=	56	"	"	"	"	"
(c) Direct bed plants 4" × 4"	=	74	"	"	"	"	"
(d) Small polythene cylinders	=	67	"	"	"	"	"
(e) Large polythene cylinders	=	200	"	"	"	"	"
(f) Baskets	=	100	"	"	"	"	"
(a) + (d)	=	109	"	"	"	"	"
(b) + (d)	=	123	"	"	"	"	"
(a) + (e)	=	242	"	"	"	"	"
(b) + (e)	=	256	"	"	"	"	"
(a) + (f)	=	142	"	"	"	"	"
(b) + (f)	=	156	"	"	"	"	"

From the above, it will be seen that where direct bed planting (c) is used, the bed space required in the nursery is comparatively small, and that direct planting into small polythene cylinders (d) does not entail a great deal of space when compared with the combination of rooting beds and small polythene cylinders (a) + (d), or of rooting beds and baskets (a) + (f).

Nursery Organization (Soil Requirements)

The volume of earth in cubic feet in relation to the depth of top soil layer *per square yard* of nursery bed and the total volume per square yard of polythene cylinders and baskets is as follows:—

(a) Rooting beds 2" top layer	...	1.5 cu. ft.
(b) Rooting beds 4" top layer	...	3.0 "
(c) Direct bed plants 6" top layer	...	4.5 "
(d) Small polythene cylinders	...	5.3 "
(e) Large polythene cylinders	...	7.0 "
(f) Baskets	...	4.5 "

Therefore the volume of earth required for one field acre, *i.e.* 6,000 cuttings or sufficient material to plant 5,000 on one acre, is as follows:—

(a) Rooting beds 2" top layer (3" × 3" × 2")	...	62 cu. ft.
(b) Rooting beds 4" top layer (3" × 4" × 4")	...	167 "
(c) Direct bed plants 6" top layer (4" × 4" × 6")	...	333 "
(d) Small polythene cylinders	...	450 "
(e) Large polythene cylinders	...	1,500 "
(f) Baskets	...	450 "
(a) + (d)	...	512 "
(b) + (d)	...	617 "
(a) + (e)	...	1,562 "
(b) + (e)	...	1,667 "
(a) + (f)	...	512 "
(b) + (f)	...	617 "

The volume of earth required for direct bed planting (c) is the smallest and direct planting into either small polythene cylinders (d) or baskets (f) does not require much more. The combination of rooting beds and small polythene cylinders (a) + (d) or rooting beds and baskets (a) + (f) requires a little more but the very large amounts of soil are needed when large polythene cylinders are used. For easy working the following table is given:—

1 cu. ft. of sub-soil	=	74 lb.
1 cu. ft. of wet earth	=	101 lb.
1 cu. ft. of tea fluff	=	21 lb.
1 cu. ft. of tea fluff and sub-soil in proportion 1:5	=	60 lb.
24 cu. ft. of loose soil	=	2,240 lb.

Manuring

This important operation should commence 8-12 weeks after planting, *i.e.* after the cuttings have rooted. Commence with 6-8 applications of STARTER MIXTURE No. 1, applied once a fortnight at 4 ozs. per 10 gallons of water on approximately 10 sq. yds., followed by 2-4 ozs. of an organic such as STERAMEAL 'A' per sq. yd., once per month thereafter. Naturally, there are other organic and

inorganic fertilisers available on the market and any of these could be used. Manure should be scraped in with a small stick or iron prong and care should be taken not to manure too near the cuttings as this will scorch the leaves. Soluble manures such as T/175 can also be used at an application rate of 4 ozs. per 10 gallons of water on 10 sq. yds., applied once fortnightly. Constant stirring during application is necessary because the phosphate tends to settle at the bottom of the watering can. Diluted cattle urine or cattle manure in water has produced excellent results. It is most important that regular applications of manure be given. Often after the cuttings are planted and the shade put on, no further attention is given for several months; this is a common mistake which should be avoided. Gradual thinning out of shade from time to time is necessary.

COMPOSITION OF MANURE MIXTURES

	N	P ₂ O ₅	K ₂ O
T/175 mixture ...	20.6	14.75	12.5
Sterameal 'A' mixture ...	6.4	9.2	9.4
Starter Mixture No. 1 ...	13.9	17.5	12.0

Weeding

Regular weeding is necessary and all weeds should be hand-picked with the minimum of soil disturbance.

Spraying

During wet-weather conditions, all cuttings and plants in the nursery should be sprayed regularly with copper fungicide, 4 ozs. per 10 gallons of water, at intervals of between 5 and 7 days.

Pests

A periodical check should be made for pests such as Tea Aphids, Thrips, Mealy Bugs, Scale Insects, Yellow Mite, Cut-Worms and particularly White Grubs. Control measures should be adopted when necessary without delay and detailed information regarding control measures can be obtained from the T.R.I. on application.

Summary

- (1) The ideal soil for propagation of cuttings is one which has a friable texture, good drainage, and good aeration, as well as a good capacity for holding water. Sands and clays should be avoided. Tea fluff and sub-soil 1:5 has given satisfactory results.
- (2) With any large replanting programme nurseries have to be relatively large and soil requirements are heavy.
- (3) The time has come to do away with callousing beds and baskets. There are two alternatives—(a) bed plants and (b) cuttings planted direct into polythene bags.

- (4) The pH in the nursery should not exceed 5.0 and the soil should be fumigated routinely for Meadow and Root-knot Eelworm before planting.
- (5) The rate of manuring should be 1-2 oz Steramecal 'A' (organic) or $\frac{1}{2}$ -1 oz T/175 (inorganic) mixture per 24 plants at least once per month.
- (6) Over-shading and over-watering will result in total or partial failure and these operations should be well controlled. Soil and weather conditions should be taken into consideration at all times.

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References

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Note on shape of nursery

If the nursery consists of a single very long bed, it will have a footpath all round it, but only one side of the path will be bed. If several shorter beds are used, the footpaths between beds need be no wider, but each will be useful for two beds and thus footpath-space will be saved. With beds 3 feet wide and footpaths 20 inches wide, the most economical shape of nursery will have the bed length in inches equal to 112 times the number of beds. Roughly speaking, the bed length will then be about twice the total width of the nursery. Over one-third of the nursery at least will consist of footpaths; while a single long bed would be more than half footpath. (Ed).