

Site selection



- The site should be well sheltered from the prevailing wind
- Exposed to the sun so that the developing plants may benefit from the sun's warmth
- In cold areas site should be chosen to maximize on the sun while in hot areas some sheltering from full sun's heat is essential
- Low-lying areas which are susceptible to flooding during rains or frost attack during dry months should be avoided
- Closeness to a good source of water is prerequisite

- The locality's soil should be free draining and friable. Well-drained soils in the wet tropics are usually reddish in colour
- Both the topsoil and sub-soil should be tested for pH. pH between 4.0 and 5.8 is ok but the optimal range from 4.5 to 5.6 is generally accepted

Nursery Preparation



- The nursery should be sited near or on a site that is suitable for propagation to reduce or avoid transportation costs of soil to the nursery
- The site should be dug to a depth of about 30 cm
- The soil should be roughly leveled and beds marked out: the beds should be no wider than 1.5 m, and should be spaced at 45 cm.
- The beds should be aligned so that these beds can act as drains
- Soil should be removed from the paths and placed on the beds until the beds become raised 15 cm above the paths

- The beds should then be raked to provide a soil of fine tilth
- During the placement of soil-filled sleeves, ensure the sleeves are supported by light walls or wire round each bed; walls are preferable as they will later provide protection to the sleeves and roots in the sleeves on the edges from being sun-scorched
- The nursery should be provided with light dappled shade which in a high shade nursery, should be raised at least 2 m above the beds so that it is easy to walk in the nursery

Nursery soil

- Ideally, the topsoil should have a pH about 5.6 but the subsoil should have a pH of about 5.0
- Sub-soil with high clay content has poor drainage and therefore should be avoided
- Cuttings show no to poor rooting in soils of pH above 5.5 or which contain a large proportion of organic matter (humus)

- They should therefore be planted in subsoil or in soil from below long established grass
- The plants will grow best as the roots penetrate a more fertile soil
- When the topsoil or subsoil is being used for the first time it is advisable to test the soil for acidity (pH) before filling the sleeves
- Soil of pH above 5.5 should not be used

Polythene sleeves



- The size the sleeves will depend upon the size of plants required by the grower; larger plants will require larger sleeves and vice versa
- Large sleeves accommodate fewer plants in a bed which adds to cost of production
- Large sleeved plants are heavy and transport costs from the nursery to the field are high if distance is long

- Ideally, plants that are 20-30 cm tall at planting, which is usually reached when plants are six to eight months old, small sleeves which are 10 cm lay-flat, 6.25 cm circular diameter, 150 gauge and 25 cm long should be adequate
- Plants used for infilling require larger sleeves i.e. sleeves with circular diameter of 10 cm, 15 cm lay-flat, 250 gauge and 35-40 cm long

- Sleeves should be spot-sealed or stapled once in the middle of the bottom edge to help hold soil in place and to effect drainage
- A few holes punched near the bottom edge help drain off excess water

Filling sleeves

- Fill the sleeves to a height of 17.5-18.0 cm topsoil or topsoil/subsoil mixture mixed with fertilizer ($600\text{g}/\text{m}^3$ for single superphosphate (SSP) or $300\text{g}/\text{m}^3$ for DSP/TSP) and the top 7.0-7.5 cm filled with subsoil only
- The soil filling the sleeves should be packed fairly firm; it should neither be packed loose nor should it be packed hard and should be damp at all times

- If the soil is dry before filling the sleeves, it will run out of sleeves as fast as it is put in (where the sleeves are spot-sealed at the bottom edge)
- If the soil in the sleeves is allowed to dry up, it becomes extremely difficult to wet it later
- All roots and hard soil lumps or stones should be removed from the soil used to fill sleeves

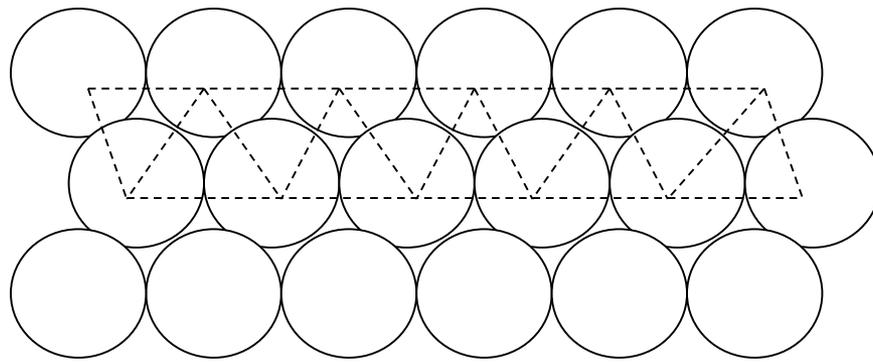
Nursery construction

- The size of the nursery depends on the number of plants required by the grower and can range from a small unit of about 1200 plants to a large nursery with thousands of plants
- There are two types of nurseries: low shade and high shade. The choice of the type of nursery to construct will depend upon the availability of the construction material or upon personal preference

Low shade nursery

- For building walls, woven bamboo laths are convenient, but even sacking, bracken, tree branches, bricks etc. can be used for the side shade
- The beds can be of any length, but 30 m (100 ft.) is convenient for large beds
- The beds should lie in a North-South direction

- The sleeves are then stacked carefully, leaving a gap of about 15 cm and 30 cm between the stacked sleeves and the side and end walls, respectively
- The polythene sheeting, or tent as it is sometimes called, will be sealed into this gap



Triangular stacking



Low shade nursery bed constructed with bamboo laths

- Hoops to support the polythene sheeting should then be placed every 1 m or less along the bed.
- These should be slightly curved or slope towards one side of the bed so that rain water will easily run off the surface of the polythene.
- The hoops should not be less than 20 cm above the top of the sleeves.

- After planting and thoroughly watering the cuttings the clear polythene sheeting (250 or 500 gauge) should be stretched taut over the hoops and sealed into the space between the sleeves and the walls
- To effect this sealing, soil from the space between the beds should be lowered
- The difference in level between this pathway and the top of the sleeves should be at least 15 cm.

- Until young plants have about 7.5 cm long roots, they should be kept shaded under a uniform overhead shade which allows only a little dappled light to pass through. The shade can be provided by bamboo lath frames, hessian sacks, coffee drying cloth, basked woven into chicken wire frames or frames made from papyrus, maize and Napier or elephant grass stems. This shade should be about 5 cm above the topmost part of the hoops in cooler areas, but in warm areas the shade should be about 30 cm above the hoops to increase the air space below the shade and, thus, reduce the temperature (smaller air spaces in cooler areas take shorter time to heat up and, hence, increase the temperature in the bed).

- If cuttings are grown in temperature which is too high they become extremely susceptible to fungi. cuttings are best grown in temperature of about 27°C. They are also highly susceptible to fungicides unless these are applied at very much lower concentration than that which is normally recommended. If fungal disease occur, the polythene should be opened up immediately to reduce humidity of the air.

Functions of the polythene cover:

- It prevents loss of soil moisture.
- It preserves a high atmospheric humidity.
- It increases the air temperature and keeps the temperature range inside the polythene cover low.

High shade nurseries

- In a high shade nursery, walls are constructed along the outside perimeter of the nursery only and not for each individual bed. As in the low shade nursery, any material can be used for walls and shade, providing dappled light passes through it. Marking out of the beds is preceded by building the side walls and the shade. Then timber planks, off-cuts, fitos, smooth fencing wire etc. are used to hold sleeves in place. Digging trenches 20-25 cm deep to stack sleeves into is not recommended because it can lead to water-logging.



- Hoops are then placed over the sleeves as in the low shade nursery.
- High shade nurseries are usually cooler than low shade ones and heavy drops of rain water falling through the shade may damage rooted cuttings. For the beginner, it can be difficult to manipulate the density of the shade in the nursery or parts of the nursery if plants grow at different rates (or are propagated at different times) and, hence, need different treatments. Attempts to improve the growing conditions by thinning out the shade may lead to excessive shoot growth without corresponding root growth.

Preparation of cuttings



- The cut branches or pruning's for cuttings are wrapped in wet sacking and taken to a shelter near the nursery where they are immediately watered.
- These pruning's should be kept under shade. Cuttings should be made under shade and kept shaded at every stage thereafter. Only vigorous young shoots between five and seven months old should be used to make cuttings.
- The very soft tips, which can be determined by placing the stem on two open fingers and pressing in between with thumb, and the very hard lower parts of the branches where bark is forming should be discarded; if cuttings are too hard they will grow poorly and produce flowers which exhaust the food reserves in the stems and this may lead to death.

- The good shoots are made into individual cuttings, each consisting of a single leaf with 3 to 4 cm of stem below the leaf
- This is done by making two cuts; one just above the bud and sloping away from the bud, and second across the stem 3 to 4 cm below the bud again using a sloping cut. Cuttings are prepared by using very sharp knives. If the internodes are short, so that less than 3 cm of stem will be below the lower leaves, use cuttings with extra leaves but remove the lower leaves. Immediately cuttings are prepared, they should be placed into a container full of water, such as a basin, karai or debe.

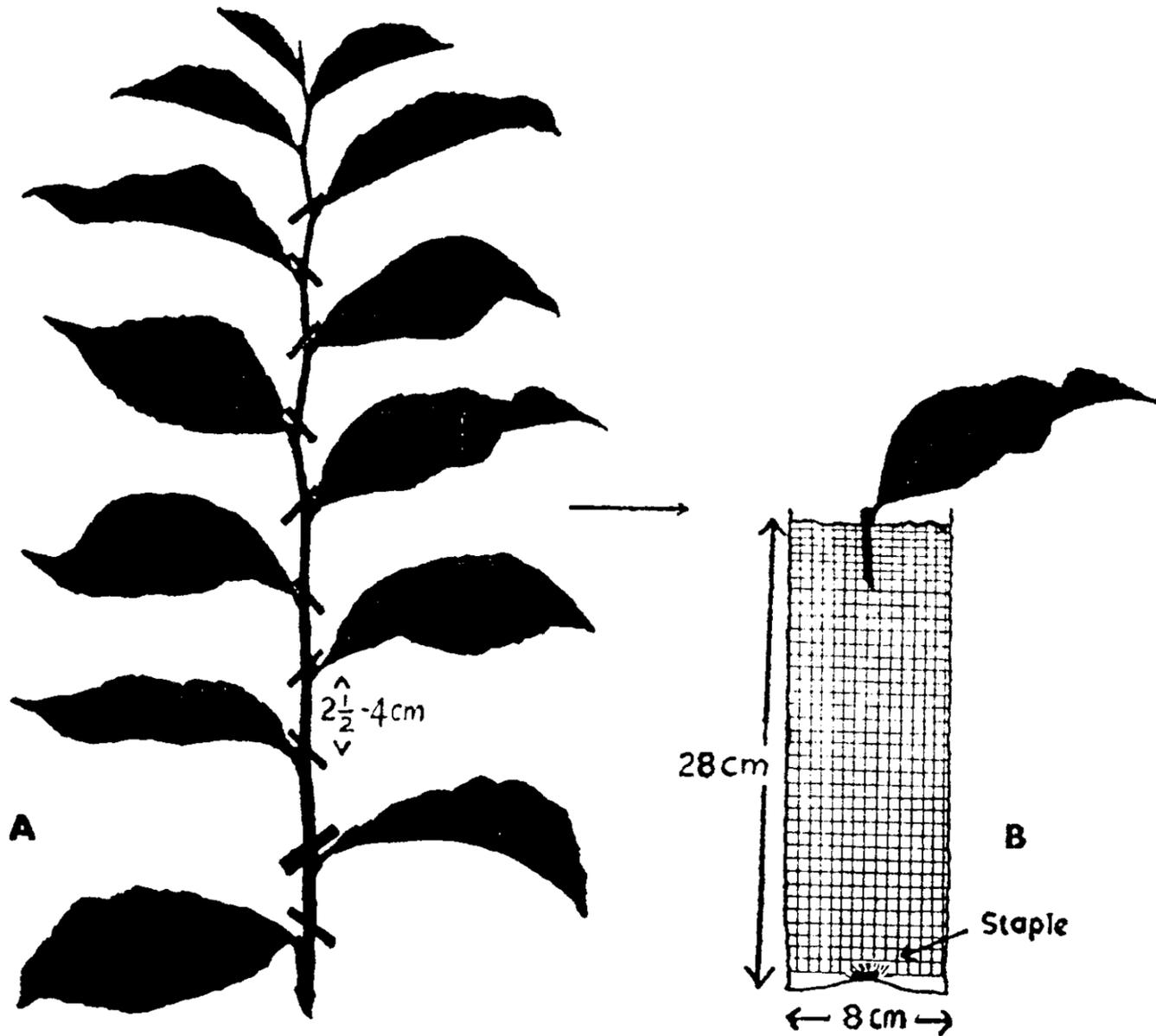


Fig. II : 3

- (A) Division of a tea shoot into internodal cuttings
(B) Polythene sleeve with one cutting

- Cuttings are soaked in water for about 30 minutes before being planted. Too many cuttings should not be placed in the container otherwise the top ones will not be in the water and the bottom ones will be pressed so hard that the leaves may be damaged.
- Cuttings with damaged leaves should be rejected because they generally grow slowly or die if fungal diseases attack them through the wounds.

Planting cuttings



- Cuttings are planted in the sleeves so that the leaves do not rest on the soil surface and the bud is just above the soil level
- Where the cuttings' leaves are naturally deflexed (bending backwards instead of upwards), the stems should be inserted into the soil at an angle so that the leaves are clear of the soil
- During planting, fingers should not touch the top or bottom cuts of the stems as the sweat from the fingers may affect survival
- The cuttings are kept moist during planting by frequent watering.

- When the whole bed is completely planted, the cuttings and the soil between the sleeves and the walls are thoroughly watered. Watering should be done gently as strong jets may displace cuttings
- The clear polythene sheeting is then stretched taut over the hoops and sealed into the soil, all round the bed. To help stretching and sealing the polythene sheeting, a few turns of sheeting are made round pieces of wood at both ends of the bed and after stretching the polythene sheeting, these pieces of wood are buried length wise in the soil
- Immediately afterwards, the beds must be shaded in the case of low-shade nursery.

Care after planting cuttings



- All beds should be inspected at least once a week. Little condensation found on the under surface of the polythene sheeting, suggests that the soil in the sleeves is becoming dry due to either inadequate watering or that the sheeting is torn or that the seal is poor
- These faults should be checked and the aim is to have a heavy condensation inside the sheeting, sufficient to prevent a clear view of the cuttings inside. The beds should be regularly checked for weed growth, insect pests and diseases and treated as necessary. Weeding should always be by hand pulling. Chemical herbicides should not be used. After each opening or after the faults in the polythene sheeting are corrected, the beds are watered thoroughly and covered again.



- If the nursery becomes too cold or the growth of cuttings is slow due to heavy shading, the shade should be thinned slightly
- In the cooler areas the shade should cut out about half the daylight, but in hotter areas a more dense shade may be necessary
- During dry weather the soil around the polythene should be kept damp. Mist units have been used in VP nurseries successfully but they are expensive and there is a possibility of losing many cuttings if there is a power failure.

Hardening-off

- When plants grow under polythene sheeting and shade, they are soft and will scorch and many of them will die if the polythene sheeting is removed too quickly without a hardening-off period.
- Methods of hardening-off are:
 - Hardening-off in low-shade nursery
 - Hardening-off in high-shade nursery

Hardening-off in low shade nursery

- During the first four weeks of hardening-off, the polythene is gradually opened but throughout this period the lath shades or other types of shades are kept in place and not removed.
- As soon as the new shoots are about 20 cm (8 in) tall (12 - 16 weeks), the polythene sheeting should be raised on the side away from the direction of the prevailing winds, at intervals of 3 m (10 ft) along its length. Each opening is held up by a stake and the rest of the polythene remains sealed in the soils so that a series of small vents are formed.

- The number of vents is doubled one week later by raising the polythene sheeting at 1.5 m (5 ft) intervals. During this time, the soil in the sleeves should not be allowed to dry and watering is done through the vents by a hose pipe. In the third week, the polythene on the vent side is rolled up completely to the top of the hoops thereby leaving one side of the bed covered.
- At the fourth week, the polythene sheeting is removed completely, washed thoroughly, dried and carefully stored under cover for further use. The polythene sheeting should not be left exposed to the sun for any length of time during storage because it will be damaged.

- Two weeks after removal of the polythene sheeting the shade frame is raised 30 cm (1 ft) on one side only and supported by stakes. Thereafter, it is raised 30 cm (1 ft) every week for three weeks after which it can be completely removed. Plants are ready for transplanting after the complete removal of the shade. Plants must be watered as necessary and fertilizer applied weekly until they are transplanted.

Hardening-off in high shade nursery

- Hardened off is the same way as under low shade up to the stage of removal of the polythene sheeting
- An alternative method involves loosening the polythene sheeting at both ends of the bed and leaving the polythene sheeting loose on the ground for a week. One week later, the polythene is rolled up at both ends and left that way for a week so that air may circulate. Then the polythene sheeting is rolled up 30 cm (1 ft) at each end and a week later it is rolled up 120 cm (4 ft) at each end. This weekly opening continues to increase by 1.2 m (4 ft) per week until the whole bed is uncovered.

- After removal of the polythene sheeting, the shade and side walls are thinned gradually by removing some of the covering material, a little every week, until all material providing the shade and covering the walls is completely removed after about four weeks
- If the weather changes and dries suddenly and plants start scorching, the hardening-off should be postponed or the beds re-covered. When the weather improves the hardening-off is resumed.

Size of new plants at transplanting time



- **New clearing:** It is suggested that plants with one shoot 20 cm (18 in) tall, or 15 cm (6 in) if decentred, or with two or more shoots 15 cm tall and with roots which have reached the bottom of sleeves (25 cm or 10 in long) are ready for transplanting.
- Plants which reach 30 cm (1 ft) tall in the nursery should be cut-across (decentred) at 15 cm.
- For **in-filling:** it is suggested that plants should remain in the nursery for about 18 months and be pruned at 15 cm (6 in) when they reach a height of 30 cm (1 ft) and again at 20 cm (8 in) when they reach a height of 35 cm (14 in). This pruning will encourage low branching. If at transplanting infills have long soft shoots, they should be transplanted during dull weather or be shaded lightly

- Ratios for mixing lower part of rooting medium
 - Forest soils: SSP 600g/m³
Sulphate of potash (SP) 300g/m³
Grassland soils: SSP 600g/m³
SP 300g/m³
SA 300g/m³
 - Exhausted soils: DAP 600g/m³
SP 300g/m³
- Fertilizer Application after rooting
 1. After hardening-off: weekly application of NPK at 1g/m² of N 1.3L of water
 2. Later: Monthly application of NPK at 4g/m² of N in 1.3L water