1. peat, bark, pumice, plus Premix

2. peat, bark, pumice, topsoil, plus Premix

3. peat-60%, pumice-40%, plus Premix, micronutrients, and wetting agent.

4. peat-80%, pumice-20% plus lime and organic Premix.

What we are working at now and have been able to do for many crops is to eliminate the topsoil entirely from our mixes. The step after the elimination of the topsoil is to use only a handful of soilless mixes that can be used on all the crops, from propagation through to saleable plant.

CONCLUSIONS

The key to quality in saleable plants in the wholesale nursery starts with the cutting material. You have a check on that quality by the records you keep of the plants, whether from your own stock plants or from sources that you buy-in. The employees are another key to your quality in that they know what quality you want "stuck" in the pots and they continue that process as they care for the plants. The final way that you can get your plants off to a good start is in the type of medium that you use for growing and making sure that it can meet the criteria that you establish that will give quality and quantity of plants.

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INTEGRATED TECHNIQUES FOR PROPAGATING AND CONVEYING COMPACT GRAFTED TREES UNDER THIRD WORLD CONDITIONS

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Abstract. Weight reduction to about 150 grams of grafted tropical and subtropical nursery trees has been achieved here by multi-directional air root-pruning, thereby moulding the root system into a flat compact mass that substitutes for containerization. This opens up the possibility of supplying genetically improved nursery trees to distant locations, particularly hill and arid regions in the Third World. At destination, the nearly bare roots can be inserted into a mud solution to fill in and protect the fibrous mass. This forms a flat solid rootplate that can be planted very fast by placing against an 18 cm. vertical wall of a small hole, made by a stroke or two of a hoe.

In the first growing stage, rootstock seedlings are air root-pruned in baskets of 6 cm. depth. Subsequently about eight are transplanted horizontally into narrow plastic mesh trays by pressing the root systems flat on the substrate surface and covering. The trays are then placed in a semi-upright position on rods approaching eye level. The slanting position prevents the substrate from sliding out. The technical advantages of the method are: ease and perfection of flat root transplanting; preventing trees grown in a small volume of substrate from being blown over; allowing for a continuous thick mulch to prevent drying out of the surface and supplying constant nutrition; optimum aeration and drainage prevention of overheating of substrate at edges by use of a white polyethylene curtain; ease of extracting trees by shaking. Special micro-grafting processes are used; length is substituted for width in the cuts, to permit precise work on the slender upper part of the rootstocks. Reasons for the generally high positioning of the grafts are: ease of forcing the scions into growth; less wastage of rootstock growth when cutting down to scion; high grafting success; the perfection of graft unions when effectively moulded on relatively soft young rootstock growth. Thin scion material sometimes has to be grown on hedged mother trees.

Propagation as a catalyst for ecological regeneration. The increasing scale of both tropical forest destruction and desert encroachment is well publicized. Although reforestation is the generally accepted solution, it is too long a process to interest populations primarily needing quick growing crops for immediate consumption. One possible key to the reversal of the erosion problem could lie in the sphere of asexual propagation of crop bearing trees, initially by reason of their early bearing. If such trees could be made cheaply available in tropical hill and arid regions, and could prove more remunerative than the destructive arable cropping, then the promise of permanent yields could help tie shifting peasants to a productively restored piece of land. Planned mixed plantings of genetically standardized trees at village level would be a new economic factor in these areas: fruits, nuts, forage, and plantation trees eventually create multiple new trading products in local processing plants. Naturally this is an issue that has to be treated in a much wider social and economic context; but if mass clonal tree crop propagation can be accepted as a potential catalyst for ecological and economic regeneration, then the main technical problem is how such trees can be supplied to vast climatic regions where all modern facilities are lacking.

Poor communications make it impractical to transport unwieldy, heavy containerized nursery trees through hot climates; they are uneconomic for air-freighting and too cumbersome for primitive conveyence. They need to be lightweight, compact, well insulated and conveniently packed for watering in transit. Consequently they have to be extracted from the original substrate. Widely branched, inflexible, and sometimes spiralling roots, common to containerized and field-grown trees, cannot be handled bare-rooted for packing without destroying the finer roots. In order to allow continuing functioning of these finer roots, they need to be concentrated within small dimensions, so that protection by some moist surrounding material can be arranged. As a result of this requirement, a flat, rectangular heavily-branched root configuration uses the least covering material when packed or re-rooted in, say, vermiculite or sawdust (Figure 1). At the ultimate field planting site, trees with root systems of this nature can be inserted in a mud solution prior to and until the moment of planting. The mud adheres to and fills in between the closely knitted roots, forming a flat rootplate. These rootplates are quickly planted by placing them up against vertical cuts in the soil made with a hoe.

The production methods for this kind of field plantable tree are described below.

Equipment. The nursery is preferably situated in the open, in full sun. The high density of the trees calls for maximum light; 8 mm metal rods at a height of about 1 metre run lengthways to form a table top. A single row of 60 cm trays are placed in a semi-upright position on the rods. The rows should

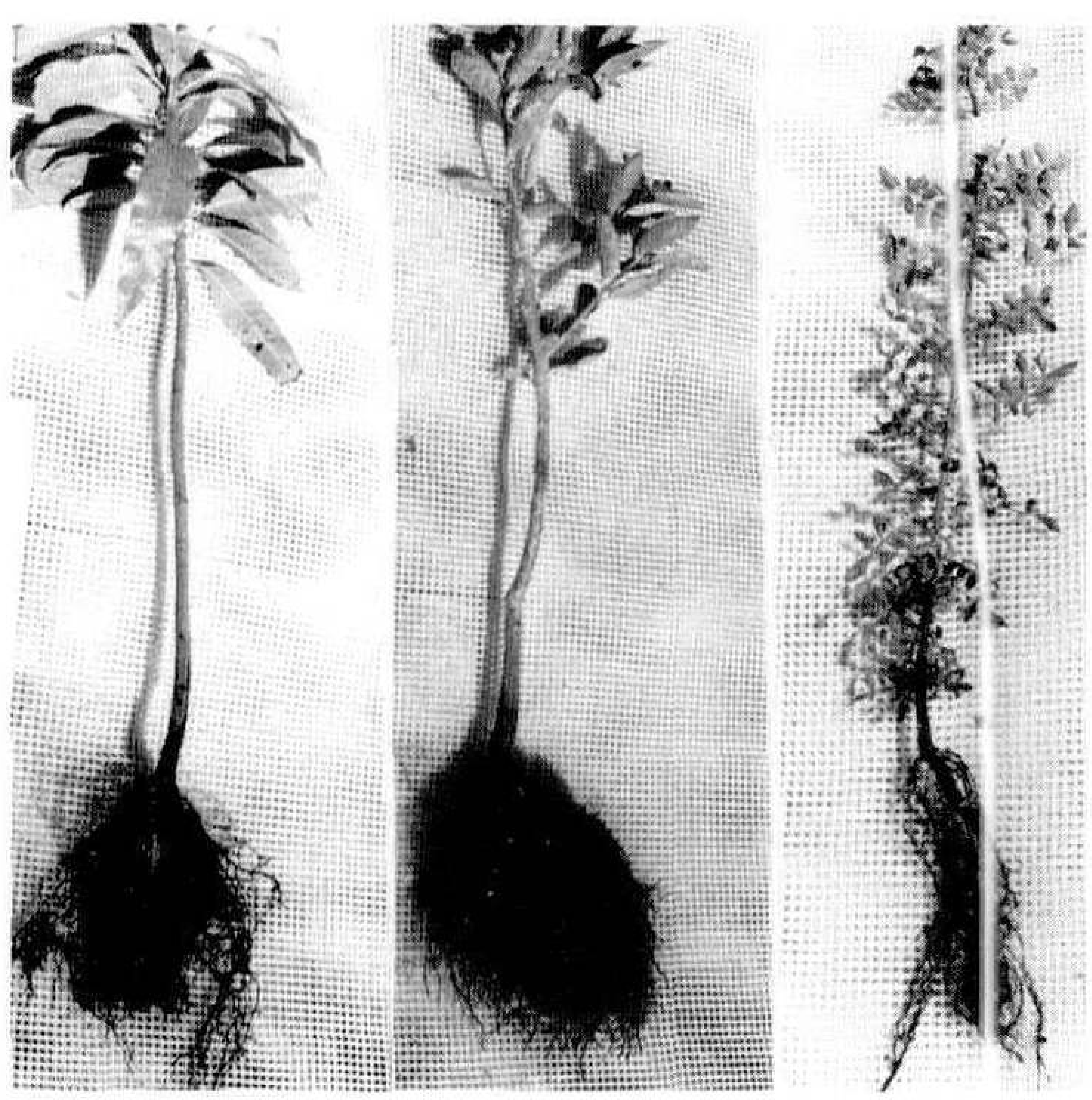

Figure 1. Root systems developed by plants propagated by the described methods.

preferably run north to south so as to allow shading underneath, if needed. Length of rows is as convenient. Firm black plastic mesh trays 60 cm × 18 cm × 6 cm are made by hand, but a manufactured product would be preferable; 60 cm lengths of plastic piping, or something similar, are attached to the upper back part of the trays, so that when they rest on each other, an air division remains, which prevents root interlacing (Figure 2). Wide sheets of white polyethylene are fixed along the outside edges of the trays to prevent drying and overheating. Any suitable overhead watering system can be used.

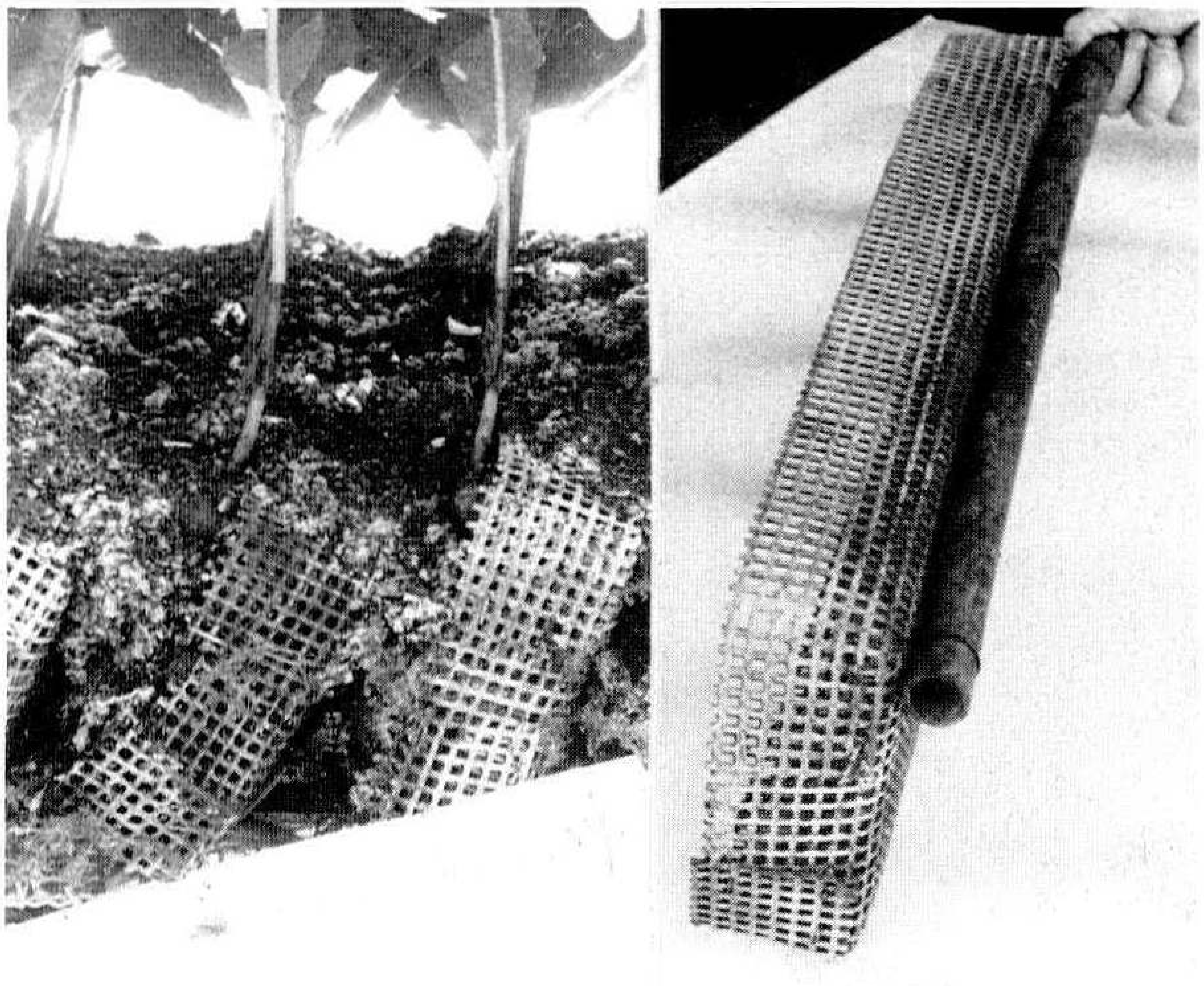

Figure 2. Plastic rooting trays showing their use when placed at an angle.

The factors determing the composition of the medium to fill the trays are much the same as with any other well drained form of containerization, except that it should be sufficiently adhesive not to slide out of the trays when they are in a slanting position. Numerous mixtures of quite different compositions have been under trial here, most having both good and bad points. The major consideration is probably what is most easily and cheaply available. Sawdust is lightweight and gives good fibrous rooting. It has two known shortcomings; nitrogen deficiency and sometimes toxicity. After exposure to winter rains it seems to be satisfactory, although somewhat variable. Nitrogen deficiency can be a problem and expensive to overcome; however, the nature of the semi-upright trays has made it possible to overcome this. The trays are filled with alternative vertical layers of sawdust and compost, four in all. The compost layers need to be thick enough to prevent the sawdust tying up available nitrogen, which occurs when sawdust and compost are mixed in the usual way. Another mixture that is, in fact, somewhat preferable to the above is tuff and composted sewage sludge, both cheaply available and the tuff being re-usable. It is heavier than the first mixture, but moisture control is better, and filling the trays is simpler. Peat, and various manufactured products are too expensive here, and unnecessary. A small percentage of loam in the mixtures helps to avoid nutritional problems.

A thick sheet of mulch is used above the trays as insulation and to prevent drying. Cotton seed husks are used for the purpose. They decompose slowly, but after a year they need replenishing. Sieved compost powder is broadcast on top of the mulch from time to time so as to supply additional nutrition by filtration.

First stage of air root-pruning in shallow baskets. Most rootstock seeds are germinated and grown in their early stages in the trays mentioned above but laid flat, giving a depth of 6 cm. These are also placed on the rodded tables so as to stop tap root growth almost immediately after germination and start lateral root development near the collar. The embryos of large seeds such as mango and pecan have to be planted uppermost in such a shallow substrate. Seedlings are retained in this growing condition usually until about May, when some lateral root development should have taken place but before the weather heats up too much to make transplanting a problem. There are five reasons for transplanting rather than direct sowing:

i). Convenience of concentration and care in early growth stage.

ii). Creating a root system that exploits the entire substrate, not only the lower part.

iii). Creating the initial flat configuration of the root system during the transplanting process, which is retained and required until the nursery trees are finally despatched.

iv). To obtain a full stand and to sort out the seedlings into uniform groups, consequently preventing domination of weaker plants by adjacent stronger ones, or alternatively, by eliminating the weaker ones.

v). To ensure that tap root cessation does not coincide with grafting operations. Top growth is naturally correlated with root growth, and is adversely affected for quite a long period when tap-root growth is artificially terminated. When this reduction in growth force coincides with grafting, it can cause failures. Terminating tap-root growth early appears to cause less shock than later on.

Flat transplanting process. Transplanting is fast and efficient. The previously filled trays are laid flat on a table. The roots of six or more seedlings are laid flat contiguously on the surface of the substrate, the collars at the upper edge of the tray. A final thin layer of any soft medium is poured over the roots and pressed down firmly. The operation should be quick, to avoid drying of hair roots, and watering immediate. When placing the seedlings in position during transplanting, ensure that any natural incline of the stem is directed upwards from the substrate, so that when the trays are placed at a semi-upright angle on the rodded table, the seedlings stand more or less upright.

High positioning of micro-grafts on rootstock stems. Generally, the density of the trees on the tables is as high as is consistant with producing grafted trees large enough for field planting. There may, however, be a preference sometimes for very small trees, to be grown on to full size under nursery conditions at destination; in this event the growing period is shorter and tree density higher. The trees cannot conveniently be spread out to obtain more light as they grow larger, but there may be some thinning out by reason of weakness or grafting failures. Although some species can be completed as grafted trees in a single season, experience has indicated better field planting results by retaining most kinds in the nursery for a second season.

Visual and practical evidence shows that grafting on strong growing, juvenile, and relatively softwood rootstocks produces the healthiest and most successful graft union. Since the graft union is recognized as one of the most senstitive parts of a tree throughout its entire life, this kind of grafting is worth attaining, even though the procedures are more delicate and time consuming. Young seedlings are in the best physiological condition for this purpose, but often do not reach sufficient diameter to take even the smallest mature scions or buds; also they may lack the strength to force the scion buds into growth. This relatively softwood, fast-growing condition is to be found at a sufficient diameter at a later stage of growth, much higher up on rootstock stems. By using special micro-grafting techniques, this high positioning of grafts has now replaced the previous techniques used in this particular propagation system (Figure 3).

Length has to be substituted for width in all these micro-grafting operations. Slender scions or budwood is therefore required, but nutritionally high and with well-developed buds. They are best taken from mother plants that are constantly cut down to force out numerous thin shoots. If the scions are taken from normally growing trees, they should be selected from the outside perimeter; shoots that are thin as a result of shading in the inner parts of the tree are too weak for grafting purposes.

There are some additional reasons for high grafting:

i). It is easier to operate on compliant stems that are well above the dense lower crowded conditions.

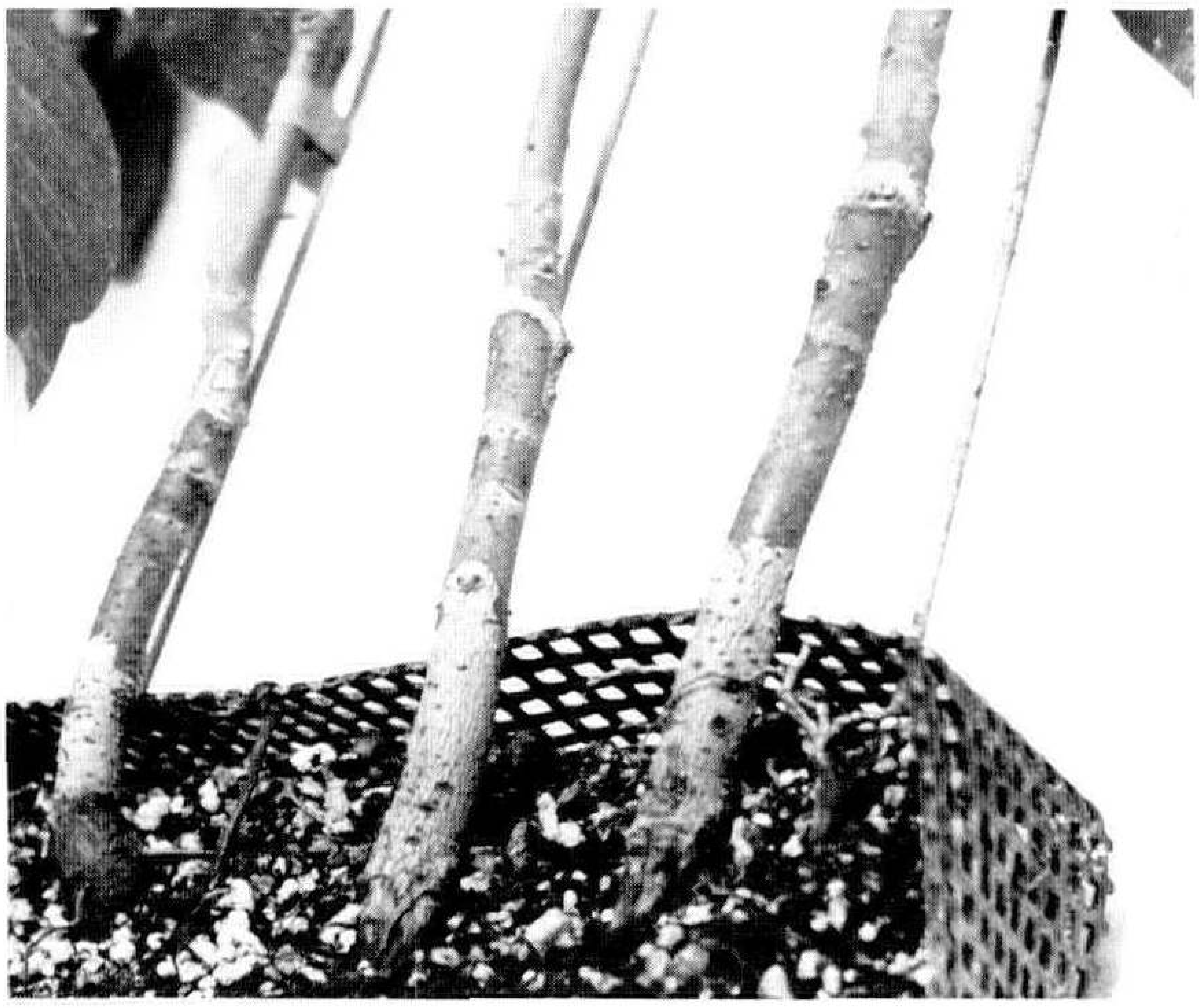

Figure 3. Finished plants showing graft union.

ii). To force out scion buds after grafting, it is advisable to cut down rather drastically to very near the graft; however, healthy leaves have to be retained, and these are not generally found lower down on the stem.

iii). There is less wastage of rootstock growth, consequently the trees are produced in shorter time.

Grafting techniques are under constant trial in relation to this growing method but, unfortunately, considerable more work needs to be carried out on tropical species under actual tropical conditions; only mango, cashew, and mangosteen have so far been tested. Under sub-tropical conditions here, good results have been obtained with pistachio, persimmon, pecan, walnut, avocado, citrus, cherimoya, macadamia, litchi, feijoa, loquat, guava, jujube, olive, carob, and oak.

Whenever possible, long chip budding is used because of it's simplicity; otherwise, side veneer and tip cleft with long cuts. For pecans and walnuts, a kind of long Forkert budding is easy and effective at normal budding height. Long strips are peeled downward on the rootstock and cut to form a pocket. The same is done on the budwood, but a slit is made on either side of the leafstalk to facilitate removal together with the bud-trace. The bark pocket prevents the bud-strip from swivelling. The buds are exposed. Fitting does not need to be precise.

All micro-grafting (not Forkert) is done with a mounted injector razor blade, by wedging it together with a plastic slither into a flattened copper tube.

Tying is with white polyethylene strips. The tie is extended beyond the cut section of the side veneer and tip cleft grafts to cover the remainder of the scion, leaving a cavity at the end through which a shoot can subsequently grow. The plastic strip is secured with a pin.

Chip budding and side veneer grafting is on the north side, but due to the high positioning, sun may penetrate to a greater or lesser degree with some possibility of causing overheating during hot weather. Particularly difficult subjects may need additional protection; this can be arranged by encircling the graft with a rootstock leaf and securing it in position by the pin on the plastic tie. Tip cleft grafting needs a paper hat protection or an encircling leaf.

When the grafts have made sufficient growth, all buds on the rootstock should be firmly rubbed off.

Second stage growth of laboratory in vitro plantlets. With careful initial treatment, these plantlets can be grown on in trays to full-size nursery trees.

Preparing trees for despatch. The leaves of evergreen trees are severely reduced in number before removing from the trays. Several species of evergreen nursery trees with suberous roots have been packed completely defoliated under simulated hot conditions for 3 weeks, then planted out with shading. Etoilated shoots had just started to grow and needed careful handling. They all grew satisfactorily. Further tests will have to be carried out to find out the limits of this potential.

The trees are shaken out of the trays and the interlacing roots are quickly separated to prevent drying. The root systems can be placed flat in a container, with material such as vermiculite, sawdust, and woodshavings spread between them. Containers may be something like orange boxes, wooden framework supporting jute, or rectangular cane or bamboo baskets, all with an interior perforated polyethylene lining. Alternatively, they can be rolled in strips of polyethylene together with some added substrate, the minimum required to cover the roots. The stems of the trees are tied together and protected by moist paper, hessian, or the like.

The compact nature of the trees makes packing and insulation fairly simple, but the kind of packing material used must depend on the anticipated transit conditions. Allowance sometimes has to be made for additional watering and insulation en route, which needs planning, especially by primitive conveyence.

Planting out in the field. At destination, insertion of the close-knitted fibrous roots in a mud solution results in a flat rootplate, the mud filling in and adhering to the rootmass; these can be quickly planted in the field when placed up against 18 cm vertical cuts in the soil, made with a hoe. They establish themselves quickly, but sometimes need initial paper protection around the stems and, in arid climates, mulching.

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PROPAGATION OF PRAWNS AND PLANTS IN THE SAME ENVIRONMENT

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Abstract. Neotoma Enterprises is investigating the potential of combining aquaculture, hydroponics, and solar technologies. Our experimental and prototype polyculture systems demonstrate a significant net income increase per square foot of growing area over conventional aquaculture and plant propagation facilities. The use of solar collectors and a large volume of water for heat storage minimize system heating costs.

INTRODUCTION

Recent years have seen large increases in production and marketing costs for many nurseries. Petroleum products used in fertilizers, heating, and transportation have risen dramatically in price during the last ten years. Land prices and taxes, especially in areas near large metropolitan centers, often make expansion of a business economically unfeasible.

Our goals in developing polyculture systems are to increase production of marketable products from a given space, offer a diversity of products to minimize effects of market