Understanding Vegetative Propagation

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INTRODUCTION

There are compelling reasons why propagators in the U.K. should seek increased understanding of relevant underlying principles. The nursery industry here is extremely diverse, producing many thousands of individual taxa on nearly 3000, mainly small, nurseries which are spread throughout the country. Different attitudes towards propagation, different technical backgrounds and working practices, and different commercial objectives compound this diversity. Against such a variable background there is little purpose in developing narrow blueprints for a few specific plants. Nurserymen need new insights, information, and knowledge with which to adapt and improve **their** operations in ways that suit **themselves**. If they don't have the **correct** understanding nurserymen can easily develop the **wrong** understanding, which at best may prevent progress, and at worst be counter-productive as they move to meet the challenge of market-led propagation systems (Vallis, 1992).

INFORMATION WHICH IS HELPFUL BUT NOT ESSENTIAL

Some information comes into the category of "it's helpful to know," because an explanation of how something works gives growers confidence and the ability to apply the information flexibly.

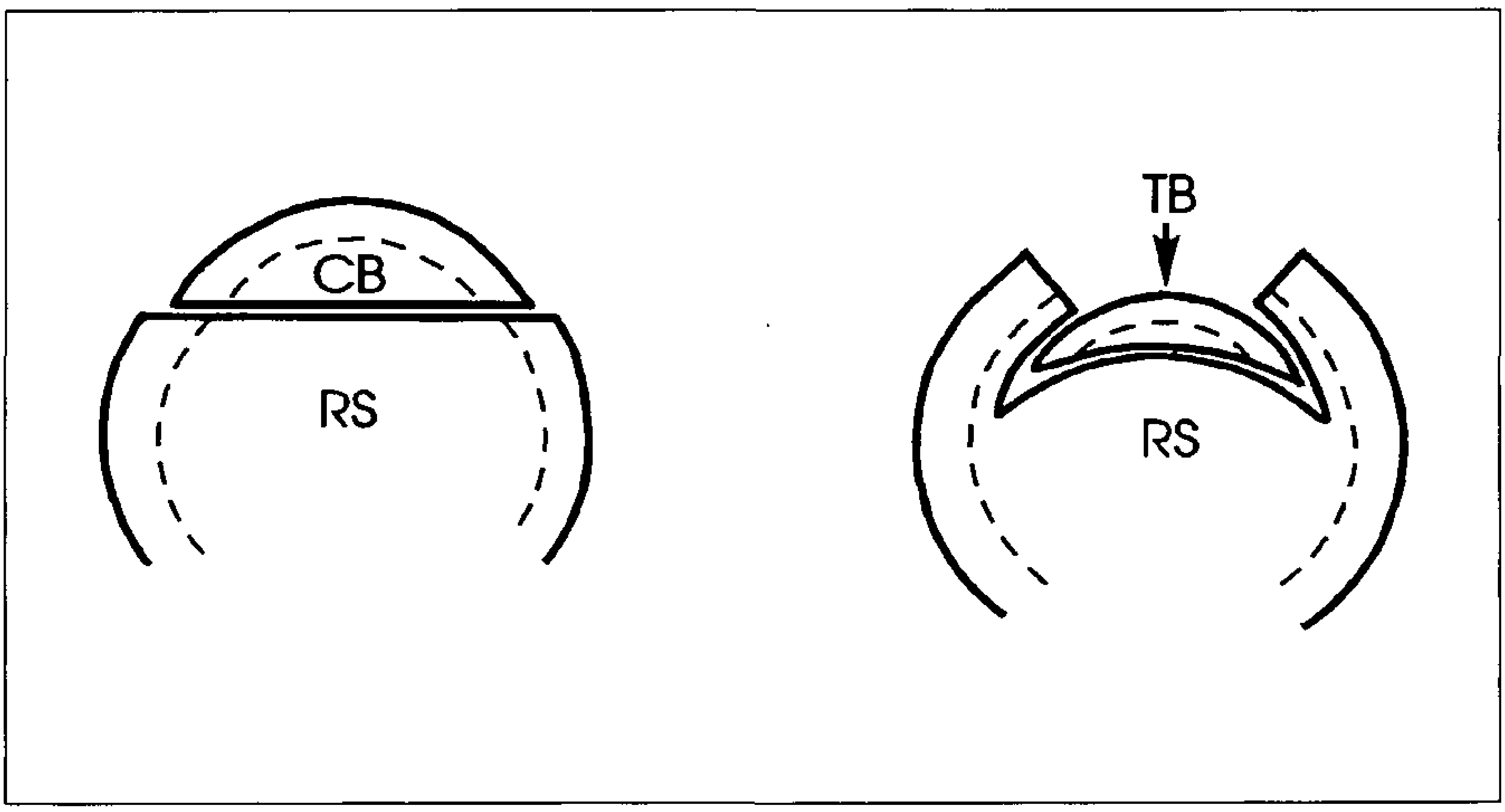

Figure 1. Representation (left) of a cross-section of a chip-bud (CB) and rootstock (RS). Because the chip-bud substitutes exactly for the part of the rootstock which is removed the cambium (— — —) of stock and scion are placed close together resulting in a rapid and strong union. When a T-bud (right) is slipped under the 'bark' the cambium of stock and scion are not adjacent, and union formation can be slow and weak.

Budding. An understanding of the improved anatomical relationships between the scion and rootstock in chip-budding compared to T-budding (Howard et al., 1974; Skene et al., 1983, Fig. 1) has implications for the range of plants that can be budded successfully, the time of budding, tying materials, avoidance of diseases, and the quality of the final product.

Wounding. New insights about the effects of wounding the bases of cuttings come into the same category. The practical benefits of wounding have long been known and exploited by nurserymen, but awareness of the advantages of splitting the ends of non-basal and other difficult hardwood cuttings, to simulate the anatomical advantages at basal nodes of easy-to-root subjects, (Howard et al., 1984, MacKenzie et al., 1986, Fig. 2) convinces nurserymen that this treatment is worth trying in appropriate cases.

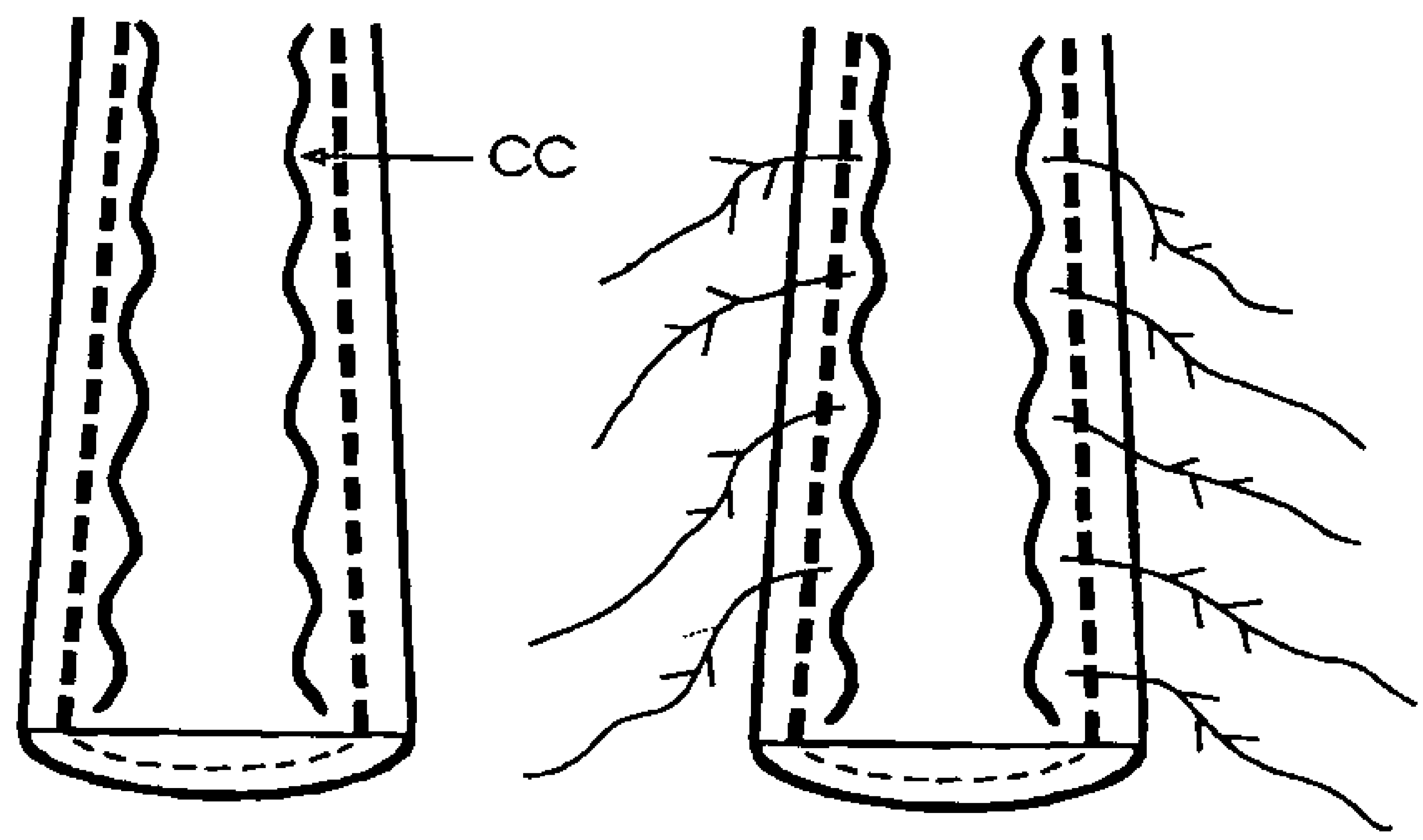

Figure 2. The inner surface (left) of a hardwood cutting wounded by splitting. When split longitudinally, as opposed to cutting across the stem, cambial cells (— — —) are able to regenerate in response to auxin treatment and produce cambial callus (CC) from which roots emerge (right). Other types of wounds expose much less cambium.

ESSENTIAL INFORMATION

In most situations improved understanding focuses on the need to obtain **essential** information, which is made more necessary by the multi-disciplined and highly interactive nature of propagation, where success in one objective based on one scientific or technical discipline is influenced or controlled by conditions elsewhere that are not obvious, and are often unsuspected. The relevant areas of science may range from hormone or nutrient physiology to the physical characteristics of composts. Unless these various interacting factors are all adjusted to optimum levels the results are often poor; when the optimum levels all coincide, results are often impressive.

Hormone treatment. It is widely held that the most critical factor affecting the response of cuttings to hormone treatment is the concentration of auxin in the liquid or powder preparation. In fact, it is the total dose of auxin received by those tissues capable of responding that determines rooting. For quick-dip preparations factors such as duration and depth of dipping, and the position in which the cutting is dried, affect the amount of solution taken in through the cut end of the stem. Both are relatively more important than auxin concentration when treating hardwood cuttings (Howard, 1985a, Fig.3). When using powder preparations important factors are those which affect the transfer of auxin from the powder carrier through the epidermis as well as via the cut end of the stem. These include whether or not the cutting is pre-dipped in an organic solvent, the amount of powder which adheres to the cutting, and whether it is retained or lost at planting (Howard, 1985b, Fig. 3). Awareness that a standardised technique is of greater importance than the concentration of auxin applied provides the incentive for nurserymen to set up simple procedures that will improve overall survival and rooting of cuttings, and increase the uniformity of response within a particular batch.

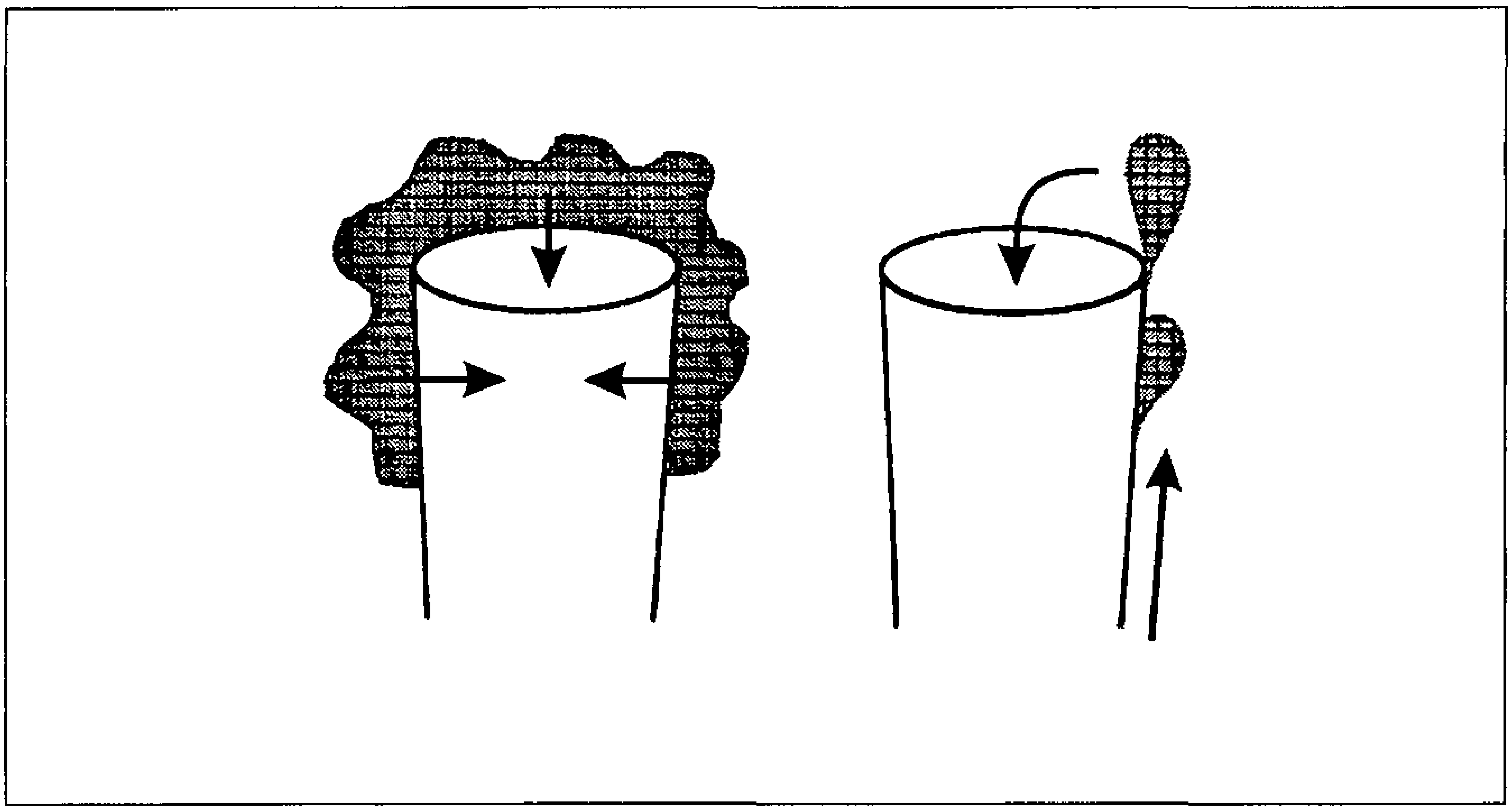

Figure 3. Liquid hormone preparations tend to run-off the waxy epidermis (left) and factors which determine how much solution is absorbed through the cut base are those which mainly determine rooting. In contrast, the rooting response to a powder preparation (right) is determined more by factors which affect its retention on both the cut end and the epidermis, and assist the transfer of auxin into the tissues.

Stockplants. Although cuttings can be taken from plants in the production cycle, this must often be done in association with the need to prune at a certain time, and it can also conflict with marketing objectives. This commercially pragmatic approach may be successful for subjects that have the genetic basis for ready rooting, but it is totally unsuitable for subjects that are difficult to root, and where stockplant management and precise timing of cutting collection contribute to success.

Research aimed at understanding why rooting in cuttings of *Syringa vulgaris* 'Madame Lemoine' is enhanced when stockplants are grown in the dark for a short period from bud-burst (Howard, 1992), hinted at interdependence between the type of cutting and its rooting environment. Cuttings grown initially in the dark were found to have relatively thin stems, resulting in a higher leaf-to-stem ratio than normal light-grown ones, and this was associated with a net accumulation of dry matter at the cutting base before the first roots emerged (Howard and Ridout, 1992). Further work has confirmed this for lilac, and shown that the same principle operates for other species subjected to a period of darkness, as well as to different size cuttings grown normally in the light. As such, these results provide new insights concerning how best to grow cuttings of difficult-to-root species.

Environments. Much is known about the role of leaves in the rooting of softwood cuttings, but nurserymen pay insufficient attention to maximising their beneficial effects and minimising their drawbacks in propagation terms.

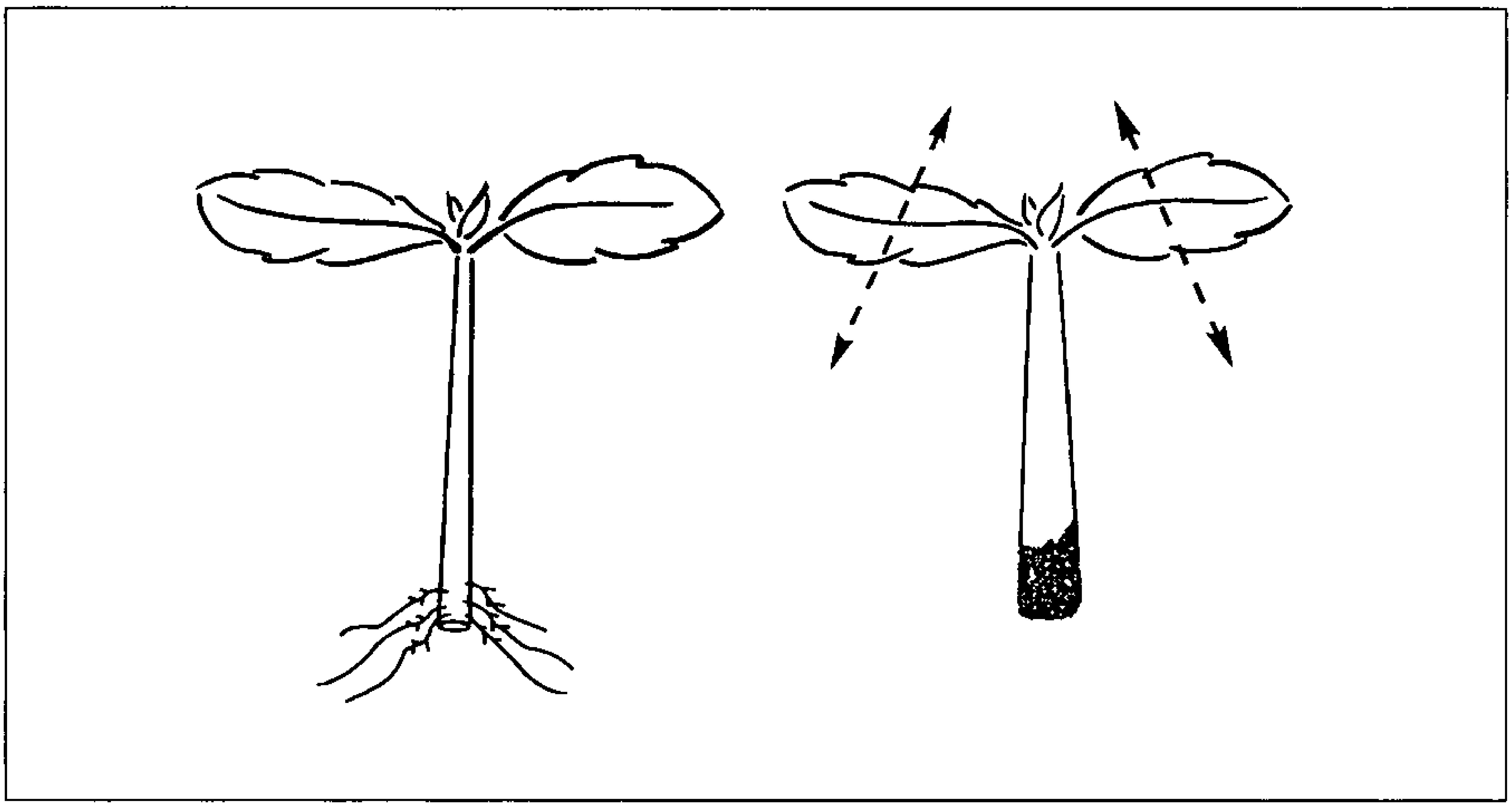

Figure 4. For difficult-to-root subjects factors which favour a high leaf : stem ratio, such as not trimming leaves, and selecting cuttings with relatively thin stems (left) favour rooting, whereas leaf-trimming and selecting thick fleshy-stemmed cuttings may result in stem rotting (right).

This conflict is because the stomata, typically on the underside of the leaf, allow intake of the carbon dioxide essential for photosynthesis, while also allowing water vapour to be lost. Photosynthesis provides the carbohydrates required for energy and growth, whereas loss of water initially causes stomata to close, thereby reducing photosynthesis, and eventually causes wilting and perhaps death of the cutting. This conflict is made worse by the fact that the light energy which drives photosynthesis is accompanied by heat energy which drives water loss through transpiration. It is essential to weight the balance in favour of photosynthesis. A cutting must produce carbohydrate in excess of its maintenance requirements for rooting to proceed, which has implications for the ways cuttings are produced and treated and the environments in which they are placed. Hedges should be grown to produce the maximum number of relatively thin-stemmed cuttings with a high leaf : stem ratio if the variety is difficult to root. Large fleshy-stemmed cuttings are acceptable for *Forsythia* × *intermedia*, but not for difficult subjects such as *Syringa vulgaris* (Fig. 4). By the same token such cuttings should not have leaves removed or reduced in size in order to increase sticking density, nor should they be crowded to the point of mutual shading, all of which have been found to depress rooting. "Wet fog" is seen increasingly as providing conditions suitable for stress-sensitive cuttings

(Harrison-Murray and Thompson, 1988, Harrison-Murray et al., 1988, Fig. 5).

Hardwood cuttings. Here, too, there is interdependence between the rooting potential—governed by the stockplant—and the ability to realise that potential—governed by the propagation environment. The advantage of hard-pruned hedges is not to increase the vigour of shoots to mimic juvenile material, as has long been assumed. Thick cuttings from vigorous shoots may survive better than thinner ones, but the latter root faster as long as propagation conditions are

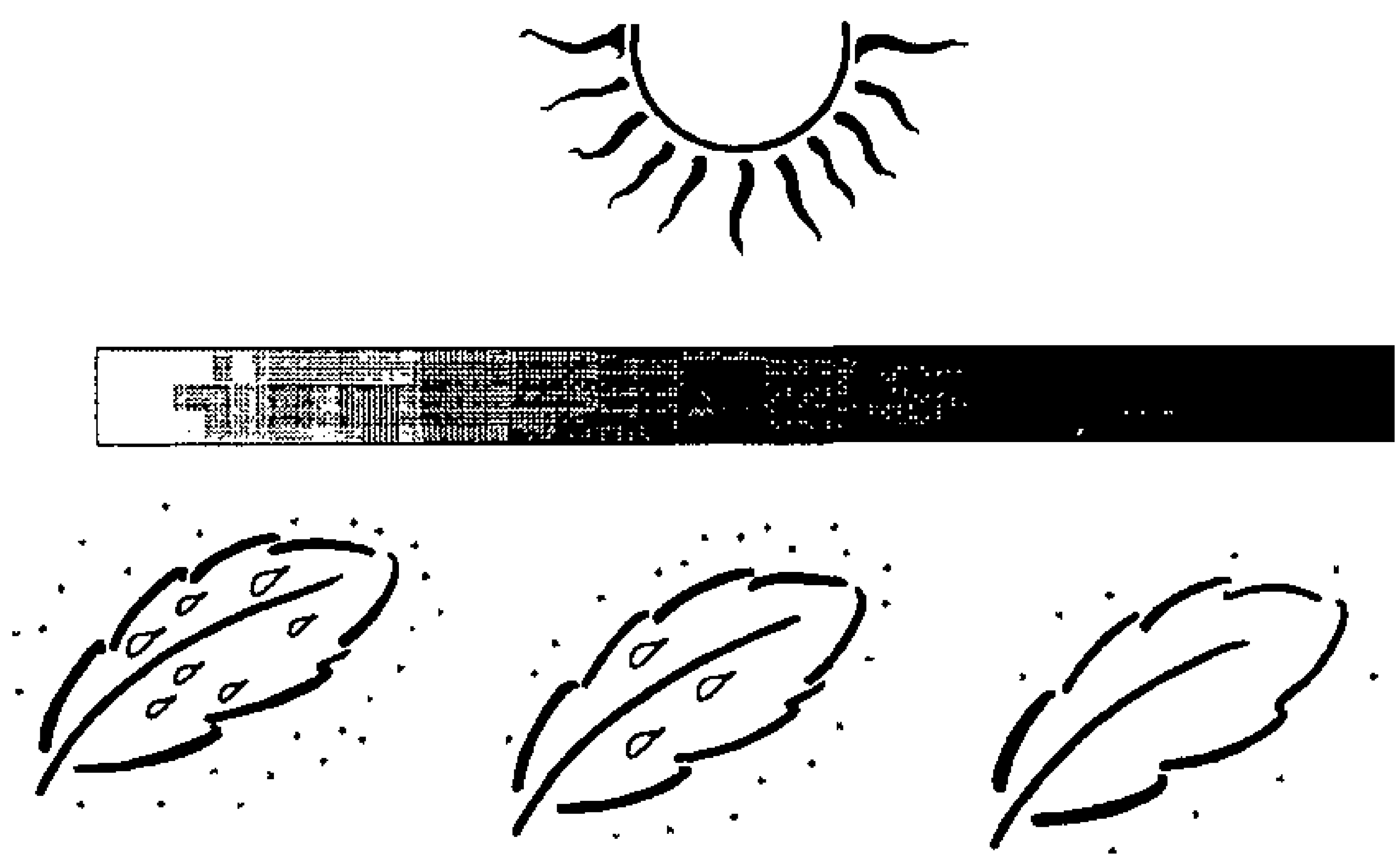

Figure 5. As water deposition on the leaf and water vapour around the leaf decreases (from left to right) shade must be increased to avoid stress, at the expense of beneficial photosynthesis. 'Wet fog', or mist with 'dry fog', provides a suitable mixture of large and small water droplets to enable cuttings to receive adequate light.

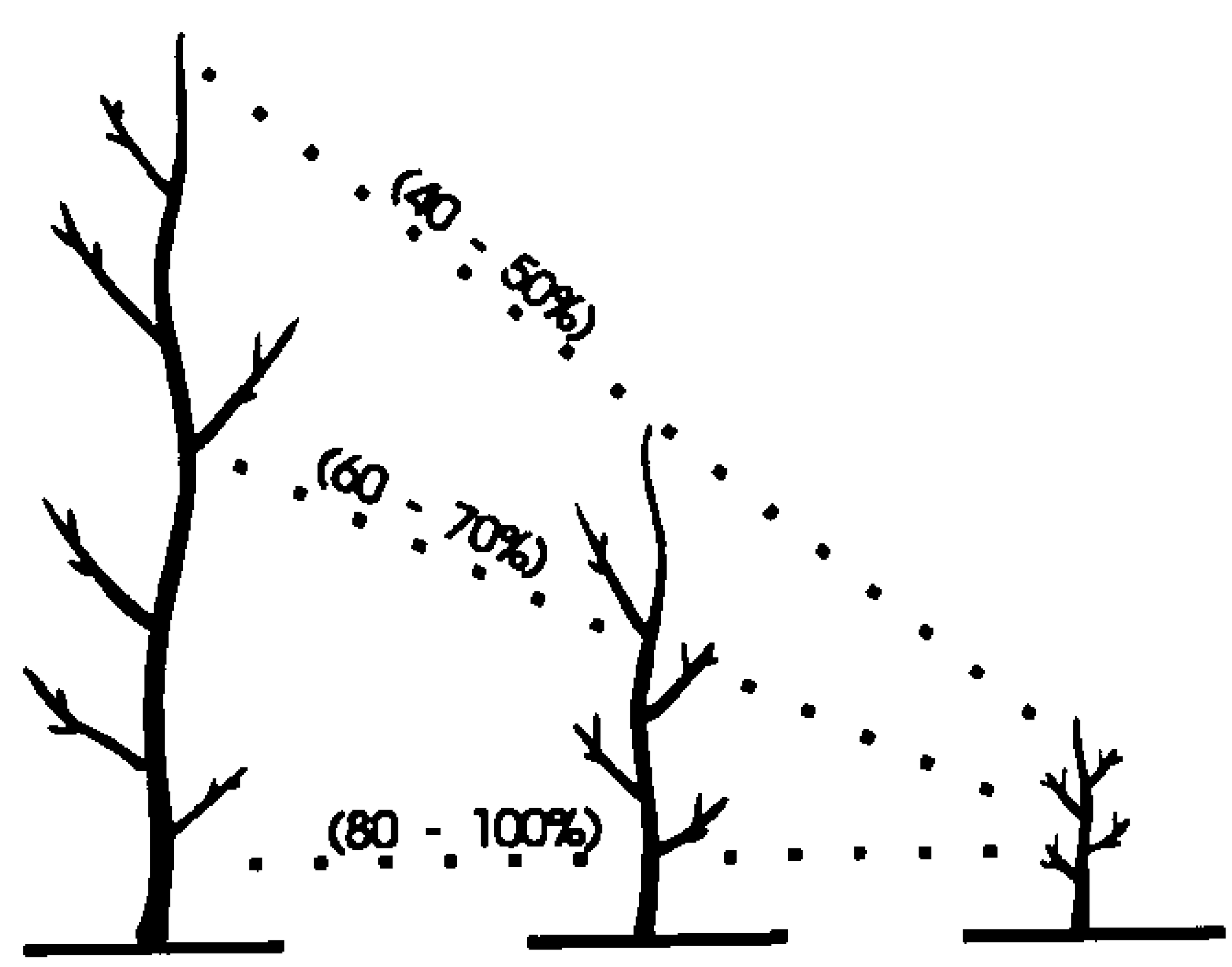

Figure 6. Rooting potential (typical values in brackets) of hardwood cuttings in a hard-pruned hedge is more influenced by the relative position of shoots than by their absolute position in terms of the distance between themselves or from the root system.

designed to rapidly drain away the excess water that causes hardwood cuttings to rot (Howard and Ridout, 1991). Thinner cuttings are particularly prone to rotting.

Ongoing research has confirmed the faster rooting of thinner hardwood cuttings and results of new experiments suggest that rooting potential among shoots in a hedge is more dependent on their relative position than whether or not they are close to the ground, as was previously thought important (Figure 6).

CONCLUSION

Success in understanding general physiological processes in the special context of vegetative propagation provides opportunities for nurserymen to adapt their techniques and procedures and improve their facilities in ways convenient to themselves, and which are compatible with their business objectives. Knowing how and why cuttings can be rooted better, or budding success increased, gives the necessary confidence to implement change.

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