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MODERATOR SHUGERT: Larry, that was an outstanding paper. Larry expressed many ideas he feels strongly about and we all benefitted from it without question.

We are now going to hear from a gentleman who is with the Pershore College of Horticulture, in Pershore, England, the Editor of the Great Britain and Ireland Region of the International Plant Propagators' Society. Richard Martyr is now going to speak to you on "Hardwood Cuttage Practices in England". Richard Martyr.

HARDWOOD CUTTAGE PRACTICES IN GREAT BRITAIN— A REVIEW

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The term "hardwood cutting" in Britain is almost exclusively limited to denote the ripened wood of deciduous species and would not ordinarily include, for example, the autumn cuttings of narrow-leaved evergreen species — though technically this might be "ripened wood". Within this definition it is true to say that there is a much decreased (and probably still decreasing) use of hardwood propagation techniques in the production of ornamentals. In some nurseries it is a technique that has been dropped altogether and in most others it is

restricted to the simplest and most straightforward subjects such as *Salix*, *Populus*, *Ribes*, *Spiraea* where 100% take can be reasonably achieved.

It is now becoming known amongst nurserymen that 100% takes with hardwoods is a reasonable expectation with a much wider range of subjects than hitherto thought possible provided that material of high rooting capacity is used. Provided also that due consideration is given to season of taking, hormone treatment and to the rooting environment. It has been abundantly demonstrated that the best way of obtaining the right material is to have special stool or hedge plants and to maintain them annually by heavy pruning whether or not the material is needed for propagation purposes. On a rapid survey of nurseries recently I was surprised to find how few growers — fruit stock producers apart — have yet developed these stock lines.

It would seem, therefore, that the centre of the propagation department on these nurseries is more and more within the mist unit and this may well have simplified the work flow on many nurseries.

Traditionally hardwood cuttings were regarded as something that could be done at any slack period from October to March — now it is known that much more precision is needed in timing and technique; nurseries tend to run down their staff in winter and there are still important lifting, despatch and planting jobs to be done. It is often more convenient to get propagation labour peak requirements in the summer when student and other casual labour is more available. Thus, Humphrey has described how at Hilliers of Winchester hardwood cuttings have been run down to a mere 20 to 30 thousand compared with over half a million summer cuttings, all of which fits in with their labour requirements.

Nevertheless it must be surprising that this trend away from hardwood propagation should have not have been more affected by the work carried out by Garner, Howard and others at East Malling, which has had such an impact on the production of various fruit plants. Why has the temperature treatment and storage work in the heated bins as first developed at East Malling by Garner not been adopted for the more difficult rooting ornamentals?

Here it is essential to point out that critical research work in the field of hardy plant nursery stock is as yet negligible in Britain; so far as government sponsored research is concerned it has only just begun with the introduction of a very small nursery section and staff appended to the Glasshouse Crops Research Institute — a quite inadequate allotment but, at least, a start and perhaps, more significantly, the Ministry of Agriculture has this year appointed within the National Agricultural Advisory Service (the Government extension service) a senior advisory nursery specialist stationed at Reading near the main nursery production area. Some of the Experimental Horticulture Stations have begun to include some nursery

crops and it must, of course, be mentioned that in Eire the Government Research Station at Kinsealy has opened a very active ornamental horticulture section. In England, four universities offer courses in horticulture or horticultural science and their interests in nursery problems is probably growing, particularly at Nottingham and Bath. But the nurseryman in our region must look with some envy at the abundance of directed research stemming from the universities in North America. We have no equivalent — and look more to work at Boskoop and Wageningen in Holland and increasingly, to Denmark and Germany.

Now an industry which is expanding and capitalizing as fast as the nursery industry in the U.K. is doing must be forward-looking and research-minded. It is, in fact, hungry for research. Bluntly speaking, the progressive nurseryman is frequently ahead of the research worker; but however much energy and enthusiasm, this is a state of affairs which brings its failures as well as its successes. It must also inevitably lead to delays in communications between research centre and grower. There is no better example of this than in the adaption of the "heated bin" work at East Malling, which obviously has tremendous possibilities for the rooting of a whole range of ornamentals, some of which may be very difficult to root by other means. Careful research here is overdue, for growers who have tried to adapt the techniques to ornamentals have almost invariably failed — although an abundance of roots may be developed, this is followed by an almost complete loss of plants afterwards.

It is obvious that there are wide differences between the optimum temperatures for root initiation and those for root development and that the temperature-treated plant is very susceptible to unfavourable environmental conditions. Garner and his co-workers have constantly emphasized that the desired product from the heated bin must be a cutting beginning or about to root as it leaves the store. Over-stimulation is usually fatal. It is clear, therefore, that the precision temperature control and timing needed, with the probable variations between different genera and species, have proved too exacting for the early pioneers of this technique in rooting hardwood ornamentals.

Yet the encouraging root production which is produced by certain plants, which are difficult to root by other means, must offer some hope that we are on the brink of an important breakthrough once the blueprint for the treatment of hardwood cuttings (particularly after the root initiation stage) has been perfected.

Some investigational work has been done at Hadlow College and at the Ness Botanic Gardens (University of Liverpool). Hutchinson's work at Hadlow is recorded in Volume 19 of the I.P.P.S. Proceedings; he had encouraging rooting but subsequent heavy loss with *Tilia x euchlora*, *T. platyphyllos* 'Rubra' and *T. petiolaris*, *Corylus avellana*

and *C maxima* 'Purpurea', *Prunus spinosa* and *P. cerasifera* cultivars, *Rhus cotinus* and *Malus* 'Profusion'.

Hulme at the Ness Botanic Gardens has had rather similar experiences over the past two years. Typical results are summarised in Table 1. All these hardwood cuttings were rooted in a peat-sand mixture at around 75° F; potted and plunged in the rooting media in early April. Shoot growth commenced in many cases but the plants then collapsed.

Table 1. Rooting results obtained with hardwood cuttings of several ornamentals. Peat-sand mixture. 70-75° F. bottom heat. J. K. Hulme, Ness Botanic Garden, 1969-70.

	Rooting	Survival
Alnus incana 'Aurea'	30%	total loss
Aronia melanocarpa	high percent	10%
Chaenomeles spp.	,, ,,	,,
Cornus stolonifera 'Flaviramea'	,, ,,	total loss
Prunus padus 'Watereri' *P. sargentii* *P. serrulata* 'Shirofugen' *P. s.* 'Shirotae'	20%	all died later
Pterocarya fraxinifolia (*P. caucasica*) *P. x rehderiana*	high percent	90% died by early summer

Few commercial nurserymen will have had wider experience in the use of heated bins than Jack Matthews (Matthews Fruit Trees, Limited, Thurston, Suffolk). He has adapted East Malling techniques during the past 14 years and streamlined them to fit into his considerable output of wholesale tree production. He soon learnt that it was impossible to control the moisture content of the peat and sand mix in the bins in the open, so he built a nursery barn with a section specifically designed for the storage of hardwood cuttings for long or short periods.

Large quantities of cuttings, mostly *Prunus* species, as listed below, are taken in October and November; they are all derived from stools or hedges grown specifically for the purpose and are given IBA dips of various strengths. They are stored in a peat / sand mix without

any heat, the barn itself being the only protection. These are put outside in February. When these have been taken out the soil heating is switched on and another batch of cuttings, mainly apple rootstocks, are inserted which root in a few weeks.

Scientific name	Commercial name when sold as hedge plants
Prunus cistena	Crimson Dwarf
P. cerasifera 'Atropurpurea'	Blaze
P. cerasifera 'Atropurpurea nigra'	Purple Flash
P. x blireiana	Pink Paradise
'E. M. Myrobolan B '	Greenglow
Malus 'Profusion', 'John Downie' 'Golden Hornet', and others.	

Water is given as seldom as possible during storage but after planting out the success rate depends much on weather conditions; overhead irrigation is an advantage in order to keep the cuttings constantly moist until established.

One of the first difficulties was the build-up of replant diseases in the peat and sand mixture; it is now policy to change the mixture annually rather than sterilize, as the texture of the peat deteriorates under constant use. Evidence is accumulating that diseases can be more damaging to hardwood cuttings than to normal rootstocks under field conditions.

It has been established in this nursery that propagation by hardwood cuttings can be successful with a wide range of ornamental cherries and crabapples. In practice, however, they restrict the method to the rather cheaper line of plants sold for hedge plants or for cheaper site planting schemes rather than for those used in gardens or landscaping, where individual specimens are required. The reason for this, Matthew claims, is that the plants on their own roots, on the average, are not so good in quality and are susceptible to poor environmental conditions, with a number of deaths occuring after establishment.

Rose rootstocks are mostly imported from the Continent and are mainly produced from seed. There is considerable interest in the evaluation of different rootstocks for rose production in Britain today but most production is still on types of *Rosa canina.* Investigation proceeds, too, on the growing of roses on their own roots and dormant

cuttings have proved quite feasible but such an uneconomical use of 'eyes' is not likely to commend itself to the average rose grower.

The Forestry Commission has shown how hardwood cuttings can be used to produce a range of trees; here again the technique is unlikely to prove economic, but there are exceptions, such as the production of the London plane *Platanus x acerifolia*, which is a hybrid between *P. orientalis* and *P. occidentalis* — the most popular of all street trees where atmospheric pollution is a problem. It is fertile but variable (in fact there are several varieties) and, therefore, is normally reproduced vegetatively. Humphrey has described how well-ripened 1-year-old wood taken from the hard-pruned street trees can be rooted by giving a 24-hour soak of 25 ppm IAA.

We are all out for quick results and in some instances hardwood propagation may actually save time. In a recent survey[1] on viburnum propagation carried out by the Great Britain and Ireland Region, Macmillan-Browse has pointed out that hardwood cuttings can produce more economical results than softwoods with a number of viburnums such as *V. fragrans*, and *V. x bodnantense* cultivars, such as 'Dawn' and 'Charles Lamont'. He has produced stock hedges with plants 15-inches apart which, in good conditions, produce clean straight stems 5 ft or more in length; these at leaf fall are made into cuttings 5 or 6 inches long, treated with Seradix 3 and inserted in a cold frame and protected from frost. Watering must be done carefully in the spring, the plants fed in the summer, and good "liners" are produced by autumn. Mickelburgh has also shown that one year can be saved in the production of a saleable plant by this method; he achieved a 90% success but results fell to 50% if the stock plants were neglected, emphasizing the importance of the quality of the cutting material.

Another labour saving possibility which growers must have in mind in this container age is the prospect of rooting a hardwood cutting directly into the container in which the plant will be sold. I am not aware of anyone who is doing this yet but we have found this to be feasible with *Tamarix*. It so happened that at Pershore we had a demand for an industrial landscaping job for *Tamarix anglica*, the English tamarix, a native of our southern and eastern coasts but not in commerce as it has less horticultural merit than *T. pentandra* and *T. tetrandra*. Bob Hares had to seek propagation material from the wild source. *Tamarix* roots readily from hardwood cuttings and, provided the material was thick enough (7-8 mm diameter minimum), results should be near enough 100%. This, therefore, seemed a good opportunity to speed up techniques by rooting them straight into the final container (4½ in) using 3 peat to 1 sand, with a good fertilizer feeding (Vitax Q4 at 4 oz / bushel). This has proved very successful and may

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[1]See page 378

well save one year besides the extra handling. The technique will be tried with other plants, such as *Spiraea*, where similar results might be expected.

MODERATOR.SHUGERT: Thank you very much, Dick, for a very delightful discourse; your slides and the side remarks certainly helped the presentation. It was an excellent paper and it was fascinating to see what is being done in England in ornamental hardwood vegetative production.

I know you are anxiously awaiting the next paper that has the intriguing title of, "Can Grafting be Mechanized?" It will be presented by the Secretary-Treasurer of the Western Region, Curtis Alley, from the Department of Viticulture and Enology, at the University of California, Davis. Curt Alley, "Can Grafting Be Mechanized?"

CAN GRAFTING BE MECHANIZED?

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By grafting, for this report, I will refer to benchgrafting rather than field grafting. Propagators that produce plants vegetatively by small cuttings are indeed fortunate. This is completely different from what the nurseryman who grows grapevines has to do. Many parts of California have no nematode or phylloxera problems so it is possible to grow grapevines on their own roots. However, the nurseryman must resort to rooting a cutting that is at least 16 to 18 inches long. In the Coachella Valley of California, where the early maturing table varieties are planted and where the soil is very sandy, growers are not satisfied with cuttings only 18 inches long. A few prefer to have them 3 feet long. This is because they dig a hole 2 feet deep and then bury the cutting so that only the top bud remains above the soil. The lower 1 foot of the cutting is bent over at a right angle at the bottom of the hole to provide a greater surface for root development. However, in many parts of California (along the coast), and in practically all of France, it is not possible to grow grapevines on their own roots because of phylloxera.

French nurserymen probably have developed benchgrafting to its highest level. In the early vineyards of France most grapevines were planted on their own roots. However, because of problem soils, such as those with high lime, a few of the more enterprising growers found that