TECHNICAL SESSIONS

Monday Morning, December 5, 1977

The twenty-seventh annual meeting of the Eastern Region of the International Plant Propagators' Society convened at 8:30 a.m. in the Saturn Room of the Sheraton Columbus Hotel, Columbus, Ohio.

PRESIDENT BOSLEY: Welcome to the twenty-seventh annual meeting of the Eastern Region of the International Plant Propagators' Society. I wish to especially welcome those members from the Australian Region, the Great Britain Region, the Western Region and the newly forming Southern Region. At this time I would also like to introduce to you George Oki, President of the International and John McGuire, who is the Program Chairman for this meeting. Also with us this morning is Dean Roy Kottman, Dean of the College of Agriculture and Home Economics here at Ohio State University and he is also head of the Agricultural Extension Service here in Ohio. Dean Kottman will officially welcome us to Ohio.

DEAN KOTTMAN: It is a real pleasure for me to welcome you to the state of Ohio and the city of Columbus, Ohio's third largest city and the capital. I also extend to each of you a special welcome to the Ohio State University, established as the Ohio Agricultural and Mechanical College in 1870. From the looks of your program I am sure you will have a most successful meeting and I extend an open invitation for any of you to come and visit us at the Ohio State University at any time

PRESIDENT BOSLEY: Thank you, Dean Kottman. To get this morning's program underway I will now turn over the podium to Miss Betsy Scarborough who is the moderator for this morning's session.

CHIP BUDDING FRUIT AND ORNAMENTAL TREES

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Abstract. Chip budding achieves rapid union formation in the weeks immediately after budding because the cambium of stock and scion are placed together, in contrast to conventional T budding. Early union formation results in higher bud-take, stronger unions, greater uptake of mineral elements, faster and more uniform growth and the production of more first grade trees from chip than T budded plants. Fungal spores of *Nectria galligena* carried on apple budwood are not introduced under the bark of the rootstocks as readily in chip as in T budding and fewer union cankers develop.

Fruit trees are composite plants consisting of a scion and rootstock because scions are often difficult and slow to propa-

gate on their own roots and rootstocks produce inedible fruit. Good fruit characteristics and ease of rooting are combined by grafting scions onto rootstocks and the most convenient method is to use single bud grafts, i.e. budding. A large part of the production of ornamental trees also involves cultivars selected for their shape, foliage, flower or fruit characteristics being budded onto rootstocks.

There is a continual need to produce both fruit and ornamental trees of improved quality and uniformity for two main reasons. Firstly, fruit growers in the United Kingdom demand large, well-feathered maiden trees which have the framework to carry early crops of apples, and large-scale buyers of ornamental trees require uniform and thick stemmed trees of their selected cultivars. Secondly, it is wasteful of land, labour, planting material, spray chemicals and machinery if buds fail or poor quality trees develop in the nursery row. The objective must be to produce complete stands of high quality trees so that each operation achieves maximum effectiveness.

Budding methods. There are two basic types; those such as shield or T budding which add the scion tissue to a complete rootstock stem by sliding it under the bark through an incision and those, such as chip and patch budding, in which a piece of rootstock tissue is removed and a similar piece of scion tissue carrying the bud is substituted.

Cambial contact. Techniques which substitute scion tissue for a similar piece of rootstock tissue ensure a much better match of the cambia than do techniques involving the insertion of scion material into the rootstock below the bark. Cambial contact in chip budding is good and development of the newly placed scion tissue occurs in step with that of the rootstock during the immediate post-budding period (Figure 1a).

For successful cambial development to occur in a T budded plant callus must completely fill the spaces between the underside of the bark flap and the upper surface of the bud shield so that a new cambium can develop *de novo* in the callus between the existing cambium of the shield, which lies adpressed to the xylem of the rootstock stem, and the cambium of the rootstock, which is exposed at the edge of the raised flap which overlies the shield. The bark may not always lift at the cambium, as has been erroneously assumed in the past, but can separate in the secondary xylem, thus presenting a tortuous line for the developing cambial cells to trace (Figure 1b). Conditions which delay or prevent the filling of voids with callus, such as the onset of cold weather or premature release of the tie, prevent complete cambial development in T budded plants and it is under such conditions that chip budding gives obvious advantages.

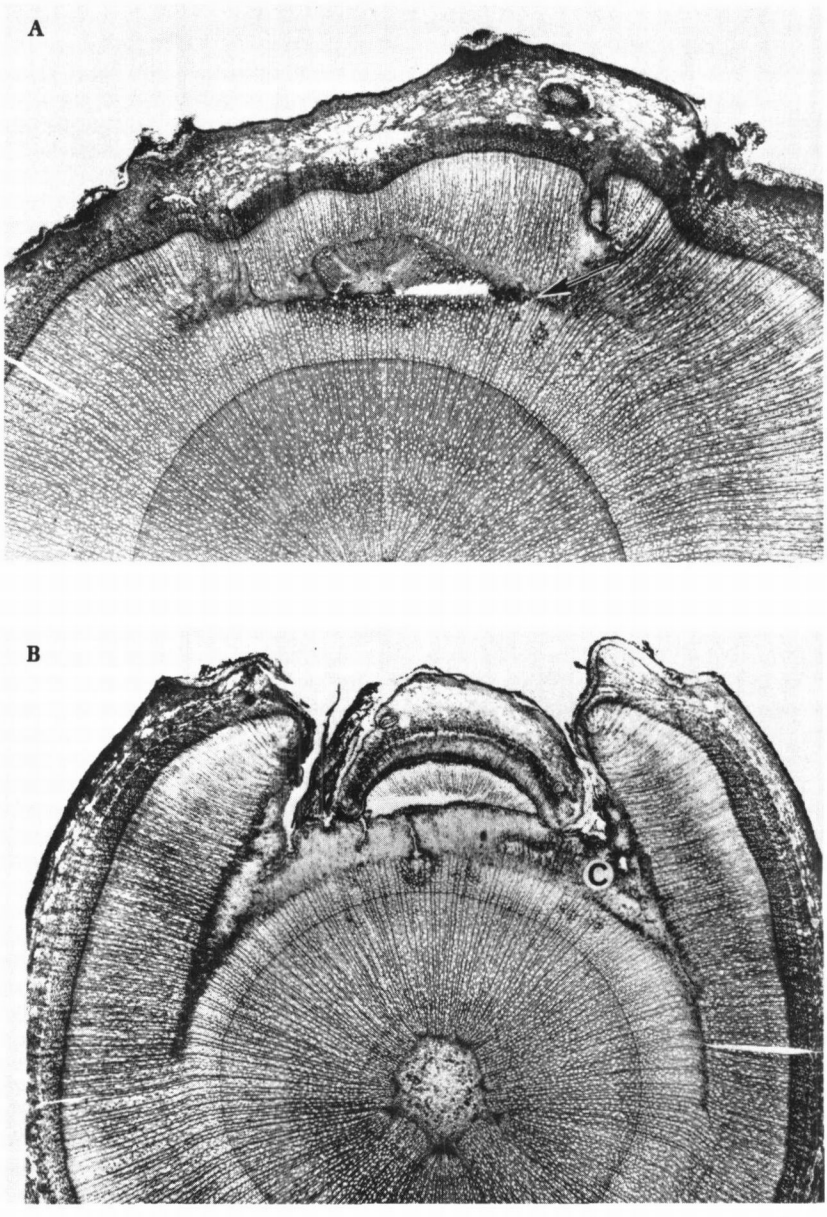

Figure 1. Transverse section through 'Lord Lambourne' apple bud shields and M.26 apple rootstocks approximately 0.5 cm below the buds. (a) Chip, (b) T, sampled November 1971. Junction between chip and rootstock is arrowed, C = callus.

Bud-take. Better matching of the cambia in chip budded plants compared to T budded plants no doubt accounts for the improved bud-take from the former method especially in a range of ornamental trees (Table 1). Among fruit plants there are a few examples of poor bud-take in most species, but reports from commercial nurseries indicate that bud-take of peaches has been greatly improved by changing over from T to chip budding.

Table 1. *Examples of percent bud-take by chip and T methods.*

	Chip	T
Prunus subhirtella 'Autumnalis' mean of 7 different rootstocks	82	25
Acer platanoides 'Crimson King' on *A. platanoides*	70	7
Tilia platyphyllos 'Rubra' on *T. platyphyllos*	89	78
Ulmus × *vegeta* 'Commelin' on *U. glabra*	70	56

Tree growth. The most obvious improvement from chip budding in fruit trees is the uniform and vigorous growth which occurs in spring from unions which were completed the previous autumn, in contrast to those from T buds where some plants invariably grow slowly in the spring as their unions are completed. Young scion growth in early summer contains higher levels of N, P and K in chip budded plants compared with T budded plants and dye passes more readily across chip bud unions as maiden growth begins (2).

By the end of the first growing season chip budded trees have grown either taller, or have produced more and longer lateral branches and are more uniform in size that T-budded plants (Table 2). Larger numbers of high grade trees result therefore from chip budding (Table 3).

Table 2. Effects of chip and T budding on growth of 'Golden Delicious' apple maidens on MM.106 apple rootstock.

	Chip	T
Scion growth from the union (cm)	120.2	111.6
Number of laterals per tree	16.5	11.0
Mean length of laterals (cm)	30.1	22.7
Range of numbers of laterals per tree	12 to 23	0 to 17

Table 3. Percent 1st and 2nd grade 'Cox' apple trees (out of 4 grades).

Apple rootstocks	Chip	T
M.27	84	36
M.9a	80	72
M.26	88	56
MM.106	80	60

Union strength. During summer gales the T budded scion varieties which develop laterals early in the season often break out of the rootstock unless the scion is tied to a rootstock snag or a cane. The 1972 growing season was preceded at East Malling by a severe frost in an otherwise mild winter, during which the temperature fell from 40° to 0°F and returned to the higher temperature during the course of only 5 days. This damaged the cambium of a wide range of plants in the nursery, and it was subsequently very noticeable that chip budded scions succeeded in growing and survived gale damage in greater numbers than T budded plants, presumably because early union formation during the preceding autumn had made them less dependent on early and extensive cambial activity of the rootstock the following spring (1).

Union diseases. In apple orchards stem cankers caused by the fungus *Nectria galligena* may cause severe damage to branches and can only be combatted by expensive treatment involving cutting-out and hand application of fungicide. A primary source of infection is the nursery where sporulating cankers may occur on 1-year-old trees that became infected from the trees used to obtain budwood. When *Nectria* spores carried on budwood are inserted under the bark of the rootstock in the T budding method they are presented with ideal conditions for germination, resulting in a union canker which destroys that tree and serves as a source of splash inoculum to others nearby. Because spores remain on the outside of the chip bud and are not inoculated under the rootstock bark the chance of infection is greatly reduced. Using apple buds treated with a *Nectria* spore suspension, union cankers developed in 64% T budded trees compared to only 15% chip budded ones (Bennett, personal communication).

DESCRIPTION OF THE CHIP BUDDING METHOD AND CONDITIONS FOR SUCCESS

Rootstocks. Rootstocks are trimmed in the normal way to give a clean leg beyond the required budding height. Standing over or to the side of the stock, a piece of smooth stem is selected and the first cut is made to a depth of about 3 mm at an angle of about 20° into the stem to make an acute lip. The knife is then withdrawn and a second cut is made 1½ inch above the first, entering the stem and cutting down to meet the first cut and the piece of tissue removed. The cut should be shaped like an inverted U, not A-shaped; this is facilitated by using a narrow-bladed knife (Figure 2)

Bud chip. The budstick is held with the base towards the operator and the scion chip is obtained by cutting the budstick with cuts similar to those made in the stock. The chip is lifted

between thumb and knife blade, transferred to the other hand and placed into the rootstock. If the lip in the rootstock stem has been cut at a sufficient acute angle and the chip placed firmly into it, it should remain in position until tied. The objective is to match the cambium of stock and scion as in all true grafting methods. Therefore, thick-barked stocks should be cut relatively shallower and thin budsticks relatively deeper. When a narrow chip is placed on a thick stock a margin of bark should be visible around the edge of the stock cut except below the lip. This ensures that cambium of stock and scion are opposite to one another (Figure 3).

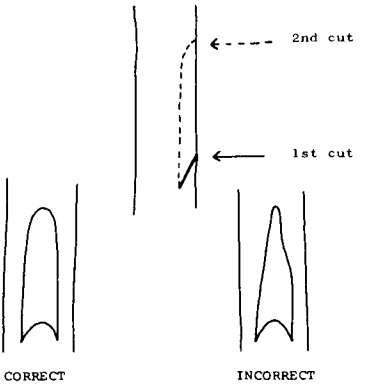

Figure 2. Cutting the rootstock. Top = side view, bottom = front view.

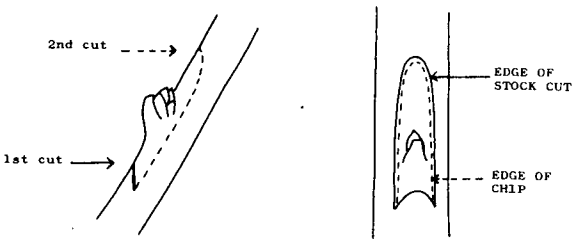

Figure 3. Cutting the budstick. Left = side view, right = front view with chip in place on the rootstock.

The most essential requirement in addition to competent knifemanship is the use of polyethylene film to cover and protect the chip during the healing process, particularly essential because unlike the T budded shield it is not protected by the bark flaps. Rubber strips and patches, thin plastic strips and twine have all proved inferior to polyethylene film. The colour of the film has been shown not to have any effect on callusing through different light transmitting properties, but differences in manufacturing processes may result in relatively brittle or

soft textured tapes, the latter being more convenient to work with and giving better results. The tape should entirely cover the bud where entry of the red bud borer midge (*Thomasiniana oculiperda* Rubs.) is to be avoided, as with apples in Southeast England, and should avoid the actual bud while ensuring complete coverage of the cut surfaces where the bud is large and soft, as in *Tilia* spp. Tape widths of 1 or 0.5 inch are available and for some species such as *Acer platanoides* it does not appear to matter which is used. The length of time the tie is left in position will depend on the growing conditions; at East Malling a high proportion of buds are healed-on in 3 weeks, but 4 weeks are necessary to guarantee optimal results in most years with apples and other fruit plants, and ornamental trees such as *Ulmus*, *Tilia* and *Acer* spp.

Budding season. In theory, chip budding can be done at any time of the year because the bark does not have to slip. In practice, successful chip budding is confied to the period April to early September when rootstocks are growing actively (Table 4). The most common time is July and August, similar to conventional T budding, when dormant buds of the current season's growth are used. Spring chip budding is also successful with respect to the effectiveness with which the chip heals onto the rootstock, but under East Malling conditions vigorous scion growth cannot be guaranteed every year and more information is needed on the correct stage at which to remove the rootstock head and how this should be timed in relation to the developing scion shoot.

Table 4. Percent bud-take of 'Cox'/M.26 apple related to date of budding. Ties released after 3 weeks.

Budding dates		Budding dates	
1974		*1975*	
18 July	98	27 February	0
8 August	100	10 April	0*
5 September	88	7 May	96
10 October	0		
21 November	0		

* April budding gave 72% take when ties were removed after 6 weeks.

DISCUSSION

Chip budding appears to have greatest relevance as a replacement for conventional T budding when the period of cambial activity is limited after budding. The faster union formation brought about by the close proximity of the cambium of scion and rootstock makes up for the shorter period during which growth is possible. On this basis chip budding is likely to be more effective in the United Kingdom, where it has been taken up rapidly in fruit and ornamental nurseries, than on the conti-

nent of Europe, and in the Eastern United States than along the Pacific Coast, where in Oregon, for example, excellent stands of T-budded *Acer platanoides* 'Crimson King' and *Gletitsia triacanthos* 'Sunburst' can be seen, whereas in England they can only be raised reliably by chip budding.

On the other hand, the use of chip budding in spring in those areas with long summer growing seasons will facilitate the regular production of large trees in one growing season by ensuring rapid union development and early growth. In less favourable areas the chip method is of even greater importance for spring budding, but it may not be sufficient to accomplished the desired tree quality every year. The more cumbersome and time-consuming whip and tongue grafting can be relied upon to produce good quality trees in one season and since the chip budding method provides similar although less extensive cambial contact an investigation is in progress to determine the essential components of the grafting method in comparison with spring chip budding.

The fewer movements involves in chip budding result in slightly faster work compared to T budding in the United Kingdom. In Japan it is reported to be preferred when very large numbers of buds must be placed in a short time, although maximum bud-take is not always achieved under these conditions.

Acknowledgements. Among my colleagues who have played a part in the investigation of the potential of chip budding and helped to rapidly establish it as the main budding method in UK nurseries, Miss M. Bennett was responsible for studies on *Nectria* infection and Dr. D.S. Skene for the anatomonical studies.

Figures 1a and b and part of Table 1 are reprinted with permission of the Journal of Horticultural Science.

LITERATURE CITED

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BEN DAVIS: Can you use chip budding on peach and cherry?

BRIAN HOWARD: Cherries are improved by chip budding. Peaches are an uncommon crop in England so I can only give you second hand information from visitors from the U.S. and

France who after visiting us have gone back home, tried it and written us that it works rather well on peaches.

BEN DAVIS: How well does that bud stay in between the budder and the tyer?

BRIAN HOWARD: If it is properly made the wedge at the bottom of the cut holds the bud in very tightly. In fact, we can pull the rootstock back, flick it and the bud still stays in; there is little probability of the bud dropping out between the budder and tyer.

RALPH SHUGERT: In southern Ohio most of our budding will be done in a 30 day period when temperatures frequently go up to 90° to 100°F. What comments would you have about this high temperature under that poly-wrap.

BRIAN HOWARD: Last year we had a very hot dry summer in England and many nurserymen were calling me complaining that they could not get the rind to slip and what about this chip budding they had been hearing about. Those people who tried it under these hot-dry conditions had very good success. However, we have never investigated the direct temperature effect you speak of but I did visit one English nursery where I thought burning might have been a problem. Traditionally, English nurserymen bud on the north side of the stock thinking that when the bud grows out it will grow straighter because it will be growing toward the sun. The fact that we bud on the north side may be one of the reasons we do not have any problem with burning. We also use milky poly tape, but as I tell all my nurserymen, try one row, don't do the whole nursery.

PETER ORUM: Can you use a patch tie on these chip buds?

BRIAN HOWARD: No, you cannot. It does not have pressure applied to the right places, in fact, the only thing we are recommending to date is the polyethylene strips which I have described.

VOICE: Do you recommend setting the bud to one side in order to match the cambia when the stock and scion are different sizes?

BRIAN HOWARD: I am not happy with the idea of placing it to one side, this defeats the concept of knitting and completing the cylinder of cambium. I would recommend that you attempt to match stock and scion as much as possible. With a thick stock you can simply cut shallower if your scion wood is thin or in some cases you can go to the opposite end of the bud stick which may be thicker in order to obtain your bud. By attempting to match the cut sizes we have not experienced a need to set the bud off to one side.