THE PROPAGATION OF CERTAIN DECIDUOUS PLANTS BY HARDWOOD CUTTINGS

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Abstract: The heated bin technique for propagating fruit tree rootstocks may be applied to ornamental and forest subjects.

When used for this purpose, modifications are required to the conditions used for fruit rootstocks. These include the use of lower temperature, lower growth regulator concentrations, and more frequent irrigation in the bins

INTRODUCTION

The propagation of fruit tree rootstocks from hardwood stem cuttings in heated bins is well established and current developments of this technique have been outlined by Howard (1). In reviewing this method of propagation, Martyr (5) suggested that it could be of value for the production of high value ornamental crops. In some of the work reported a high rooting percentage was achieved, but subsequent establishment was poor, the highest value being obtained with *Aronia melanocarpa*,where a 10% survival was observed. This low survival rate after planting would appear to be the main problem associated with the use of this technique on crops other than fruit rootstocks.

In reviewing methods of propagating *Corylus* and *Viburnum* McMillan Browse (6) also noted the possible potential of this technique for certain cultivars. This supports initial work by Howard (2) on the use of heated cutting bins for propagation of *Corylus avellana,* where the propagation requirements were considered similar to those necessary for fruit tree rootstock production

Discussing aspects of propagation used in forestry, Jobling (4) cited work with *Platanus x acerifolia,* which may be propagated from hardwood stem cuttings inserted in the field in autumn. With this method a rooting percentage greater than 70 is rarely achieved and values are often lower. He states that there is preliminary evidence that propagation in heated bins may lead to more rapid rooting, with greater success in terms of percentage rooting, but that subsequent handling of the cuttings may be more difficult.

In studies on bud dormancy in hardwood cuttings, Smith (7) and Smith and Wareing (8), observed that chilling shortened bud dormancy and increased both the number of wound roots produced on M2 apple rootstocks and *Populus x robusta* cuttings and promoted the emergence of pre-formed roots from poplar cuttings. Evidence has also been cited, (Howard (3)), that pre-rooting cold treatments may be beneficial in rooting apple rootstock clones.

At present there is little comprehensive work on the use of this technique for propagation of ornamental and forest subjects. Basal temperature, growth substance concentration and irrigation requirements of ornamental subjects may differ from those necessary for fruit tree rootstock production. Preliminary work at this Institute indicates that such factors appear to play a critical role with some of the more sensitive ornamentals.

This paper presents the results of experiments designed to provide information on the requirements of plants other than fruit rootstocks.

MATERIALS AND METHODS

The results of three experiment, using 21 different subjects, are presented. For the first two experiments, cuttings were obtained on 17 January 1972, from stock plants grown at Notcutts Nurseries, Woodbridge, Suffolk. These were cold stored in 250 gauge polythene bags in a direct cooled store at 0° C (32° F) prior to insertion in the heated bins. Cuttings for the third experiment were obtained from stock plants grown at this Institute.

Bin Construction. The heated bins were installed under cover in a pre-fabricated concrete barn. Construction was of bitumen-covered "Thermalite" blocks, with a base of light, aerated concrete blocks, also bitumen painted. Basal drainage was provided by a 23 cm depth of coarse aggregate. Within each bin, heating wires to give a loading of 15 watts/sq. ft. were tied to "weldmesh" grids with a Maclaren rod thermostat (type GAG) set 2.54 cm (1 in.) above the wires. A 23 cm deep rooting medium of equal parts peat and grit was used with a temperature at cutting base level of 15.6° C$\pm$3° . Monitoring of temperature was by a Grant D, nine channel recorder, with thermistor probe sensors (type C).

Cutting Preparation. All cuttings were made to a length of at least 30.5 cm (1 ft.). The exact length depended upon the internodal length below the distal bud and varied slightly both within a treatment and between subjects.

The basal levels of cuttings were trimmed immediately upon removal from cold storage. Cuttings were then dipped to a depth of 1.2 cm in. 4 — (3-indolyl) butyric acid (IBA) in 50% ethyl alcohol, at concentrations of either 1250 or 2500 ppm. Control cuttings were untreated in experiments 1 and 2, but dipped in 50% ethyl alcohol alone in experiment 3. The bases of cuttings were allowed to dry before being placed in the bins.

Experiment 1

Cuttings of *Acer platanoides* 'Crimson King', *Acer platanoides* 'Drummondii', *Betula pendula* 'Youngii', *Sorbus intermedia, Laburnum x vossii, Crataegus oxycantha* 'Rosea' and *Crataegus oxycantha* 'Paul's Scarlet', (Coccinea Plena) were trimmed and dipped as described and inserted into one heated bin on 20, 21 and 22 January 1972. A randomized block design was used with 90 cuttings of each subject, giving 30 cuttings of each treatment, arranged 10 cuttings per bundle in 3 blocks.

Cuttings were lifted and data recorded on 14 March 1972. Half of the experiment was field planted into a brickearth soil with the following analysis: -pH 5.72, conductivity 0.79 mmho (water:soil ratio 2.5:1 v/v), 48 ppm N, 61 ppm P, 461 ppm K, 2085 ppm Ca, and 128 ppm Mg into trenches 23 cm deep and 15 cm wide, filled with equal parts peat and grit to a depth of 10 cm, at a spacing of 1 metre between rows and 11 cm between plants, on 17 March 1972. The remaining cuttings were cold stored at 0° C until 11 April 1972 and then field planted in the same manner.

Experiment 2

Cuttings of *Acer platanoides, Syringa vulgaris* 'Esther Staley', *Acer saccharinum, Platanus x acerifolia, Crataegus monogyna* 'Stricta', *C. prunifolia, Hibiscus syriacus* 'Woodbridge' were trimmed and dipped as previously described and then inserted into the second heated bin from 24 to 27 January 1972. A randomised block design similar to that used in Experiment 1 was employed, thirty cuttings of each subject per treatment being used.

The cuttings were lifted and recorded on 15 and 16 March 1972. These were then field planted in the manner described for Experiment 1.

Experiment 3

Cuttings of *Cornus alba* 'Spaethii', *Cornus alba* 'Variegata' (Argento-marginata, Rehd.), *Viburnum x bodnantense, Corylus avellana* 'Aurea', *Corylus maxima* 'Purpurea', *Ulmus hollandica* 'Commelin' and *Betula pubescens* were taken on 8 and 9 February 1972. These were then trimmed and dipped as previously described. A comparable randomized block design, with the same numbers of cuttings, was again used. These cuttings were lifted and recorded on 6 and 7 April 1972. One third of the cuttings (i.e. one block) was field planted. The remaining two blocks were made into 'Nisula' rolls in a compost of 100% peat with the following fertilisers added, 2340 g Osmocote, 1780 g ground limestone, 1780 g dolomitic limestone and 297 g Frit 253A per cubic meter. The treatment for block 1 differed from block 2 in that twice the volume of peat was used for the latter. These cuttings were retained in an unheated bin cleared of compost for three weeks and then transferred to a cool glasshouse where a minimum air temperature of 12.8° C was maintained.

Results of Experiment 1

The results for Experiment 1, (Figure 1) showed that very few roots were produced with any subject by any of the treatments. The

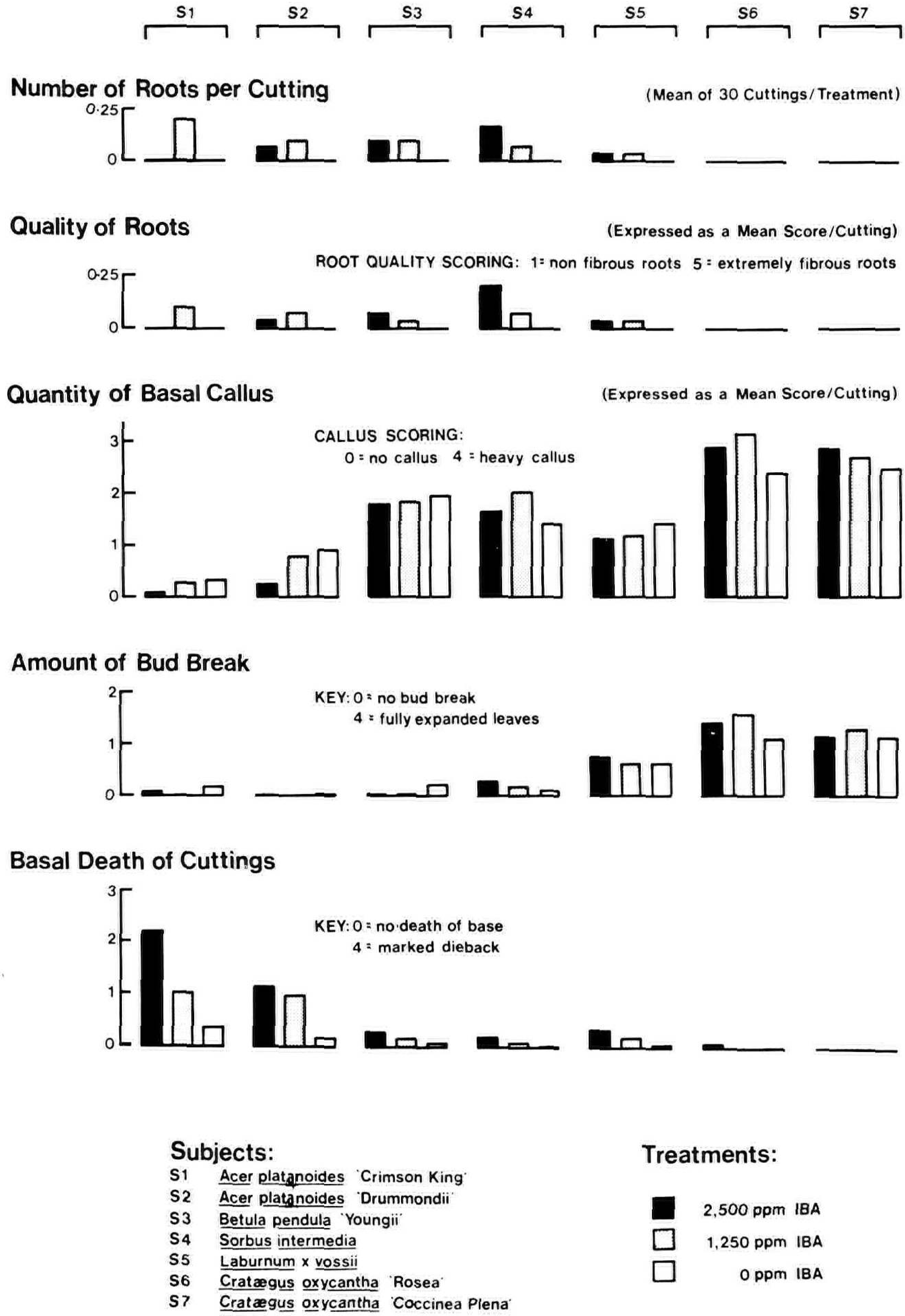

Fig. 1. Criteria recorded on lifting cuttings from the heated bin for plants used in Experiment 1.

score for root quality was therefore similarly low. However, a fairly large amount of basal callus was seen with *Betula pendula* 'Youngii', *Sorbus intermedia* and *Laburnum x vossii* and a larger amount for *Crataegus oxycantha* 'Rosea' and *C. monogyna* 'Stricta'. Very little bud break was observed except for the two *Crataegus* cultivars where a small amount was seen, corresponding to a slight greening of the bud. Little death of the base of cuttings was observed with the exception of the two *Acers* where a marked response to IBA concentration was seen, the highest concentration causing considerable browning and death of the basal few cm of stem. This was particularly noticeable with *A. platanoides* 'Crimson King', but was also marked in *Acer platanoides*, 'Drummondii'. In all cases except *C. oxycantha* 'Paul's Scarlet', a gradient in sensitivity with response to concentration was observed.

When the values for percentage rooting and percentage survival in the field 14 and 36 weeks later were compared (Table 1) it can be seen that *Acer platanoides* 'Crimson King', *Betula pendula* 'Youngii' and *Laburnum x vossii* had for all treatments both low percentage rooting and percentage establishment values. For *Acer platanoides* 'Drummondii' the survival of the plants was greater than might have been expected for the corresponding figures for percentage rooting, particularly after 16 weeks. It must be emphasized, however, that this value was a score of living buds and not of extension growth or full establishment, the score after 36 weeks representing the pattern seen at the end of the season. With this cultivar it might appear that, initially, growth regulator concentration suppresses bud survival in the field and this could be related to the dieback of the stem, previously mentioned. For *Sorbus intermedia*, a response to growth regulator concentration was seen with respect to rooting percentage. However, high numbers of living buds were observed in the field but little active extension growth was evident. For the two *Crataegus* cultivars, high values for percentage survival of buds and young extension growth were noted, the greatest response being seen for the control. This was not a response to the presence of an established root system, as the cuttings had only been at the callused state when planted. The presence of developing root primordia was noted at the time of planting and cuttings lifted after 36 weeks were still healthy, possessing actively differentiating callus but few roots and showing little extension growth.

Experiment 2

When the subjects used in this experiment are considered (Figure 2), large numbers of roots and a corresponding high quality were obtained for certain treatments with *Platanus x acerifolia*, *Hibiscus syriacus* 'Woodbridge' also rooted moderately well.

Table 1. Percentage rooting and establishment of hardwood cuttings

Subject	Percentage rooting on lifting from bins.			Percentage survival in the field 3½ months later.			Percentage survival in the field 8½ months later.		
	T1	T2	T3	T1	T2	T3	T1	T2	T3
Acer platanoides 'Crimson King'	0	3	0	0	0	3	0	0	3
Acer platanoides 'Drummondii'	3	7	0	33	57	77	3	7	17
Betula pendula 'Youngii'	7	3	0	0	30	10	0	0	0
Sorbus intermedia	20	7	0	53	67	80	7	13	7
Laburnum x vossii	3	3	0	10	17	3	10	10	*3
Crataegus oxycantha 'Rosea'	0	0	0	80	63	97	70	47	77
Craetaegus oxycantha 'Paul's Scarlet'	0	0	0	83	83	87	57	73	83
Acer platanoides	14	20	0	10	23	13	10	23	*0
Syringa vulgaris 'Esther Staley'	0	0	3	10	10	3	10	0	0
Acer saccharinum	3	14	0	10	0	0	7	0	*0
Platanus x acerifolia	84	100	100	47	67	90	47	67	*80
Crataegus monogyna 'Stricta'	0	0	0	10	20	67	3	7	30
Hibiscus syricus 'Woodbridge'	87	97	0	97	100	93	97	97	*93
Crataegus prunifolia	0	0	0	0	3	7	0	0	3
Cornus alba 'Spaethii'	94	100	100	0	0	60	0	0	40
Cornus alba 'Variegata'	97	100	90	20	0	60	10	0	50
Viburnum x bodnantense	43	23	23	0	0	0	0	0	0
Corylus avellana 'Aurea'	0	0	0	0	10	40	0	0	0
Corylus maxima 'Purpurea'	7	0	3	40	10	20	20	10	10
Ulmus hollandica 'Commelin'	97	90	3	30	30	30	30	30	*10
Betula pubescens	0	0	0	0	0	30	0	0	0

T1 — 2500 ppm IBA T3 — 0 ppm IBA

T2 — 1250 ppm IBA * Cultivars showing good extension growth.

In both of these cases, the order of root production with respect to treatment was 1250 ppm>2500ppm>0 ppm IBA. The trend for all subjects is shown in Figure 2. Detail of the root type produced by *Platanus* treated with 1250 ppm IBA is shown in Figure 3.

Little root production was noted for *Acer platanoides, Acer saccharinum* or *Syringa*, the only treatment where any response was seen being the control. For the two *Crataegus* cultivars, no roots were produced with any treatment. When values for callusing were compared following the trend observed in Experiment 1, high scores were noted for *Crataegus* and both *Platanus* and *Hibiscus.* Again a general trend was for 1250 ppm IBA to be the most suitable treatment for the production of an optimum response. The highest values for bud break were observed with *Syringa* and the two *Crataegus* cultivars. However, scores for this criterion were generally very low

The only subject where high values for death of the base of the stem were observed was *Acer platanoides*, where a gradation of response with increasing growth substance concentration was noted, as reported for Experiment 1.

Experiment 3

Three subjects showed high values for the number of roots produced; these were: *Cornus alba* 'Spaethii', *Cornus alba* 'Variegata', and *Ulmus hollandica* 'Commelin'. The latter responded particularly well to a high IBA concentration.

Bud break values were generally slightly higher than for the previous two experiments, probably due to the later planting. The two *Cornus* cultivars, and *Betula pubescens,* exhibited bud values corresponding to the "green bud" stage, the greatest activity being seen with cuttings treated with 1250 ppm IBA. The highest values were obtained with *Viburnum.* A stage of bud development just preceding bud break being noted for treatments 1250 and 0 ppm IBA. The greatest amount of basal death was seen for the two *Cornus* cultivars, where a concentration gradient was observed, higher concentration promoting more dieback. Some stem dieback was also noted for *Viburnum, Ulmus* and *Betula.* Data for all subjects is presented in Figure 4.

General trends from all three experiments. When these data are compared with those for percentage rooting and percentage survival measured twice in the field (Table 1) certain trends may be seen.

All *Crataegus* cultivars failed to root but produced heavy callus and two of them could be said to have produced satisfactory results in terms of bud survival, viz *C. oxycantha* 'Rosea' and *C. oxycantha* 'Paul's Scarlet'. However, with all cultivars of this genus, it can be

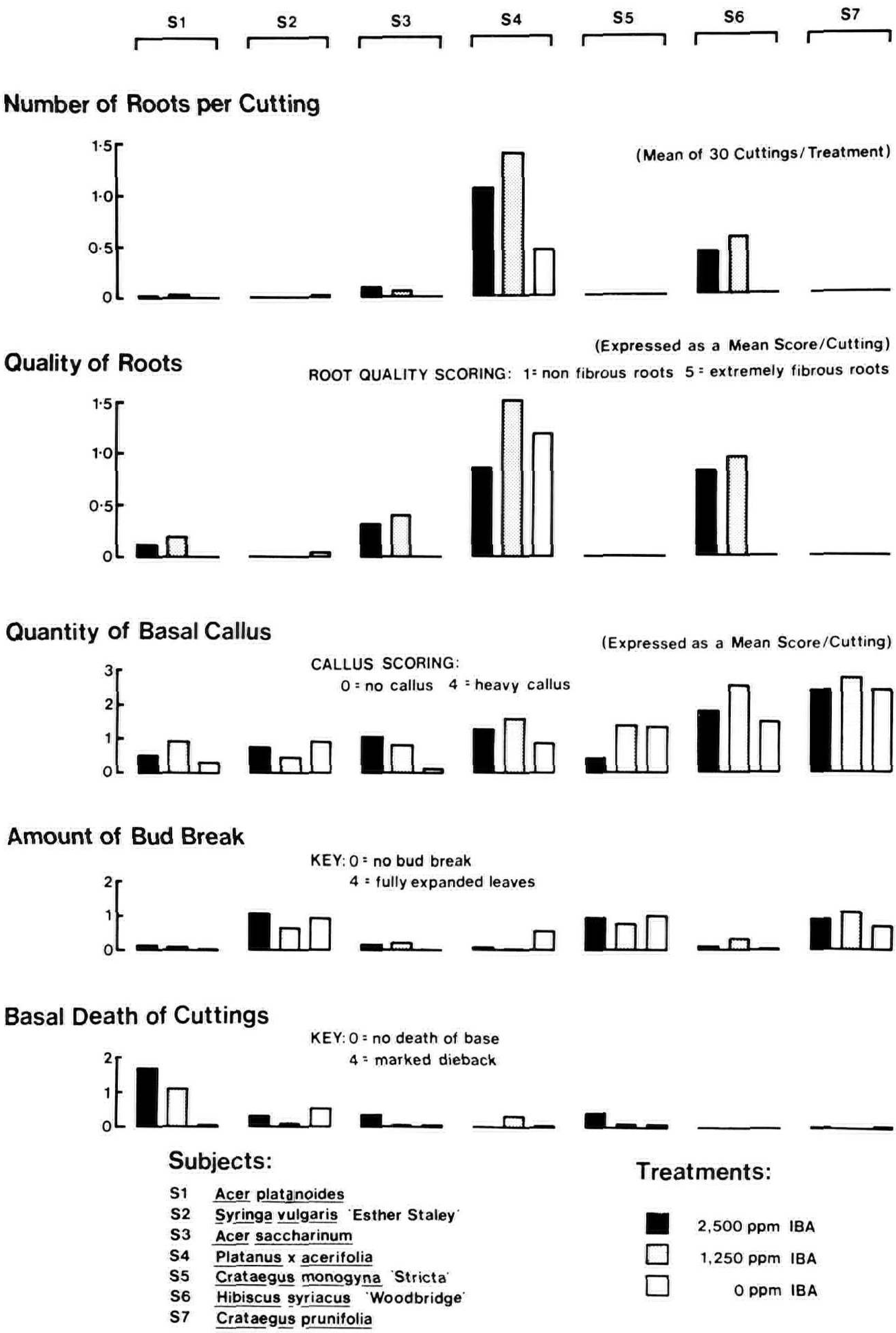

Fig. 2. Criteria recorded on lifting cuttings from the heated bin for plants used in Experiment 2.

Fig. 3. Detail of the thick, fleshy, nonbranched roots produced by *Platanus x acerifolia* cuttings previously dipped in 1250 ppm IBA.

noted that the highest values for percentage survival were seen in the untreated plots (Figure 5). It could be suggested that any subsequent rooting is a response to heat treatment of the stem bases rather than to growth substance concentration.

For *Platanus* (Figure 6) 100% rooting was obtained for both 0 and 1250 ppm IBA with a fall at the higher concentration. This effect was accentuated when values for percentage survival are considered.

For *Ulmus*, (Figure 7), percentage rooting increased with growth regulator concentration, but percentage survival was similar for all treatments. This indicates that rooting is not always correlated with survival and points to the importance of post rooting treatment. For *Acer platanoides* both percentage rooting and percentage survival were greatest at 1250 ppm IBA and declined at either a lower or a higher concentration.

Hibiscus (Figure 8) showed a marked response to growth regulator concentration, again reaching a maximum percentage rooting at 1250 ppm and declining slightly at the higher concentration. Percentage survival values showed a similar trend, but here a high value was observed where no rooting had taken place in a similar manner to *Crataegus*.

When field observations of bud number, numbers of actively growing buds, dessicated buds and fully expanded leaves were assessed, it was seen that in many cases the values observed for these criteria followed those recorded for root number and establishment. This was particularly evident where data for *Hibiscus, Acer platanoides* and *Platanus x acerifolia* were compared. Cuttings cold stored after lifting from the bin but before planting in the field, appeared to suffer less bud damage in the form of dessication and consequently to show a greater percentage of

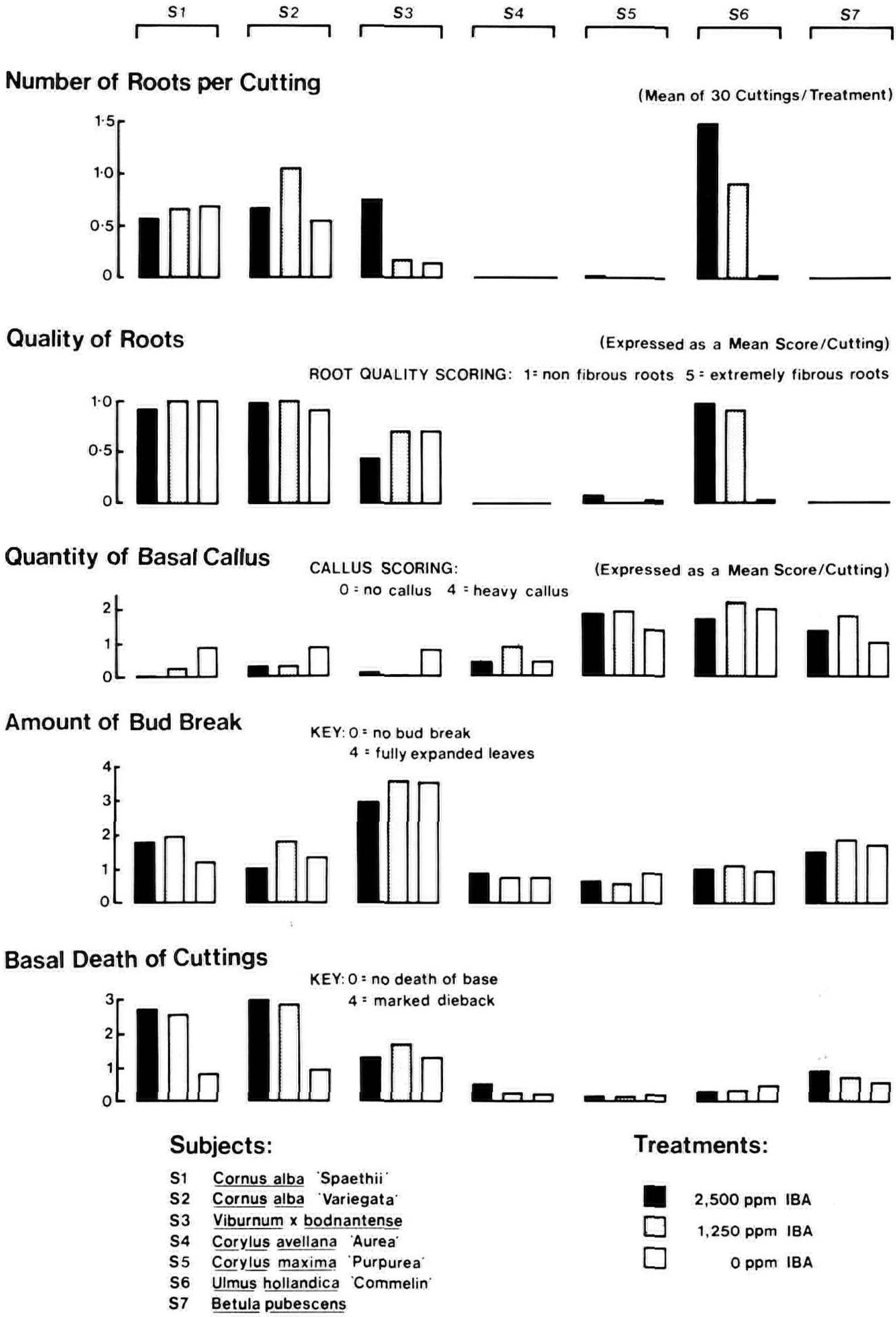

Fig. 4. Criteria recorded on lifting cuttings from the heated bin for plants used in Experiment 3.

actively growing cuttings As the season progressed this effect became less marked.

No detailed observations were made on root numbers with respect to cold chilling.

DISCUSSION

This method of propagation would appear to present certain differences than when used for fruit rootstock production. Fruit rootstocks are in many respects more tolerant of adverse conditions than many of the subjects for which data has been presented. This difference was clearly seen, in the previous season when M26 apple rootstocks were included in a preliminary trial to test the working of the cutting bins. The apple rootstocks rooted well but many of the more responsive ornamental subjects did not.

The response to rooting of the subjects used in these experiments would appear to fall into three classes.

1 Subjects which callused heavily but did not root in the bin, e.g. *Craetagus.*

2. Subjects which rooted well in the bin but showed a sensitivity to a high IBA concentration, e.g. *Hibiscus* and *Platanus.*

3. Subjects which respond in a similar manner to fruit rootstocks, with a high percentage rooting at the IBA concentrations to which the latter respond, e.g. Commelin elm.

When planted in the field, the percentage survival (as assessed by the presence of living buds) appeared to decrease with the increasing growth regulator concentration in both rooted and unrooted cuttings, examples being *Platanus* and *Crataegus monogyna* 'Stricta'

It would appear that with many of these subjects it is not always necessary to have fully developed root systems at the time of planting for subsequent establishment. Transplanting just when root development has begun appears to be more conducive to rooting.

Cold storage of cuttings after lifting from the bin, particularly in the event of adverse weather conditions, may be beneficial, enabling a crop to be held until soil conditions are more conducive to effective planting. It is possible that a problem associated with this modification of the technique could be an induced dormancy caused by this cold treatment. Another method of attempting to overcome adverse conditions which may be present at the time of planting, could be to place cuttings in "Nisula" rolls. This technique was found to induce quick rooting with certain subjects, in particular *Corylus avellana* 'Aurea', when callused cuttings were placed in rolls of this type. Subsequent survival of these plants was, however, poor and it may well be that the greater benefit of this technique could be found by rooting cuttings directly into the rolls, as the establishment phase of these cuttings would appear critical.

Cuttings taken in these experiments were planted in as near commercial field scale conditions as possible. However, this does not prevent more critical post rooting treatment on an intensive scale, where the problem of establishment, so clearly illustrated by the data for the Commelin elm, and reported by other workers, is a major factor limiting the technique at the present time. Stem dessication in early spring was thought to be an important causal factor in the death of many cuttings, particularly with *Laburnum x vossii*, Commelin elm, *Crataegus prunifolia* and *Acer platanoides* 'Crimson King'. The use of anti-dessicants may well be of benefit in such cases. It is of interest to note that certain subjects, namely, *Acer platanoides* 'Drummondii' and *Sorbus intermedia,* although retaining living buds, made less extension growth than other cultivars, the buds appearing to remain in a semi-dormant state.

It is noteworthy that where high survival values were observed, as for instance, in *Hibiscus*, the rooted cuttings produced leaf growth with a vigour directly related to the rooting score for a particular treatment.

Certain subjects appear not to respond to this technique as it has been applied in this instance. For example, *Betula, Virburnum* and *Syringa* showed very little response and *Cornus* may well be better propagated by other methods currently in use, unless a much higher survival rate is to be achieved following field planting. Rooting individual cuttings in small containers may be a possible means of overcoming this difficulty.

The values quoted in the text figures, refer to recordings taken during early summer and in late autumn and it must be emphasized that in many cases the high scores recorded for percentage survival, where the presence of living and actively growing buds was used as an index of this criterion, did not persist throughout the season. The data presented in Table 1 shows this clearly. Certain subjects look extremely promising initially but do not establish sufficiently well to grow away. This observation agrees with those of previous workers. *Crataegus* is a genus of particular interest although little extension growth was seen, the cuttings were still alive and active at the end of the season. The growth with these cultivars, which produced good extension growth, e g. *Platanus,* Commelin elm and *Hibiscus* was extremely vigorous, all plants of both the plane and the elm being of more than adequate size for transplanting into nursery rows, as were the majority of *Hibiscus*. This indicates the potential of this technique.

It would thus appear, that modifying the conditions required for fruit tree rootstock propagation, by lowering the temperature, the growth regulator concentration, increasing the irrigation requirement and field planting at an earlier stage, may lead to the rooting of certain more sensitive subjects. In general, it is probably true to say that a lower growth regulator concentration appears to be necessary, although this varies with the subject. However, it must be emphasized, that there is still a great deal of critical work yet to be done in this field.

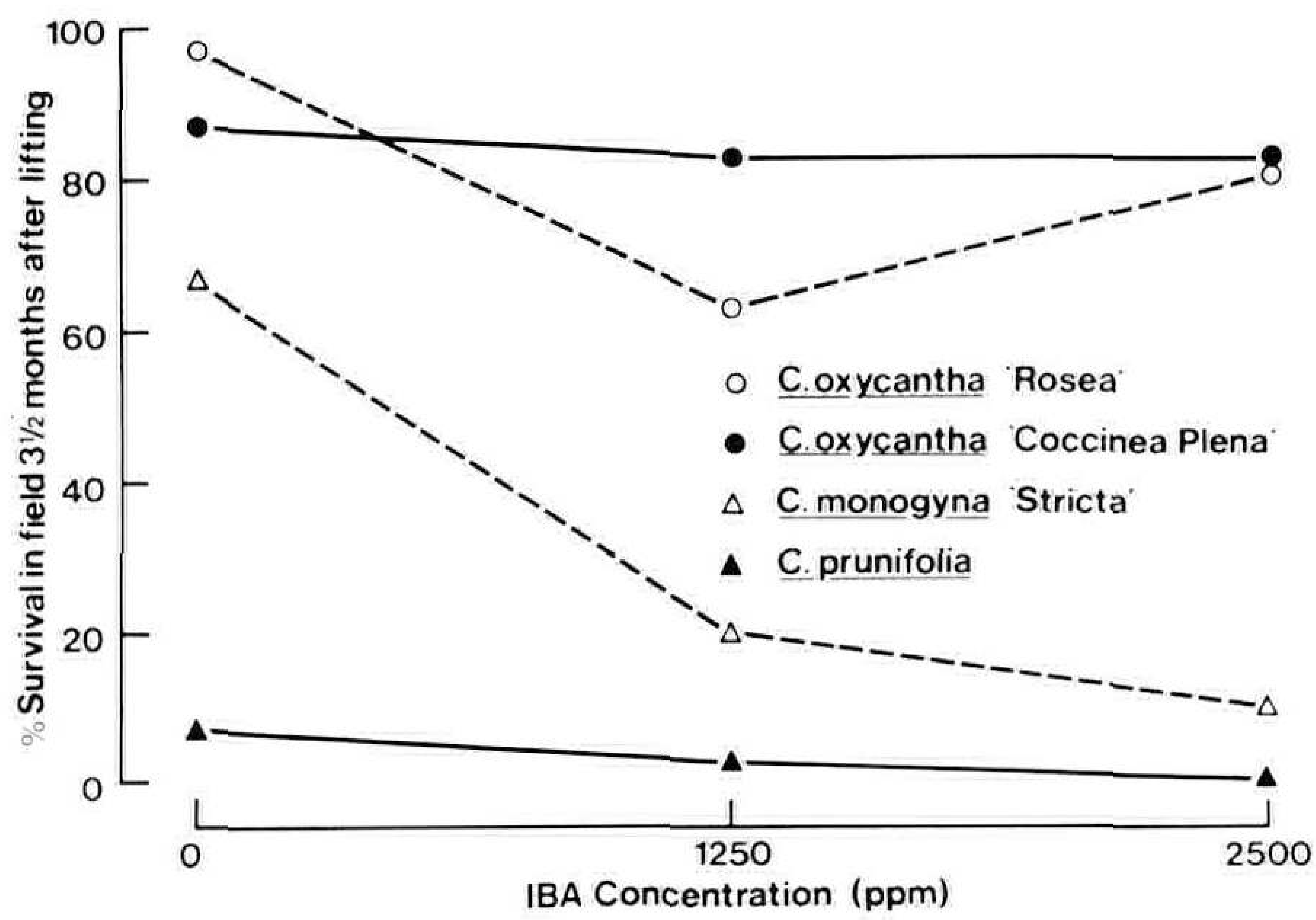

Fig. 5. Percentage survival of cuttings of four *Crataegus* cultivars.

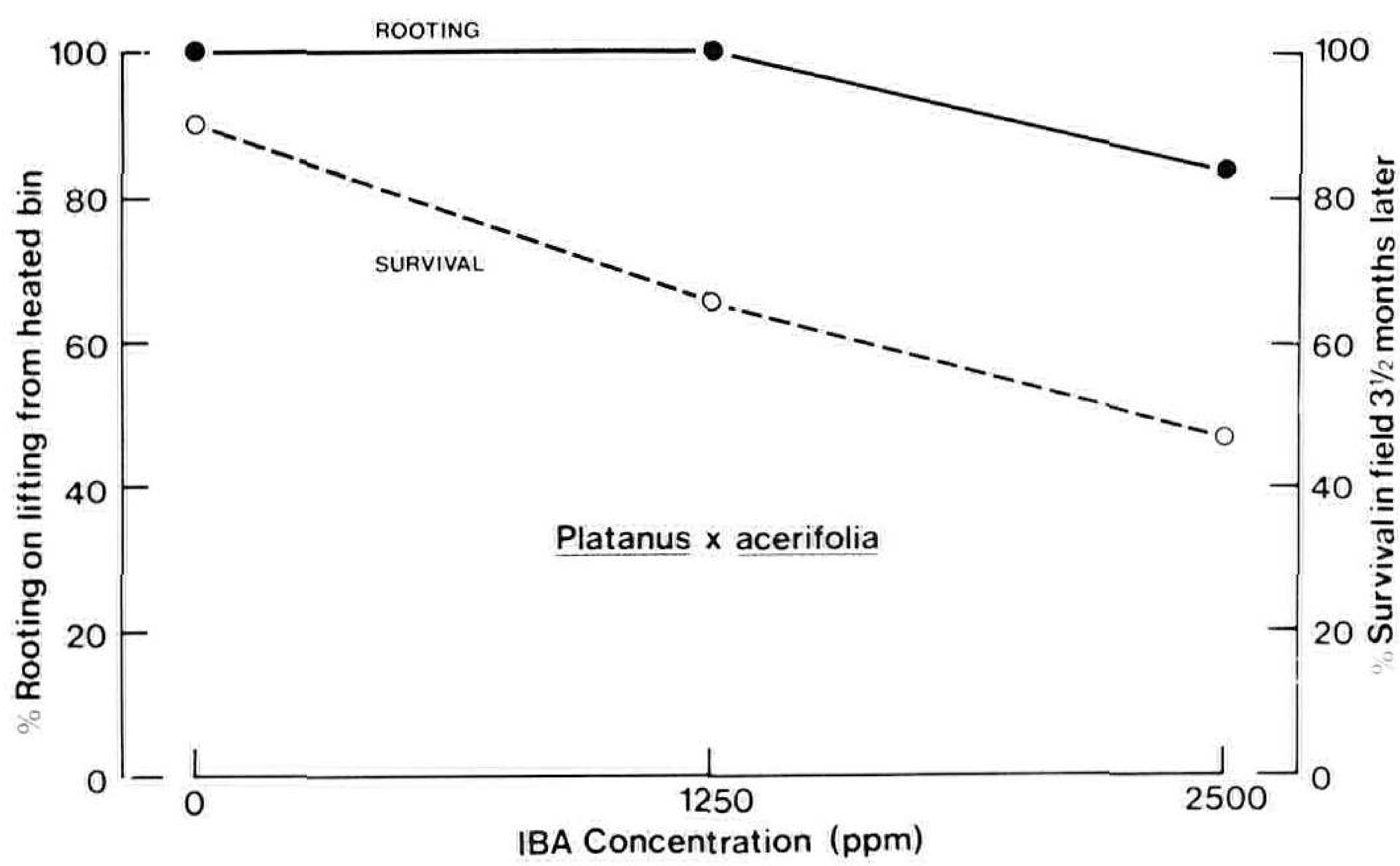

Fig. 6. Percentage rooting and survival of *Platanus x acerifolia* cuttings.

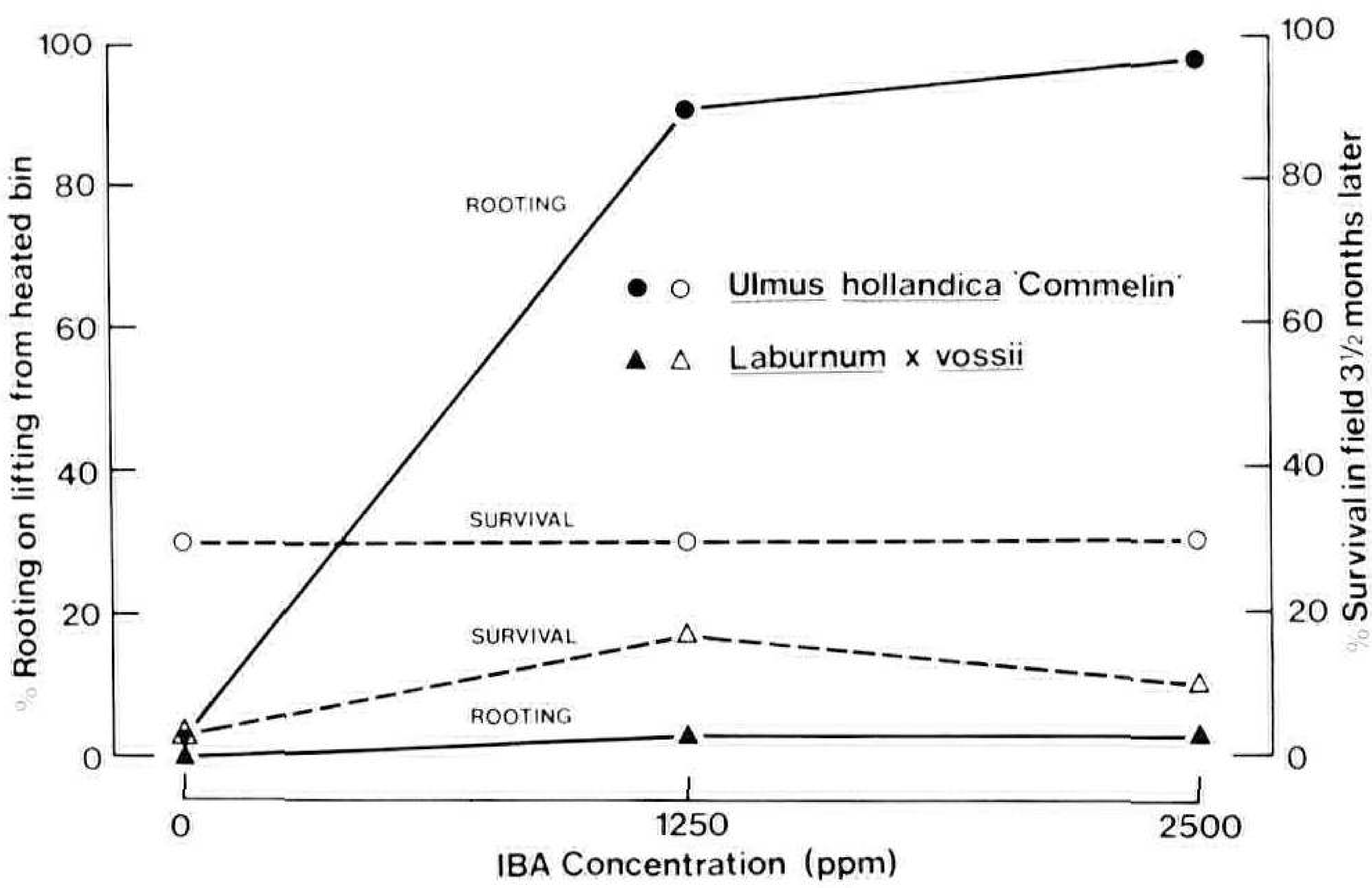

Fig. 7. Percentage rooting and survival of *Ulmus hollandica* 'Commelin' and *Laburnum x vossii* cuttings.

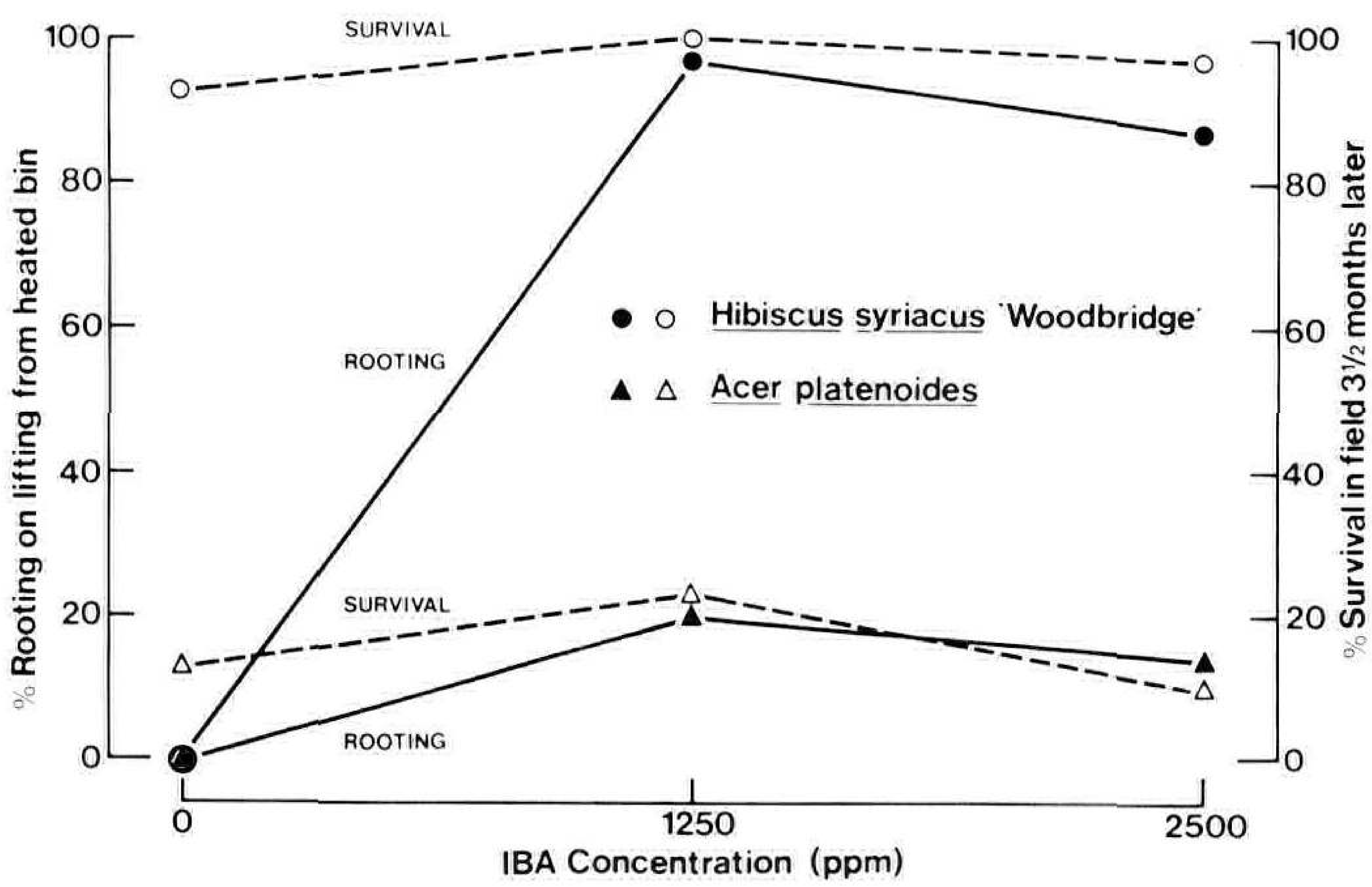

Fig. 8. Percentage rooting and survival of *Hibiscus syriacus* 'Woodbridge' and *Acer platanoides* cuttings.

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