ROOTING SOFTWOOD CUTTINGS OF MATURE *BETULA PAPYRIFERA*[1,2]

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Abstract. One-node cuttings from current shoots of six 18-year old *Betula papyrifera* trees were collected on 5 dates and treated with indolebutyric acid solution (IBA) 5-second dip at 0, 2000, 4000, 6000 and 8000 ppm. Three trees produced over 40% rooting over all dates compared to 12% or less for other trees. Cuttings from mid-shoot had higher rooting percentages than basal or apical cuttings except on the last two dates when apical cuttings had higher percentages. Three indices of maturity, which were stem length, stem diameter and leaf number, showed a linear growth pattern throughout the sampling period with no distinct change related to the time for best rooting. IBA concentrations of 4000 and 6000 ppm resulted in the highest rooting percentages for most trees on most dates of collection.

INTRODUCTION

Rooting birch by cuttings has been considered difficult (2,7). However, some reports cite success with standard nursery practices. Hares (6) reported rooting in England with basally wounded cuttings on August 18 and September 1, using 2000 ppm IBA as a 5 sec. dip. Cuttings of several birch species rooted best when the last leaf on the cutting reached full size and the last bud was not fully matured (1).

Considerable variation in rooting has been reported among clones of birch species (5) and among clones of other species (3,9). Our preliminary studies during the summer of 1983 showed variation from 0 to 88% rooting of *Betula papyrifera* cuttings from 5 different trees of seed-bearing age. Cuttings made in mid-June using 3000 ppm IBA (0.3%) in talc gave better rooting than 1000 ppm (0.1%). In mid-July, quick dip in 2000 ppm IBA solution gave better rooting than 1000 ppm. One-node cuttings rooted as well as multi-node cuttings in our preliminary study, as with *Acer rubrum* (8).

The effect of cutting date, IBA concentration, and tree-to-tree variation in rooting cuttings of seed-bearing paper birch is presented here.

[1] Vermont Agr. Exp. Sta. Jour. Art. No. 587.
[2] This research was supported by funds provided in part by the Northeastern Forest Experiment Station of the USDA Forest Service through the Northeastern Consortium for Environmental Forestry studies. Special thanks are given to Lawrence O. Safford, Principal Soil Scientist, Northeastern Forest Experiment Station, Durham, NH, for his assistance and counsel.

MATERIALS AND METHODS

Current-year shoots from 18-year-old *B. papyrifera* trees were collected on 5 dates during the summer of 1984. These trees were seedlings of a local provenance growing in the White Mountain National Forest at approximately 290 m elevation near Bartlett, New Hampshire. Trees were thinned to a pure stand of 2500 plants per hectare when they were 8 years old and fertilized in 1974 with 3600 Kg/ha dolomitic limestone, 400 Kg/ha N, 200 Kg/ha P, and 100 Kg/ha K. Five uniform trees selected for sampling ranged from 9.2 to 11.2 cm DBH and one tree was 14.7 cm DBH. Trees were considered mature, being approximately 8 m tall and bearing seed.

Shoots were collected from randomly selected quadrants in the upper one-third of the tree crown. They were placed in polyethylene bags on ice in an insulated chest and transported to Burlington, Vermont where they were prepared as cuttings and stuck within 24 hr of collection.

On collection dates, cuttings from each of 5 shoots were randomly assigned to the 5 IBA treatments. From each shoot, 1-node cuttings were made and kept in serial order. Wounds 1-cm long were made through the cambium on one side of the cutting base. Each cutting consisted of a node with attached leaf at the top and subtending internode with the basal cut made above the next node. Leaves over 4 cm wide were trimmed to remove the terminal one-half of the leaf.

The basal 1-cm portion of cuttings were dipped into IBA solution for approximately 5 seconds at 0, 2000, 4000, 6000 or 8000 ppm (50% ethanol). Cuttings were stuck 1 to 2 cm deep in 5 cm-deep flats of a 1:1 mixture of perlite-vermiculite and placed in the University of Vermont glass greenhouse under intermittent mist controlled by Mist-A-Matic device.

Cuttings were arranged in a randomized block design with 30 tree-IBA treatments (6 trees, 5 IBA treatments per tree) randomly assigned within each of 5 blocks. Cuttings of each shoot were serially ordered in a row. The number of cuttings from shoots was variable depending on the number of nodes. There were more cuttings per shoot on subsequent sampling dates.

Considerable variation in the stage of shoot development occurs in different locations due to climatological and latitude influences. Since maturity of shoots on a given date may vary in different regions, identification of some stage of maturity may be a better index of when to take cuttings than date. Shoot diameter, shoot length, and number of leaves over 4 cm wide were recorded as objective indices of maturity.

Flats were removed from the mist after 5 weeks to harden off the cuttings. Rooting was evaluated 6 weeks after sticking; cuttings were considered rooted if they had one root at least 1-cm long. In addition, rooted cuttings were given a quality rating of 1 (poor) to 5 (excellent) based on number and length of roots.

RESULTS AND DISCUSSION

Rooting percentages differed among the six trees for all dates (Figure 1). Trees 3, 5 and 6 had rooting percentages of 43, 46, and 49 respectively, over all dates while trees 1, 2 and 4 had only at 8, 9, and 12 percent rooting, respectively.

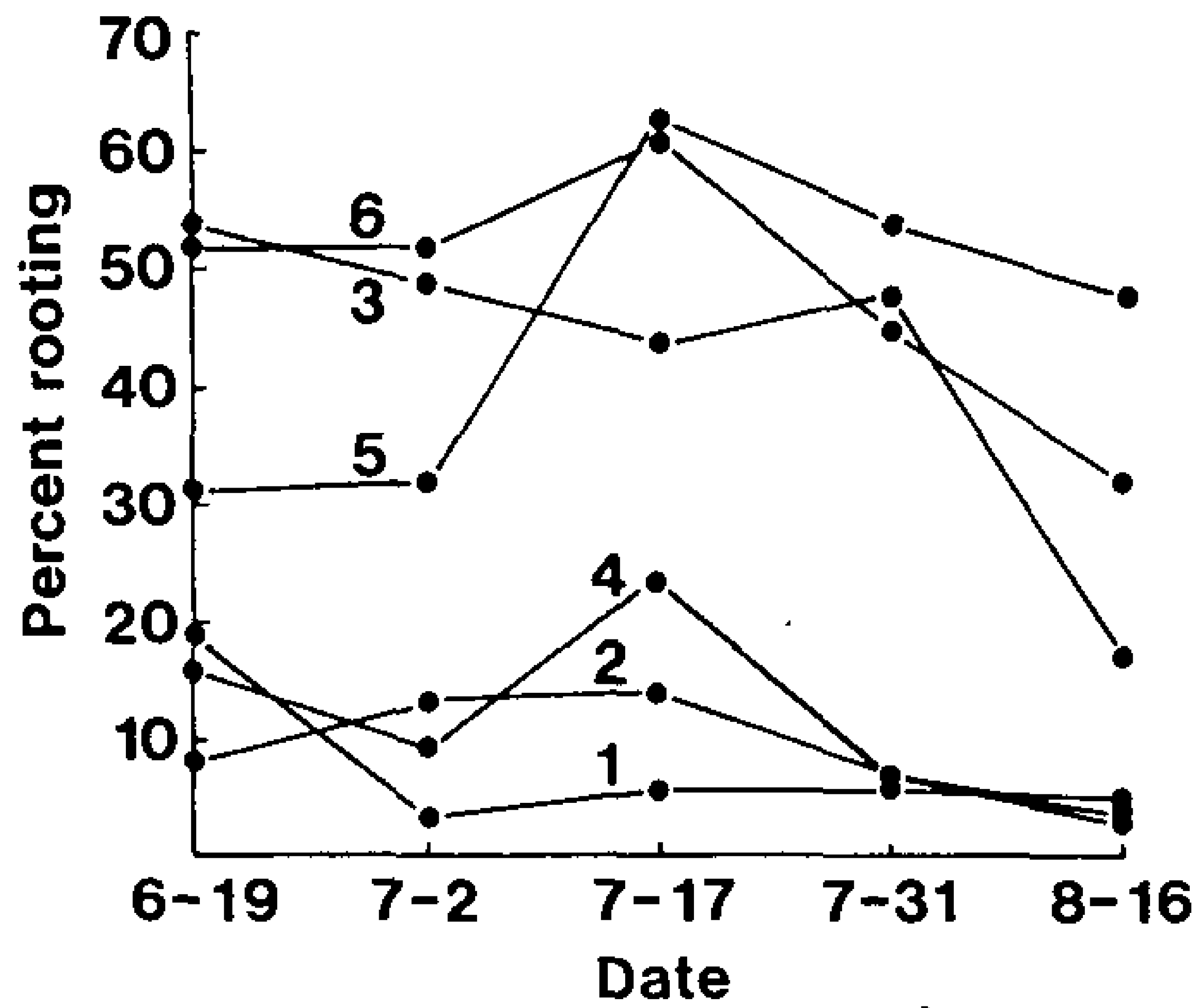

Figure 1. Percent rooting for 6 *Betula papyrifera* trees for 5 cutting dates — 1984. Means of cutting from 25 stems.

Mid-stem cuttings generally had better rooting on the first three dates than basal or apical cuttings (Table 1). Apical cuttings had as high or higher rooting percentages than mid-stem cuttings on the later dates (July 31 and August 16). This could be a function of the increasing maturity of apical shoots when cuttings were made.

The three indices of maturity, shoot diameter, shoot length, and number of leaves, showed a steady increase throughout the sampling period (Table 2). In general, rooting of cuttings collected over an 8 week period appeared to be unrelated to any change in growth. The only apparent relationship between shoot development and rooting was the better rooting of apical cuttings stuck on August 16 using 4000 to 8000 ppm IBA (Table 1). By this time most shoots had set terminal buds and ceased terminal growth.

Figures 2 and 3 show the contour representation of the relationship between the mean percent rooting, IBA concentrations, and date of cutting. Each contour line connects the cutting dates and IBA concentrations which give the same predicted percent rooting.

Table 1. Effect of cutting location within shoot and IBA concentration on percent rooting[1], of *Betula papyrifera* shoot cuttings on 5 dates in 1984, composite of 6 trees.

Date and location on stem	IBA concentration (ppm)				
	0	2000	4000	6000	8000
June 19					
Basal	10.3b	30.0b	24.1b	30.0b	36.7a
Mid-shoot	27.7a	43.4a	59.1a	50.0a	40.8a
Apical	3.4b	16.7b	10.0b	13.3b	13.3b
July 2					
Basal	3.3b	6.7b	26.7b	16.7a	30.0a
Mid-shoot	18.0a	40.6a	44.3a	35.1a	36.7a
Apical	3.3b	20.0b	13.3b	16.7a	33.3a
July 17					
Basal	10.0b	23.3b	13.3b	23.3b	13.3b
Mid-shoot	28.0a	47.4a	52.1a	49.6a	37.5a
Apical	0b	23.3b	33.3b	33.3b	40.0a
July 31					
Basal	6.7a	20.0a	33.3a	30.0a	10.3a
Mid-shoot	15.2a	40.8a	39.0a	28.2a	24.3a
Apical	13.3a	36.7a	43.3a	40.0a	26.7a
August 16					
Basal	0a	6.7a	0b	13.3b	0b
Mid-shoot	10.8a	15.2a	24.3b	24.5b	16.2b
Apical	13.3a	23.3a	53.3a	43.3a	33.3a

[1] Percents of all trees. Percents in a column on a date followed by the same letter are not significantly different at the 0.05 level by proportion separation (4).

The lettered lines in Figure 2 show how to read the graph. For cuttings taken on July 2, horizontal line AB connects the date to the rooting percentage of 35%. This was the highest rooting percentage averaged over all trees. The vertical line BD shows the lowest IBA concentration to give 35% rooting. Vertical line CE shows the highest concentration of IBA that was effective in rooting 35% of the cuttings. For July 2, horizontal distance axis DE gives the range of IBA concentrations (4200 to 6000 ppm) most effective in rooting cuttings.

On July 31, using the same procedure, A'B' and A'C' predicted the limits on the 35% contour line. The vertical lines B'D' and C'E' predicted the range of IBA concentrations of approximately 2800 to 7000 ppm IBA which resulted in 35% rooting on that date.

A 60% rooting percentage was predicted for the trees with the highest rootability (trees 3, 5, 6) during a 5-week period from early July to mid-August (Figure 3). Optimal IBA concentrations for the mid-point of this period (approx. July 25) ranged from approximately 3500 to 7000 ppm. For earlier or later cutting dates, a narrower range of IBA concentrations gave optimal rooting.

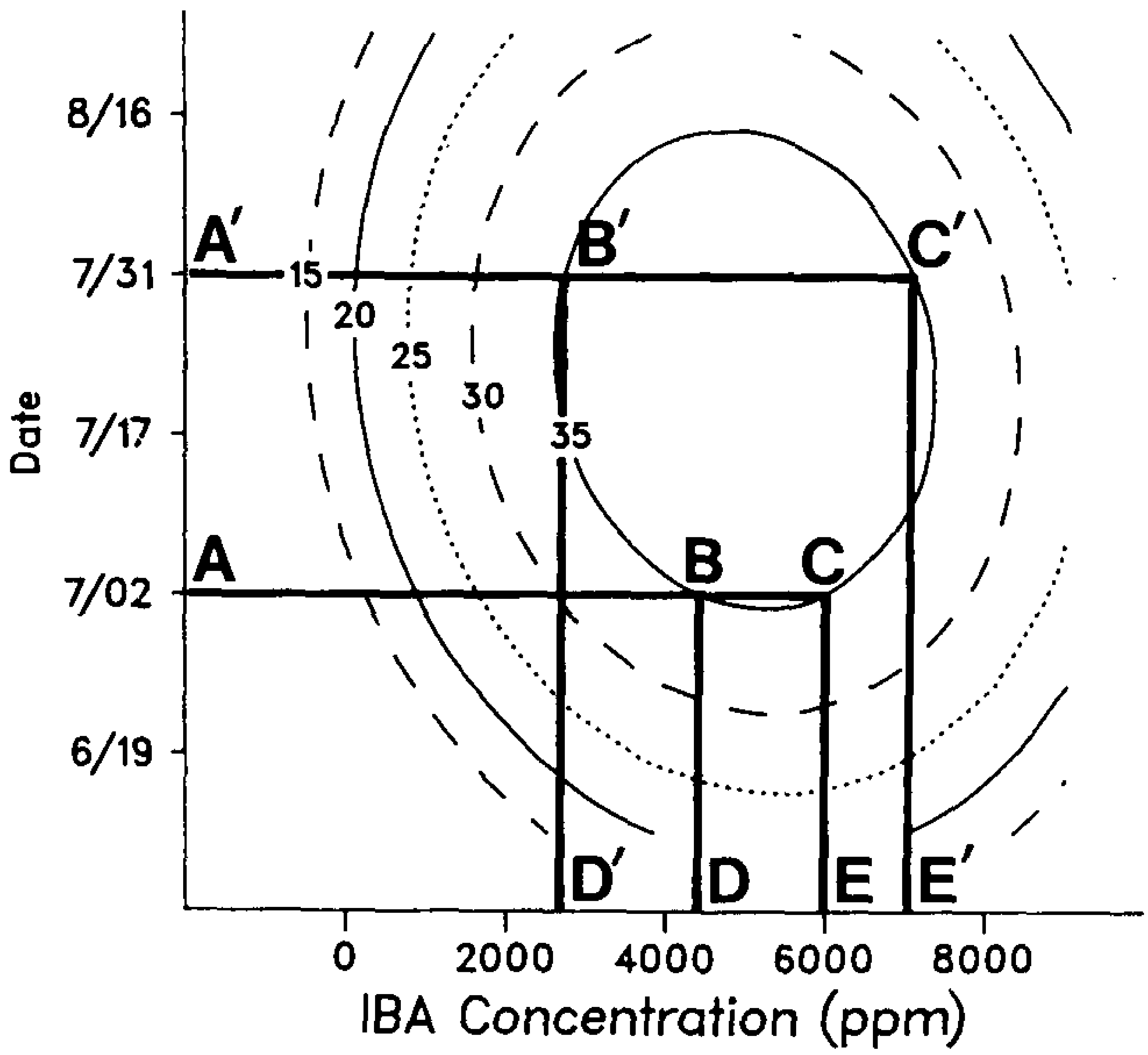

Figure 2. Contour plots of the effect of IBA concentration and date of cutting on percent rooting of *Betula papyrifera* cuttings from six trees — 1984.

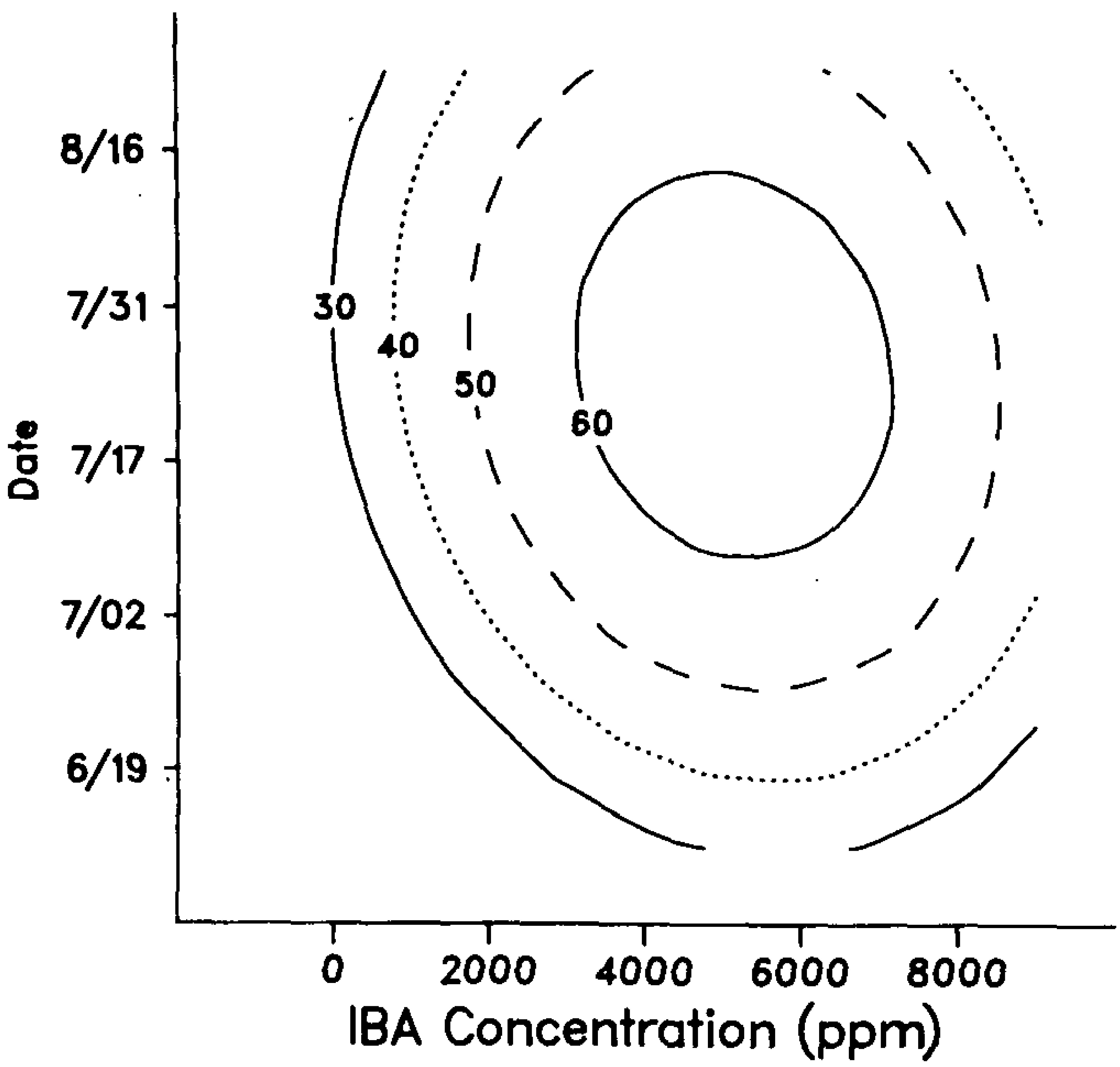

Figure 3. Contour plots of the effect of IBA concentration and date of cutting on percent rooting of *Betula papyrifera* cuttings from the trees showing good rooting percentages — 1984.

Date of collection (maturity) and IBA concentration for rooting birch cuttings were not highly critical in these studies. Optimal rooting over all IBA treatments for trees with over 50% rooting was predicted from July 7 to August 16 (Figure 3) when shoot diameter increased from 0.28 to 0.45 cm and leaf number increased from 4.9 to 11.0 (Table 2).

Table 2. Shoot diameter, shoot length, and number of leaves on *Betula papyrifera* shoots[1] used for cuttings on 5 dates — 1984.

Date	Shoot diameter (cm)	Shoot length (cm)	Number of leaves[2]
6-19	0.30 ± .06	18.9 ± 5.4	3.7 ± 1.1
7-2	0.28 ± .06	16.0 ± 5.8	4.9 ± 1.3
7-17	0.35 ± .07	31.7 ± 9.2	7.8 ± 1.5
7-31	0.38 ± .08	35.9 ± 11.7	9.0 ± 1.9
8-16	0.45 ± .12	44.3 ± 13.9	11.1 ± 3.9

[1] Means and standard deviation of 150 stems, 25 each from 6 trees.
[2] Number of leaves wider than 4 cm on current-season shoots.

Root quality ratings were highest for trees, dates, and IBA concentrations giving highest percent rooting (data not shown). Root quality ratings were not significantly correlated to stem diameter, shoot length or number of leaves.

While cuttings of some trees showed substantial rooting, subsequent lack of growth and survival was a problem. The leaves of most cuttings deteriorated during rooting. Leaves abscised when cuttings were removed from mist. Cuttings were potted and fertilized weekly with 20-20-20 at 150 ppm of N after rooting, but few new shoots developed even in the presence of 16-hr days effected with artificial lighting. More than 50% of the rooted cuttings died within 2 months of potting.

Survival of rooted birch cuttings may depend on forcing new stem growth simultaneously or subsequent to root formation. This has proven necessary for first year survival of many hard-to-establish trees from rooted cuttings (7).

In an attempt to improve survival, Osmocote 20N-6P-11.6K (14-14-14) at 2.65 kg/m^3 (4.5 lb/yd^3) and fritted trace elements (Peter's 555) at 62.47 gr/m^3 (1/4 tsp/ft^3) were incorporated into the perlite:vermiculite rooting medium. Two-node cuttings taken July 2, 1985 were subirrigated with the basal 1 to 2 cm of media submerged in tap water. No mist or overhead irrigation was applied, but cuttings were shaded for 1 week following cutting. Cuttings from 2 of 5 trees made significantly more shoot growth than unfertilized cuttings (Figure 4). Further studies are planned to establish the benefit of slow release fertilizer.

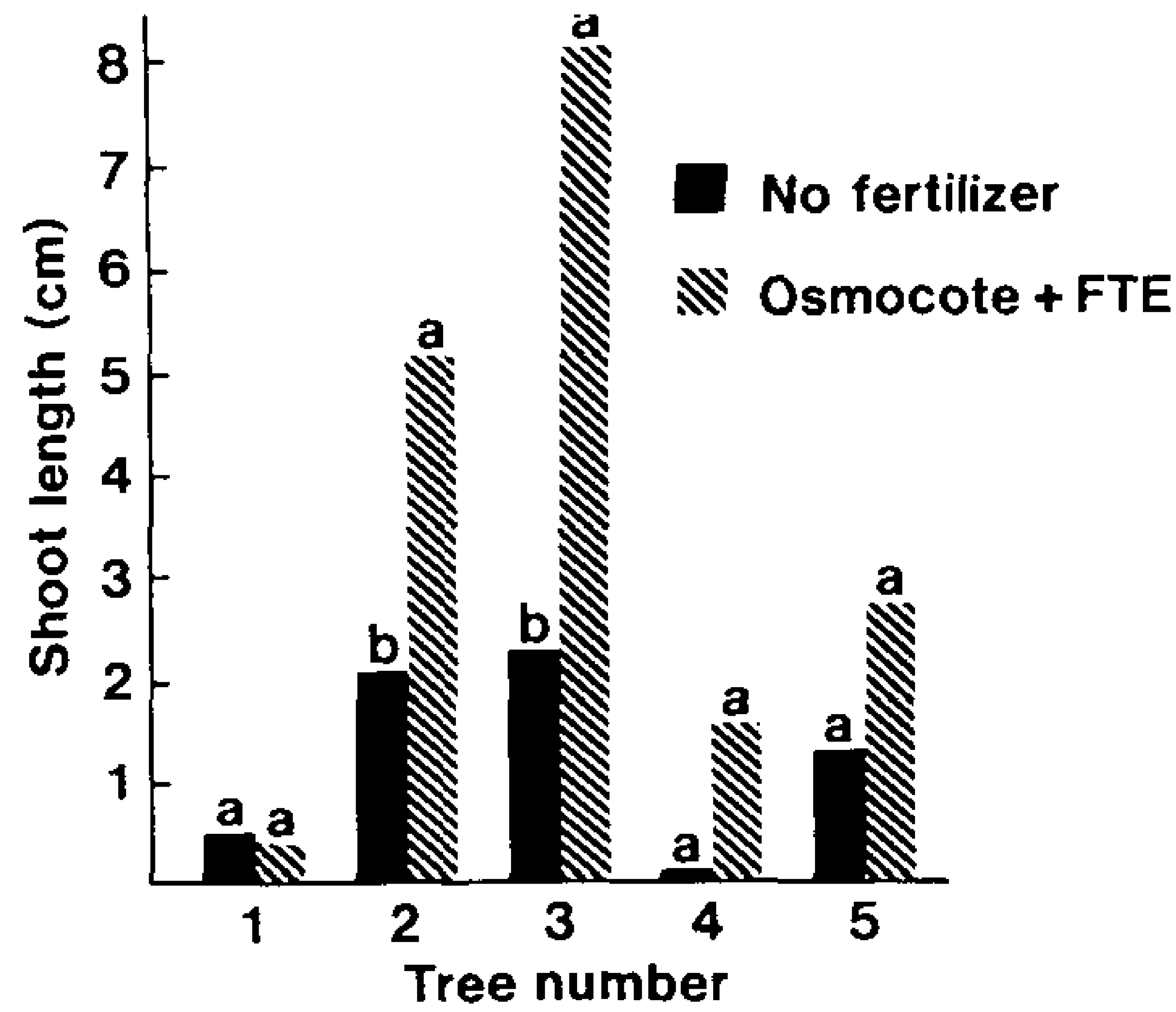

Figure 4. Effect of Osmocote (14-14-14) and fritted trace elements in rooting medium on shoot length of rooted cuttings 8 weeks after sticking. Comparisons for each tree with the same letter are not significantly different at the 0.05 level.

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