the elastic will deteriorate in the sunlight.

VIRGIL DRAKE: What is the understock for camperdown elm. Can it be Chinese or Siberian elm?

JOERG LEISS: If you use Chinese elm you get a big bowl. We use a hybrid and I am not sure of the parents. There is no incompatibility problem.

Thursday Morning, December 16, 1982

The Thursday morning session covened at 8:00 a.m. with Charles Tosovsky serving as Moderator.

ROOTING *EUONYMUS* CUTTINGS OUTDOORS UNDER THERMO-BLANKETS OR UNDER GREENHOUSE INTERMITTENT MIST USING PROPAGATING MEDIA WITH AND WITHOUT COMPOSTED SEWAGE SLUDGE[1]

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Abstract. Microfoam thermo-blankets can be used throughout the year to root *Euonymus kiautschovica* Leos. 'Sieboldiana'[3] cuttings outdoors. Microfoam thermo-blankets help in maintaining cooler temperatures around the cuttings in the summer than white copolymer alone. Euonymus cuttings taken in March will root equally as well under microfoam covered with either clear or white copolymer with or without bottom heat. However, cuttings propagated in the fall rooted significantly better under intermittent mist than similar cuttings stuck under the thermo-blankets. Compost with other materials made from lime dewatered sewage sludge and woodchips blended at ⅓ by volume significantly reduced rooting and survival as compared to cuttings rooted and grown in equal parts by volume of milled pine bark and expanded shale.

Since the 1950s propagation of cuttings under intermittent mist has become widely accepted. However, skyrocketing production costs and inherent problems with intermittent mist propagation (5,6) have led some growers to seek alternatives.

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[3] Bot. Ed. Note: *E. sieboldiana* = *E. hamiltoniana* but is sometimes confused with *E. Kiautschovica*.

For years propagation of certain species was done under glass, in cold frames, under lath, or beneath polythylene chambers in the fall, spring, and summer. More recently, studies by Gouin (2) have shown that cuttings can be directly rooted year round into containers outdoors beneath thermo-blankets.

The advantages of direct rooting include reduced labor requirements, elimination of transplant shock, and possibly shortens the time to produce a crop. For direct rooting to be successful, the medium used must maintain ample oxygen levels near the base of cuttings while retaining acceptable moisture and nutrient levels (3). The following studies were conducted between March, 1980, and October, 1981, to further test the thermo-blanket propagation system and to evaluate the effects of various media on the direct rooting of euonymus cuttings.

MATERIALS AND METHODS

Thermo-blankets consisted of a single layer of 0.635 cm thick Microfoam (E.I. Dupont DeNemours and Co., Wilmington, Delaware 19898) covered with 4 mil white or clear (85% and 95% light transmittance, respectively) copolymer (Monsanto Nursery film). Bottom heat during the fall, winter, and spring was supplied by rubberized heating pads (Famco Electric Co., Progrow Supply Corp., Butler, Wisconsin) laid directly on the ground.

After the initial watering, the edges of the thermo-blankets were sealed to the ground. Cuttings stuck directly into pots were inspected daily and hand watered when necessary to maintain a nearly saturated environment. Temperatures beneath the thermo-blankets were recorded at 2 hour intervals using a Digitec thermocouple thermometer (model #590JC) equipped with a 636 Scanner frame and Digitec recorder (model 6140). Greenhouse propagation was conducted on raised benches at a minimum temperature of 18°C under intermittent mist of 6 seconds every 3 minutes.

Media components included: raw sewage sludge compost (compost) made from lime dewatered sludge and woodchips (supplied by Maryland Environmental Services, Annapolis, Maryland); expanded shale (Solite) 0.318 to 0.953 cm (Solite Corp., Alexandria, Virginia); milled pine bark (bark) (Forest Products, Salisbury, Maryland); Canadian sphagnum peat (peat); and horticultural grade perlite (perlite).

Soluble salt levels were determined using a 1:5 (medium: water) dilution and measuring conductivity with a Beckman Solubridge. Media pH were measured as described by Bunt (1).

RESULTS

Experiment 1. The initial experiment was conducted to evaluate the effects of Microfoam covered with clear or white copolymer (clear thermo-blankets and white thermo-blankets, respectively), with 21°C bottom heat and with no bottom heat, and 6 propagating media combinations (Table 1) on the rooting of euonymus.

Terminal hardwood cuttings of euonymus were taken on March 19, 1980 and trimmed to a uniform length (15 cm). The cuttings were treated with 0.3% IBA powder (Hormodin #2) and stuck into 1 liter containers filled with each medium. The thermo-blankets were laid directly over the cuttings and the edges sealed to the ground. To monitor the progress of rooting, similarly treated cuttings were placed under intermittent mist in a greenhouse at the same time.

On April 25, 1980, when the majority of cuttings in the greenhouse appeared heavily rooted, the experiment was terminated and rooting was evaluated. Each cutting received a score of 1=no roots, 2=callus, 3=lightly rooted, 4=moderately rooted, or 5=heavily rooted.

Table 1. Rooting response of *Euonymus kiautschovica* 'Sieboldiana' as influenced by propagating medium.

Medium by volume				Rooting Value[y]	pH	Initial Soluble Salts m mho/cm
Compost	Bark	Solite	Perlite			
1	1	1		2.83 abc[z]	7.3	3.40 a[z]
1	1		1	2.69 bc	7.1	1.50 b
1		1	1	2.43 c	7.5	1.30 b
	1	1	1	3.19 ab	7.0	0.32 c
1		1		2.33 c	7.6	1.40 b
	1	1		3.29 a	7.2	0.34 c

[y] 1 = roots, 2 = callus, 3 = lightly rooted, 4 = moderately rooted, 5 = heavily rooted.

[z] Means followed by the same letter or letters are not significantly different at the 5% level (Student-Newman-Keuls).

There were significant differences in rooting between heated and unheated thermo-blankets or between under clear and white thermo-blankets. However, compost incorporated into the medium caused a reduction in rooting (Table 1). The initial pH levels of the propagating media were from 7.0 to 7.2 without compost and from 7.1 to 7.6 for compost amended media. The initial soluble salt levels were consistently higher in all compost amended media.

Daily maximum and minimum temperatures beneath

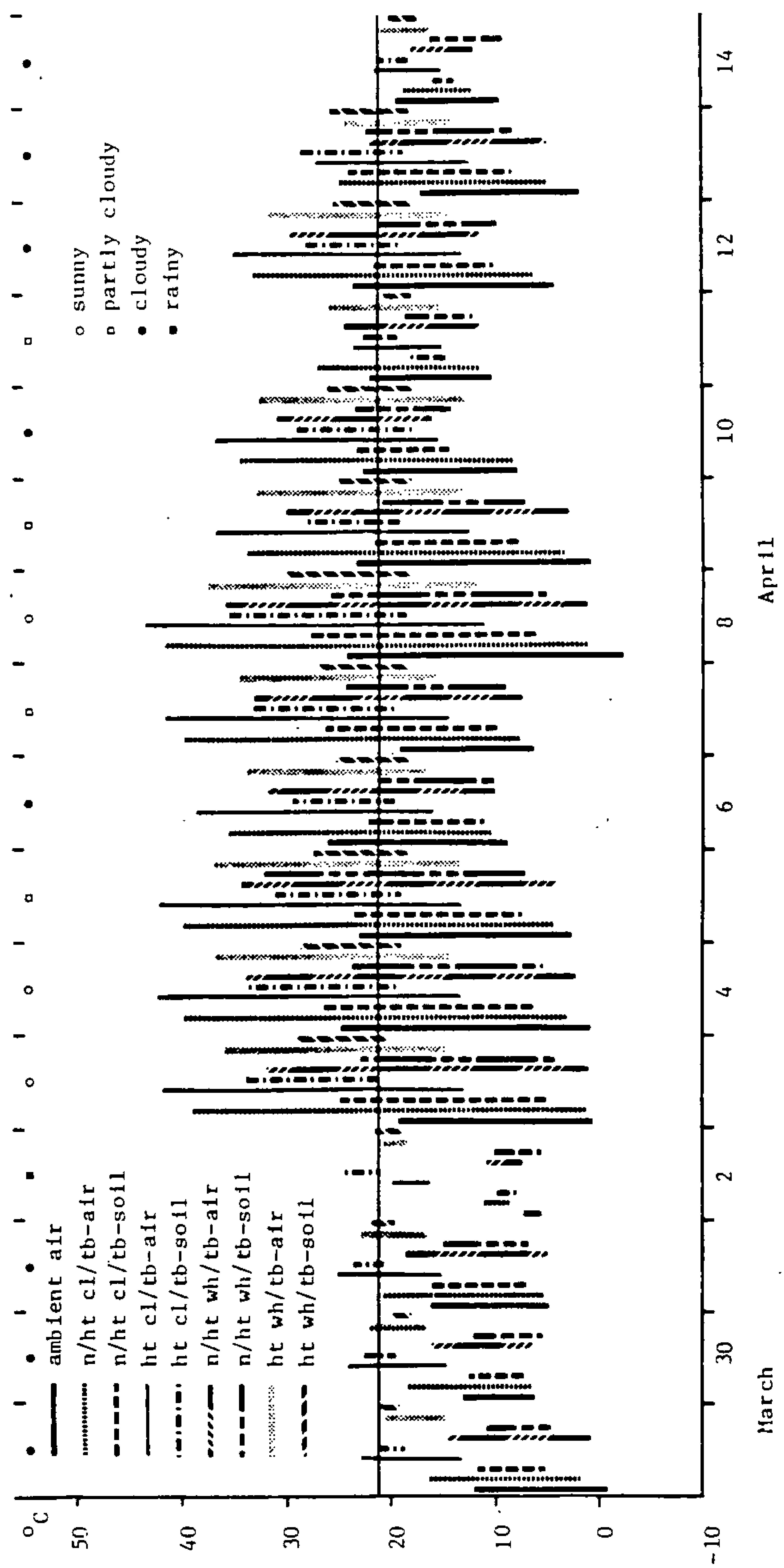
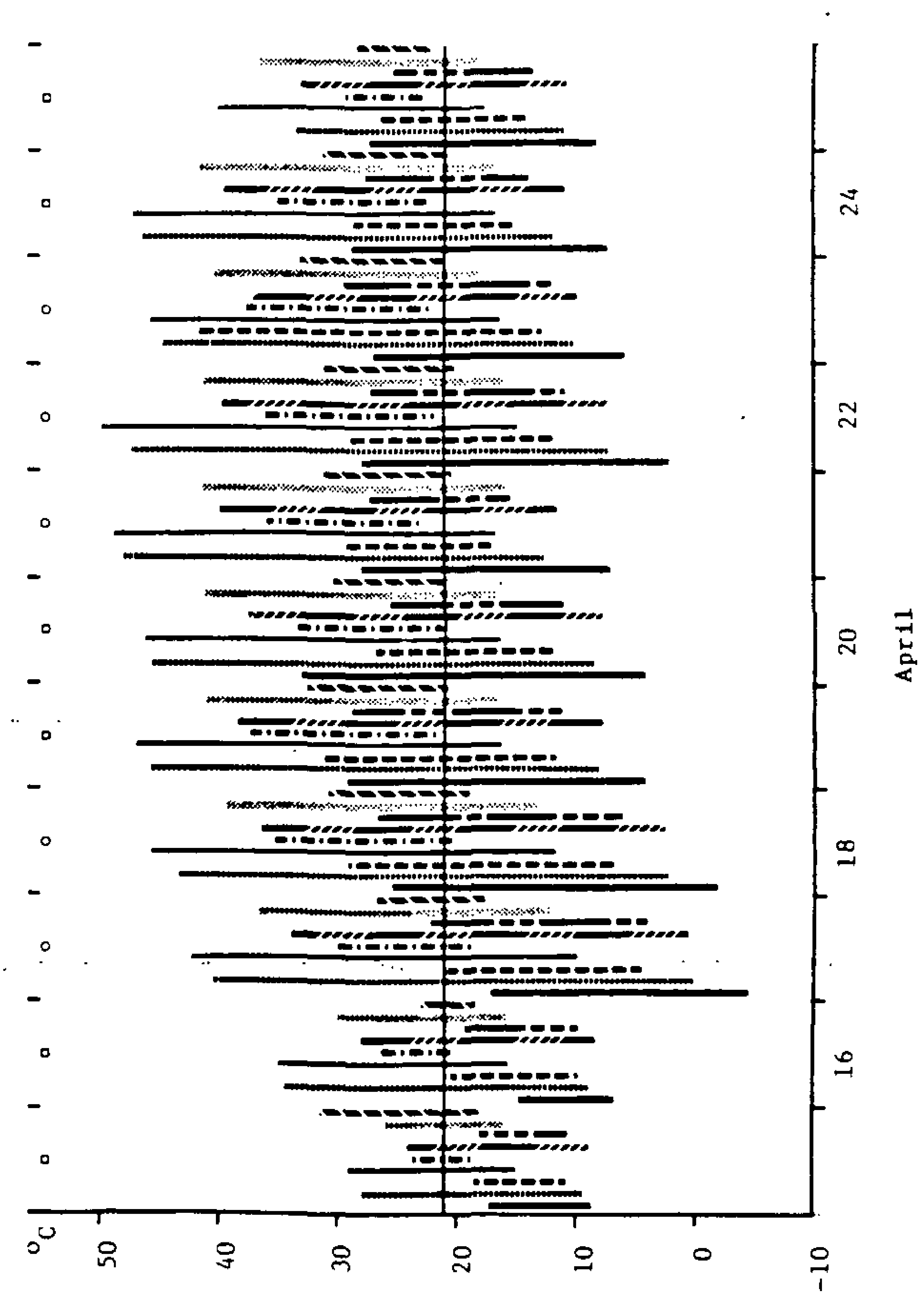


Figure 1. Daily outdoor ambient air and air and soil temperatures under clear and white thermo-blankets (cl/tb and wh/tb, respectively) coverings with and without bottom heat (ht and n/ht, respectively) as influenced by weather conditions.

Figure 1 Continued



thermo-blankets were at least 8° to 12°C higher than outdoor ambient air levels regardless of bottom heat application. Daily maximum air temperatures beneath clear thermo-blankets were 3° to 8°C warmer and soil temperatures were 2° to 6°C warmer beneath clear thermo-blankets than under white thermo-blankets with and without bottom heat. However, minimum soil temperature beneath clear and white thermo-blankets with bottom heat and minimum soil temperatures beneath clear and white thermo-blankets without bottom heat were similar (Figure 1.)

Experiment 2. The results of Experiment 1 indicated that heat build-up can occur during the early spring under clear thermo-blankets. Therefore, a more reflective white copolymer may be needed to minimize spring and summer temperature fluctuations. The objective of this study was to determine whether Microfoam was necessary beneath white copolymer for spring and summer outdoor propagating periods.

Softwood cuttings of euonymus were prepared as in the first experiment but dipped in 0.1% IBA powder (Hormodin #1). Using the 6 propagating media from Experiment 1, cuttings were placed in 1 liter plastic containers without bottom heat under a quonset-shaped frame made of concrete reinforcing wire. The frame was sufficiently tall so that the foliage of the cuttings would not touch the thermo-blankets. After watering the cuttings thoroughly, the frames were covered with white thermo-blankets or white copolymer alone.

On August 11, 1980 the experiment was terminated and rooting and root growth were evaluated using a cm^2 grid system. Media pH and soluble salts were determined as previously described.

White copolymer alone did not provide adequate protection for spring and summer rooting of euonymus cuttings outdoors (Table 2). Cuttings beneath thermo-blankets rooted significantly better than those beneath white copolymer. As in Experiment 1, compost incorporated into the medium reduced rooting and root growth (Figure 2).

Table 2. The rooting response of *Euonymus kiautschovica* 'Sieboldiana' as influenced by covering material.

Treatment	Mean root area (cm^2)
White thermo-blanket	92.26 a[z]
White copolymer	40.23 b

[z] Means followed by different letters are significantly different at the 5% level (Student-Newman-Keuls).

Initial pH levels of the media were lower than in Experiment 1; however, the pH of media without compost remained lower (6.8 to 6.9) than that of compost amended media (6.9 to 7.3).

Air temperatures beneath both propagating units were higher than outdoor ambient air levels during the entire experiment, but air temperatures under white copolymer were from 4° to 6°C warmer to 1° to 3°C cooler than air temperatures beneath the thermo-blankets. In addition, maximum soil temperatures under white copolymer were 2° to 3°C warmer than thermo-blanket soil temperatures.

Experiment 3. The objective of this study was to compare the growth of direct stuck euonymus cuttings propagated outdoors under thermo-blankets with cuttings rooted under greenhouse intermittent mist. The treatments included: (a) cuttings rooted under intermittent mist, transplanted to 1 liter

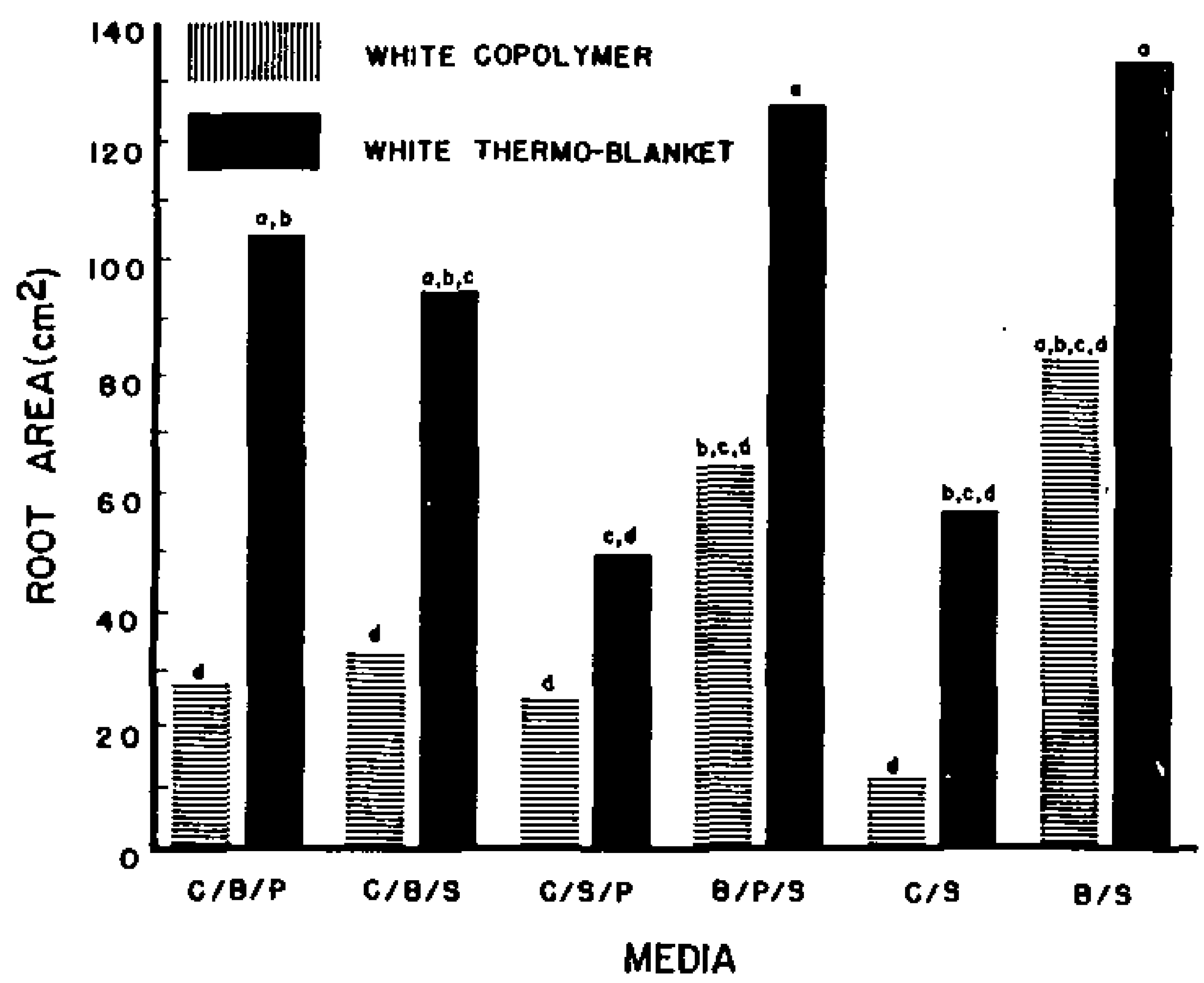


Figure 2. Root area (cm^2) of *E. kiautschovica* 'Sieboldiana' cuttings rooted in media combinations of compost (C), bark (B), solite (S), or perlite (P) beneath white copolymer or white thermo-blanket coverings. Mean separations were performed at the 5% level (Student-Newman-Keuls).

square plastic pots, and later transplanted to 2.8 liter nursery pots (System I); (b) cuttings rooted outdoors beneath white thermo-blankets in 1 liter square plastic pots and later transplanted to 2.8 liter nursery pots (System II); and (c) cuttings rooted under white thermo-blankets directly in 2.8 liter nursery pots (System III). The media consisted of bark/Solite, bark/Solite/perlite, and compost/peat/Solite.

On November 15, 1980 hardwood cuttings of euonymus were taken and prepared as described in Experiment 1. For System I, cuttings were stuck in wooden flats filled with 1:1 (v/v) peat/perlite and placed under greenhouse intermittent mist. In Systems II and III cuttings were stuck in containers as described in Experiment 2. On January 11, 1981 the rooted cuttings of System I were transplanted to 1 liter pots filled with each of the 3 media and placed in cold frames with 7.2°C bottom heat.

On March 24, 1981 thermo-blankets were removed and plants of Systems I and II were transplanted to 2.8 liter nursery pots using the same media used for propagation. All plants were moved to the nursery and watered and fertilized every 10-14 days with a 25-10-10 (Peter's) at 500 ppm of N water soluble fertilizer. The experiment was terminated on October 3, 1981 and the top of each plant was pruned level to the pot rim, dried, and weighed, and media samples were taken to determine pH and soluble salts before and after the experiment.

The propagation systems had no significant effect on the dry weight of euonymus but did affect survival. Cuttings propagated in the greenhouse had significantly greater survival

(96.3%) than either System II or III (60.6% and 67.6%, respectively) under thermo-blankets.

Regardless of propagation system, bark/Solite promoted optimum growth and survival of plants significantly. Cuttings rooted and/or grown in the bark/Solite medium had significantly higher dry weight (Figure 3) and percent survival (Table 3) than cuttings rooted and/or grown in compost amended media.

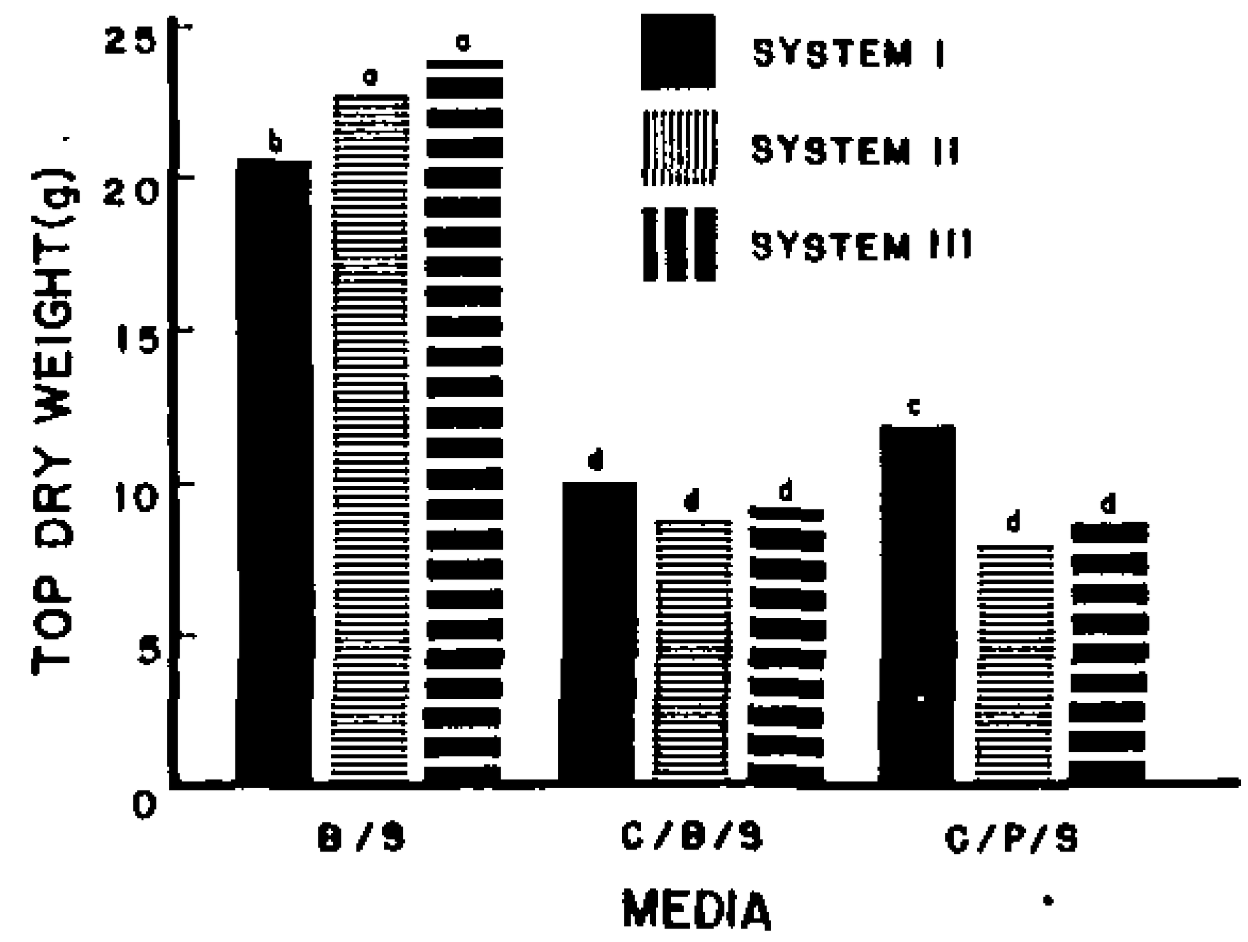


Figure 3. The influence of compost (C), bark (B), Solite (S), and peat (P) in various combinations on the top growth of *E. kiautschovica* 'Sieboldiana' rooted: under greenhouse intermittent mist, transplanted to 1 liter containers, and later transplanted to 2.8 liter nursery pots (System I); rooted under thermo-blankets in 1 liter containers and transplanted to 2.8 liter nursery pots (System II); or rooted under thermo-blankets directly in 2.8 liter nursery pots (System III). Mean separations were performed at the 5% level (Student-Newman-Keuls).

Initial pH levels of compost amended media were 5.1 to 6.6 while those of bark/Solite were 6.4. The final pH of all media was 6.6 and 6.7. The initial soluble salt levels were: 1.90 m mhos/cm for compost/bark/Solite, 1.2 m mhos/cm for compost/peat/Solite and 0.15 m mhos/cm for bark/Solite. Final soluble salt levels were similar among all media.

Though the temperatures fluctuated somewhat between the different thermo-blanket systems, in general, the minimum and maximum air temperatures were 5° to 11°C warmer than outdoor ambient air levels.

Table 3. The influence of propagating medium on the survival of *Euonymus kiautschovica* 'Sieboldiana' cuttings.

Medium by volume				Survival,
Compost	Bark	Solite	Peat	percent
1	1	1		67.1 b[z]
1		1	1	63.4 b
	1	1		93.9 a

[z] Means with the same letter are not significantly different at the 5% level (Student-Newman-Keuls).

DISCUSSION AND CONCLUSIONS

The significant reduction in rooting and growth of euonymus cuttings propagated in compost amended media indicates that these mixes are unacceptable. Soluble salt levels in compost amended media which ranged from 1.1 to 3.4 m mhos/cm possibly affected rooting and growth. This has been shown with plants grown in compost amended media. Leaching has been recommended to alleviate this problem (1,4,7), perhaps a treatment that might be used to improve rooting.

Though the pH values of media ranged from 5.1 to 7.6, rooting appeared unaffected by this fact. These results agree with those of Paul and Leiser (9) who successfully propagated euonymus in media at pH values of 4.4 to 7.0.

The nonsignificant effect of clear and white thermo-blankets on rooting of euonymus cuttings indicates that light transmittance of the coverings was not important in the early spring. However, white copolymer alone as a covering during the summer was not satisfactory. This agrees with Wong (10) who reported temperatures in excess of 35° to 40°C inhibited root growth for several days. The combination of 30° to 40°C soil temperatures and 40° to 50°C air temperatures under white copolymer suggest that reductions in root growth were temperature related.

When a bark/Solite medium was used, growth and survival of cuttings rooted directly in 1.0 and 2.8 liter containers under white thermo-blankets were not significantly different from cuttings rooted under intermittent mist in the greenhouse. This was reported previously (2).

Direct rooting of cuttings outdoors beneath white thermo-blankets can be an alternative to greenhouse intermittent mist propagation for some species. However, the potential use of compost as an amendment for a rooting medium may be limited because of the undesirable effects of high soluble salts on rooting and growth of cuttings. Successful rooting of euonymus in the bark/Solite medium does show that direct rooting can be accomplished outdoors beneath thermo-blankets with the same result as greenhouse intermittent mist. This system can reduce labor and the amount of greenhouse space needed to propagate this crop.

LITERATURE CITED

1. Bunt, A.C. 1976. Modern potting composts. The Pennsylvania State University Press, University Park and London.

2. Gouin, F.R. 1980. Vegetative propagation under thermo-blankets. *Proc. Inter. Plant Prop. Soc.* 30:301-305.

3. Hartmann, H.T. and D.E. Kester. 1975. Plant Propagation: Principles and Practices, 3rd ed. Prentice-Hall, Inc., Englewood Cliffs, N.J.

4. Hornick, S.B., J.J. Murray, R.L. Chaney, L.J. Sikora, J.F. Paar, W.D. Burge, G.B. Willson, and C.F. Tester. 1979. Use of sewage sludge compost for soil improvement and plant growth. USDA Agricultural Reviews and Manuals, ARM-NE-6.

5. Klougart, A. 1975. Propagation houses. A critical review. *Acta Horticulturae* 54:117-20.

6. ________. 1979. Mist propagation — past, present, and future. *Proc. Inter. Plant Prop. Soc.* 29:217-29.

7. Mastalerz, J.W. 1977. The greenhouse environment. John Wiley and Sons, New York.

8. Mewshaw, C.T., F.R. Gouin, and C.B. Link. 1979. Propagation of woody plants under a thermo-blanket. Horizons, 230 Southern Bldg., Washington, D.C. (Horticultural Research Institute). pp. 22-24.

9. Paul, J.L. and A.T. Leiser. 1978. Influence of calcium saturation of sphagnum peat on the rooting of 5 woody species. *Hort. Res.* 8(1):41-50.

10. Wong, T.L., R.W. Harris, and R.E. Fissell. 1971. Influence of high soil temperatures on five woody-plant species. *J. Amer. Soc. Hort. Sci.* 96(1):80-82.

PHILIP SOMMER: What was the temperature difference between the copolymer and thermoblanket? What was the high temperature outside?

FRANK GOUIN: Under the thermoblanket the high was 110°F and under the copolymer it was 150°F. The outside was 96° to 99°F.

LEN STOLTZ: What is the difference between lime and polymer dewatered sludge?

FRANK GOUIN: Lime dewatered is easier to do they tell me. It does not cost any more. The polymer is made in Germany and they will not tell me what it is. It flocculates the solids so they can be dewatered.

RAY MALEIKE: Did you use a mist system?

FRANK GOUIN: No, we just lifted the blanket up once a week and hand watered.