Root Formation, Bud Growth, and Survival of Ornamental Shrubs Propagated by Cuttings at Different Planting Dates©

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INTRODUCTION

Propagation by semihardwood cuttings is mostly done in a humidity, temperature, and irradiance controlled environment to ensure high survival percentages. Unheated tunnels with intermittent mist systems are used for summer propagation of semihardwood cuttings (Wennemuth, 1975; Bärtels, 1982). Some ornamental shrubs are propagated by planting leafy semihardwood cuttings directly in the field under polyethylene cover. This low-cost system is easy to manage but results vary from year to year presumably due to environmental fluctuations. Growers are, therefore, planting an excess of cuttings to ensure a sufficient number of plants the following year.

In Denmark planting of cuttings in the field takes place in June and July. This creates a labor peak for most nurseries. The aim of this experiment was to determine whether it is possible to extend the planting period of cuttings towards autumn for a number of ornamental shrubs in order to level the peak of propagation.

MATERIALS AND METHODS

Plant Material, Experimental Conditions, and Design. Leafy semihardwood stem cuttings from shoots of current season were taken from hedges of *Cornus alba* 'Sibirica', *Deutzia* x *hybrida* 'Mont Rose', *Forsythia* x *intermedia* 'Lynwood', *Ligustrum vulgare* 'Liga', *Philadelphus* 'Virginal' (syn. *P.* x*virginalis*), *Potentilla fruticosa* 'Goldfinger', and *Spiraea* x *vanhouttei*. The experiment was performed at Department of Horticulture, Årslev (Funen), Akkerup Nursery, Akkerup (Funen), and Salling Nursery, Jebjerg (Salling, North Jutland). Cuttings planted at Årslev originated from Akkerup Nursery. Cuttings were approximately 10- (Akkerup Nursery) or 15-cm long (Salling Nursery) stem segments of partially matured wood. Cuttings were not excised at fixed distances below or above nodes, thus, the number of nodes per cutting varied. Lower leaves were not removed.

The same experimental design was used at all locations. Seven planting dates were selected, 16 and 30 July, 13 and 27 Aug., 10 and 24 Sept., and 8 Oct. in both 1996 and 1997. For each species 75 cuttings were planted per planting date, location, and year.

Beds were thoroughly irrigated before cuttings were planted at a density of 400 (Årslev), 480 (Akkerup), or 160 (Salling) cuttings per m^2. Cuttings were immediately irrigated after planting and covered with a white, opaque polyethylene sheet. The cover was laid directly on the cuttings and tightly closed by soil along the sides.

When vigorous growth of cuttings in individual species could be observed the cover was perforated and after further 2 to 3 weeks it was removed. With few exceptions the polyethylene cover was removed before winter for cuttings planted 13 Aug. or earlier. Later plantings were not uncovered before termination of the experiment the following spring. All cuttings were winter covered in the middle of January with a white polypropylene fiber cloth (Agryl P 17) to reduce evaporation from plants not covered by polyethylene.

Recordings and Statistics. Cuttings were lifted from the field in the middle of May the year after planting. Root formation, axillary bud growth (> 0.5 cm), and plant survival were assessed. Cuttings with roots and/or bud growth and cuttings with nonwithered stems without roots and bud growth were classified as survived. Those with necrotic tissue without roots and bud growth were classified as dead. Rooting, bud growth, and survival percentages were calculated within each plot of 75 cuttings and these percentages were used for statistical analysis. Effects of planting date, location, and year were determined by analysis of covariance (SAS Institute, 1985). For detailed information on materials and methods see Hansen and Kristiansen (2000).

RESULTS

Results for cuttings originating from Akkerup Nursery and propagated at Årslev and Akkerup, were rather similar with respect to root formation, axillary bud growth, and plant survival. Cuttings from Salling Nursery generally had higher rooting, bud growth, or survival percentages than cuttings from Akkerup Nursery, however, percentages were often not significantly higher. Only for *Spiraea*, results for Salling were in between results for Årslev and Akkerup. For *Forsythia* bud growth and survival percentages were significantly lower at Salling as compared to Årslev and Akkerup (Fig. 2).

For all species except *Cornus* and *Potentilla* percentages for axillary bud growth and plant survival of cuttings planted late September or October were substantially higher than the rooting percentages. For detailed information on results see Hansen and Kristiansen (2000).

***Cornus alba* 'Sibirica'.** *Cornus alba* 'Sibirica' is normally difficult to propagate under field conditions. Root formation and bud growth were significantly affected by planting date and decreased linearly from about 40% in July to 0% in October (Fig. 1). Cuttings at Årslev and Akkerup generally had a low survival percentage at all planting dates whereas those planted at Salling had a linearly decreasing survival percentage (Fig. 2).

***Deutzia* ×*hybrida* 'Mont Rose'.** In *Deutzia*, root formation varied considerably among planting dates, locations, and years. For the two planting dates in July the rooting percentages at Akkerup and Årslev were low the 1st year and high the 2nd year whereas at Salling the opposite result was found. At planting dates in August rooting percentages were high (average 83%) and decreased subsequently to about 10% for the latest planting.

Bud growth was not significantly affected by planting date with an average bud growth of 51% (Fig. 1). For bud growth the percentage at Salling was high (82%) the 1st year compared to Akkerup (31%) and Årslev (45%). The 2nd year no significant differences were found among the three locations with an average bud growth of 46%.

Plants survived better the 1st year (76%) as compared to 49% the 2nd year. Plant survival increased slightly from July to October where about 65% of the cuttings were alive the year after propagation (Fig. 1). Surprisingly, up to 25% of the cuttings with roots from the July and Aug. plantings did not survive.

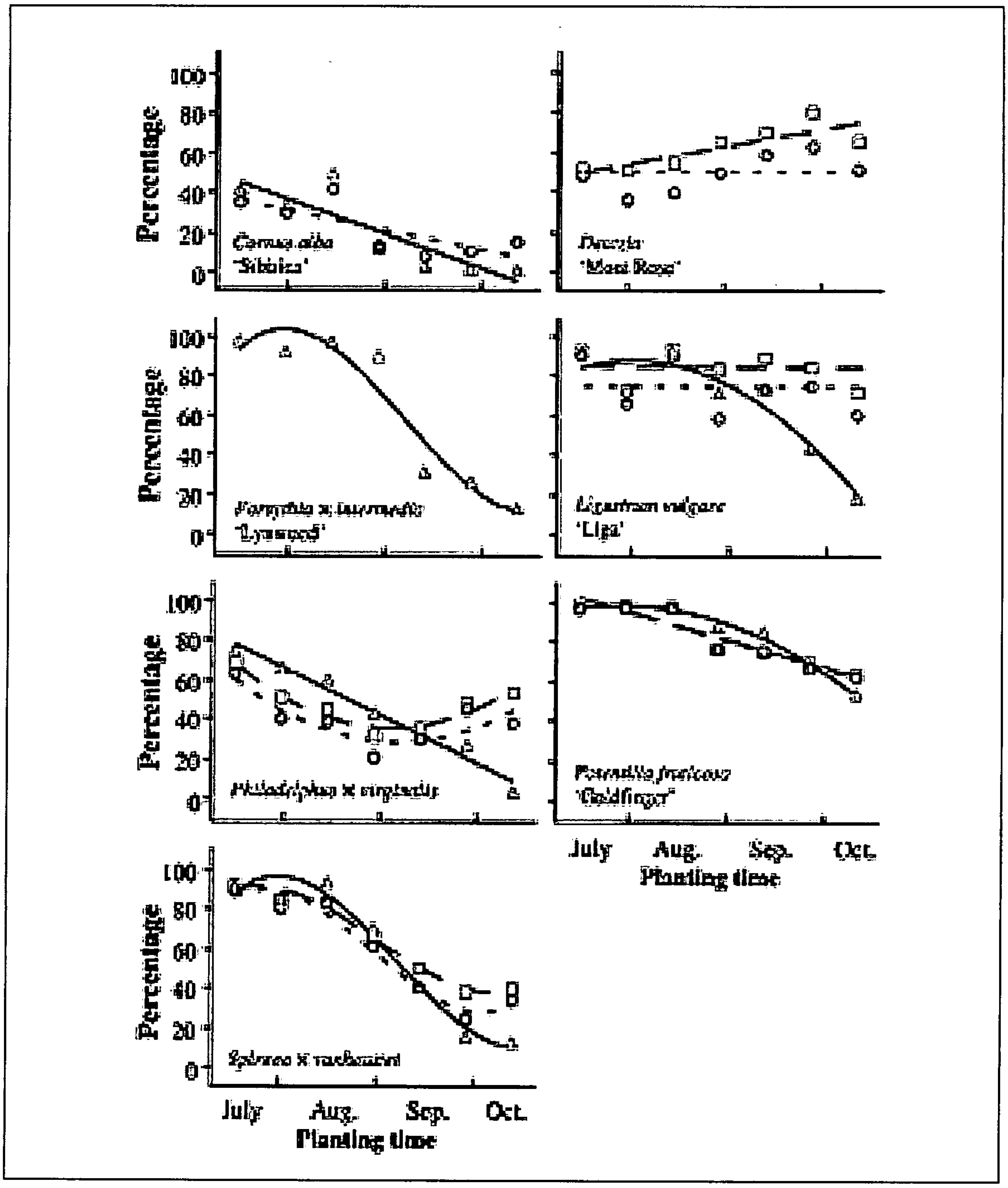

Figure 1. Root formation (Δ, solid line), axillary bud growth (O, short dashes), and/or survival (□, long dashes) as a function of planting time. Each point is average of 2 years and three locations. Curves are best fit to average values of each planting time. Effects of planting time are not shown if interactions of importance with year and location were found.

***Forsythia*×*intermedia*'Lynwood'.** Root formation of *Forsythia* was significantly affected only by planting date. Rooting percentages above 90% were obtained until 27 Aug. whereas at later planting dates approximately 20% of the cuttings formed roots (Fig. 1).

Significant interactions between location and planting date on bud growth and plant survival were found due to high and almost constant percentages at Akkerup as compared to initially high but decreasing percentages at Årslev and Salling (Fig. 2).

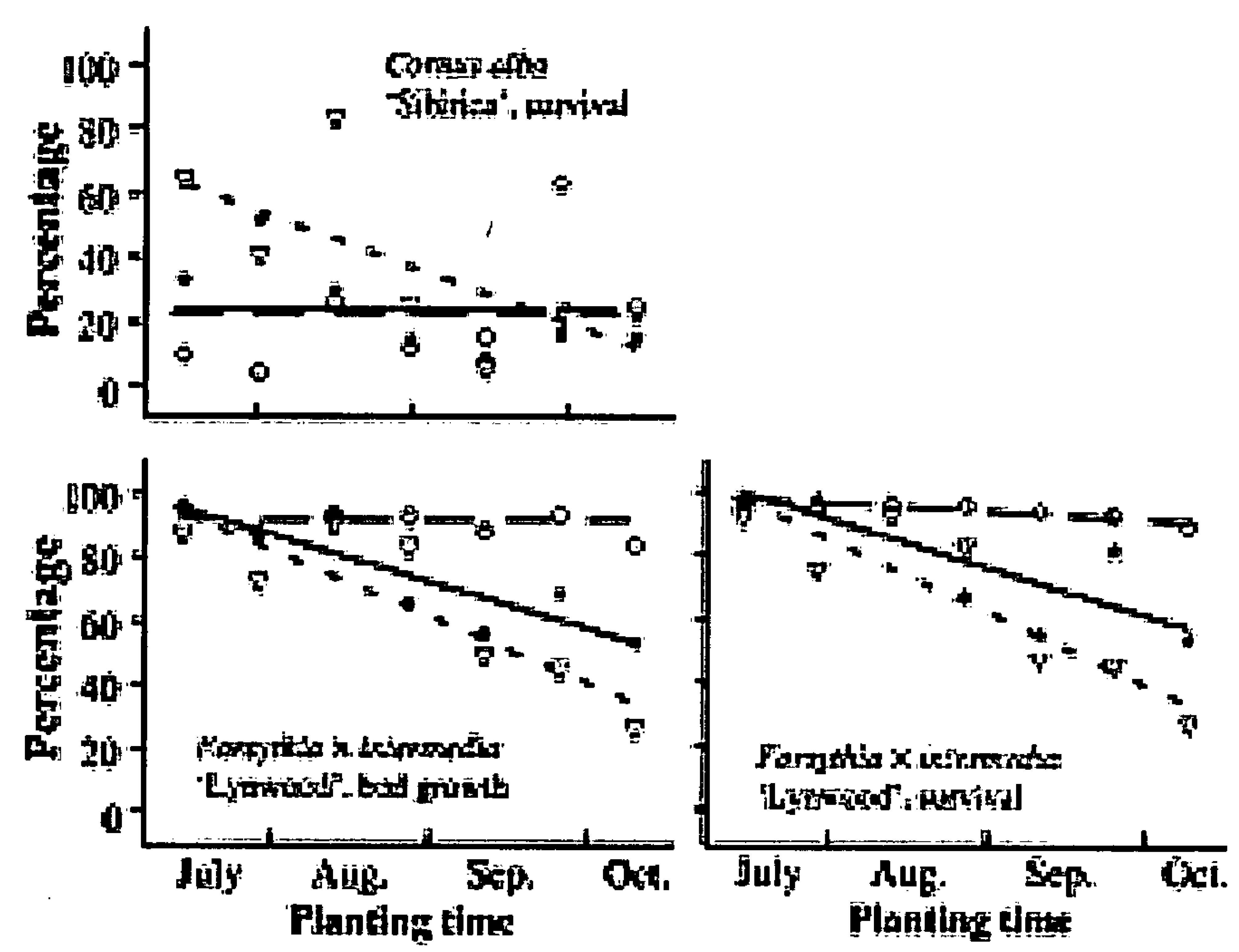

Figure 2. Plant survival of *Cornus alba* 'Sibirica' and axillary bud growth and plant survival of *Forsythia* ×*intermedia* 'Lynwood' at Årslev (★, solid line), Salling (▽, short dashes), and Akkerup (◇, long dashes) as a function of planting time. Each point is average of 2 years. Lines are best fit to average values.

Ligustrum vulgare **'Liga'.** A significantly lower rooting percentage was found the 1st year (60%) as compared to the 2nd year (75%). Root formation was also affected by planting date and rooting percentages were about 80% until 10 Sept. followed by a decline to 20% for the October planting (Fig. 1).

Bud growth and plant survival were neither significantly affected by location, year, nor planting date probably due to large fluctuations among individual plots. Bud growth percentages fluctuated between 60% and 91% and survival percentages between 72% and 95% with respect to planting date (Fig. 1).

Philadelphus **'Virginal'.** Only planting date had a significant effect on root formation with a linear decrease from 76% in July to 5% in October (Fig. 1).

At Salling the average bud growth percentage (53%) was significantly higher than at Årslev (31%) or Akkerup (37%). Bud growth percentages declined until the September plantings where after bud growth increased to 40% (Fig. 1).

Plant survival at Salling was 64% which was significantly higher than at Årslev (37%) or Akkerup (45%). Survival percentages the 1st and 2nd year were 58% and 39%, respectively. Plant survival followed a similar pattern as for bud growth but at a higher level (Fig. 1). About 12% of the rooted cuttings did not survive the winter (Fig. 1).

Potentilla fruticosa **'Goldfinger'.** For *Potentilla* almost 100% of the cuttings planted until 13 Aug. formed roots followed by a decrease to 55% in October (Fig. 1). Both bud growth and survival decreased linearly with planting date from almost 100% in July to 65% for the October planting (Fig. 1).

***Spiraea* ×*vanhouttei*.** Despite the interaction between location and planting date the course at all three locations was rather similar. Rooting percentages were above 80% for the first three plantings and decreased to about 15% for the two last plantings (Fig. 1).

The average bud growth percentage at Årslev (47%) was significantly lower than at Salling (61%) or Akkerup (68%). Bud growth percentages above 80% were recorded for the first three plantings followed by a decline to about 30% for the latest plantings (Fig. 1). Generally plant survival followed the same pattern as for root formation and bud growth (Fig. 1).

DISCUSSION

Seasonal variations in root formation of cuttings of woody plants under greenhouse conditions have frequently been reported (e.g., Hartmann and Loreti, 1965; Hansen and Ernstsen, 1982; Howard, 1996; Day and Loveys, 1998). Results are species dependent and have been related to variations in photoperiod, irradiance, or temperature during stock plant growth or propagation (Moe and Andersen, 1988). Seasonal variations in root formation have also been attributed to changes in stock plant growth activity at time of cutting excision (Howard, 1996).

The decrease in root formation with planting date in the present experiment could be a result of the decrease in photoperiod from July to October. Smith and Wareing (1972) found with leafy cuttings of *Populus* that the decrease in natural photoperiod resulted in a reduced root formation. However, Roberts and Fuchigami (1973) found with *Pseudotsuga* that root formation was best in February and March. Further, Hansen and Ernstsen (1982) reported for *Pinus* that decreasing photoperiod during stock plant growth had a strong positive effect on formation of adventitious roots and this effect was closely related to the radiant exposure. Furthermore, Baker and Link (1963) tested 26 woody ornamental species and concluded that in most species root formation was not significantly influenced by seasonal changes in stock plant photoperiod or by photoperiodic treatments during root formation.

Reductions in stock plant irradiance have been reported to promote root formation in a number of woody species (Hansen, 1987). Since both natural irradiance and photoperiod in the present experiment gradually decreased with planting date without positive effects on root formation we consider the light conditions under the prevailing experimental conditions to be unimportant factors in the control of root formation.

Rooting in the present experiment is, therefore, probably controlled by other factors of which temperature likely is the most important. Decreasing temperature delays root emergence in cuttings of *Humulus* (Howard, 1965), *Forsythia* (Dykeman, 1976), and *Stephanotis* (Hansen, 1989). Late-planted cuttings faces low temperatures soon after planting which implies that cuttings are not able to form roots before winter. The lack of root formation of late plantings before winter is probably also very important for the low survival of these cuttings as the importance of root formation and development is generally recognized (Bärtels, 1982). The observations that early planted *Deutzia* and *Philadelphus* cuttings had formed a well developed root system before winter but were dead next spring are probably not the result of an insufficient acclimatization. Most likely these species are sensitive to unfavorable climatic conditions during the winter or early spring.

As bud growth and survival percentages exceed rooting percentages of cuttings planted late fall adventitious root formation is not a prerequisite for bud growth in the following spring. Bud growth without the presence of roots, however, indicates a fatal situation as cuttings without roots will die shortly after removing the water-retentive cover due to high evaporation. The question whether such cuttings could have survived if the polyethylene cover was maintained for a longer period was not addressed in this experiment.

The generally higher rooting percentages found for the longer cuttings from Salling Nursery compared to cuttings from Akkerup Nursery are in agreement with the positive relationship between cutting length and root formation found in, e.g., *Hedera* (Poulsen and Andersen, 1980), *Triplochiton* (Leakey and Mohammed, 1985), and *Schefflera* (Hansen, 1986). However, also other factors differed between locations and might have influenced the results.

In summary, the tested species can be propagated until mid August with the present method. Root formation is less affected by factors other than planting date, year, and location than axillary bud growth and plant survival. Other factors affecting the results may be variations in the environment or the physiological condition of the cuttings. Therefore, efforts should be directed to understand the variability in the cutting material. Also the handling of cuttings in the period from excision until cuttings are planted and covered with polyethylene may be of importance.

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