EFFECTS OF PLANTING DATE ON OUTPLANT PERFORMANCE OF COLD-STORED AND FRESH-LIFTED BLACK WALNUT, RED OAK AND SILVER MAPLE SEEDLINGS

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ABSTRACT

Fresh-lifted and cold-stored black walnut (*Juglans nigra* L.), red oak (*Quercus rubra* L.) and silver maple (*Acer saccharinum* L.) seedlings were planted at 2-week intervals from 21 April to 16 June in a former field near Parkhill, in southwestern Ontario. June planting significantly reduced the 3-year survival of fresh-lifted seedlings of all three species but had little effect on the survival of overwinter cold-stored seedlings. Three-year height increment was greatest for seedlings planted in early May and lowest for seedlings planted in June. Overwinter cold storage of planting stock assured high survival of seedlings planted in June but height increment was lower than that of fresh-lifted and cold-stored stock planted before the end of May. Planting of fresh-lifted stock in June reduced survival and height increment of all three species to unacceptable levels.

RÉSUMÉ

Des plants de noyer noir (*Juglans nigra* L.), de chêne rouge (*Quercus rubra* L.) et d'érable argenté (*Acer saccharinum* L.) fraîchement arrachés ou conservés au froid ont été plantés à des intervalles de deux semaines entre le 21 avril et le 16 juin dans un ancien champ situé près de Parkhill dans le sud-ouest de l'Ontario. La plantation en juin s'est traduite par une survie significativement plus faible au bout de trois ans du matériel planté peu après l'arrachage pour les trois espèces, mais a peu influé sur la survie des plants qui avaient été conservés au froid pendant l'hiver. L'accroissement en hauteur au bout de trois ans a été supérieur pour les plants qui avaient été plantés au début de mai et inférieur pour ceux qui l'avaient été en juin. L'entreposage au froid pendant l'hiver a assuré une survie élevée au matériel planté en juin, mais l'accroissement en hauteur a été plus faible par rapport au matériel fraîchement arraché et au matériel conservé au froid qui avaient été plantés avant la fin de mai. La plantation en juin du matériel fraîchement arraché a réduit la survie et l'accroissement en hauteur pour les trois espèces à des niveaux inacceptables.

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INTRODUCTION

Traditionally, spring has been the preferred season for planting because the soils are generally moist after the spring thaw, the growing season is about to begin, and freshly lifted stock is physiologically attuned to the climatic progression experienced (Sutton 1982). The ideal planting season for hardwoods in southwestern Ontario extends from the end of April to the middle of May (von Althen 1979). Before the end of April the soil temperature is near freezing and many planting sites are too wet for efficient planting. After the middle of May the possibility of high temperatures and severe drought conditions increases the risk of plantation failure. Further, most hardwood nurseries in Ontario are located a considerable distance south of the majority of planting sites. Seedlings lifted in these nurseries after the middle of May have generally flushed and may have undergone a major burst of root activity (Dumbroff and Webb 1978).

Because the ideal planting season is very short, extension of the season is a highly desirable goal. An extended season would ease the pressure on manpower and equipment, make planting sites more accessible, and probably improve planting quality since planting would be done in drier, warmer and more friable soil. Previous experiments showed that overwinter storage maintained high root-regeneration capacity and overall seedling growth potential (Webb 1976, 1977, von Althen and Webb 1981, 1982) and that cold-stored sugar maple *(Acer saccharum* Marsh.) seedlings could be outplanted until the middle of June without significant loss of survival or growth (von Althen and Webb 1978).

To determine if overwinter cold storage could be equally effective in extending the planting season for other hardwood species, cold-stored and fresh-lifted black walnut *(Juglans nigra* L.), red oak *(Quercus rubra* L.) and silver maple *(Acer saccharinum* L.) seedlings were planted at 2-week intervals from 21 April to 16 June. This report presents the 3-year results of seedling survival and height increment and makes recommendations on the optimum planting period for southwestern Ontario.

METHOD

In November 1981, 1+0 black walnut and 2+0 red oak and silver maple seedlings were lifted at the Ontario Ministry of Natural Resources tree nursery at St. Williams, Ontario and transported to Sault Ste. Marie. At the time of lifting, all stock was leafless and dormant. Following root pruning to 20 cm, the seedlings were packed in Kraft bags with polyethylene liners. Moist peat was placed around the roots and the bags were sealed. The black walnut and red oak seedlings were mostly enclosed in the bags while the tops of the larger silver maple seedlings protruded from the bags. Seedlings were stored in a cold room at a temperature of 0.5°C and a relative humidity of approximately 70%. Planting dates were 21 April, 5 and 19 May, and 2 and 16 June. On the day before planting the bagged seedlings were transported to the planting site.

On the day before planting, seedlings of the same three species were lifted from the same nursery beds as the cold-stored stock. Following root

pruning to 20 cm, the seedlings were packed in polyethylene-lined Kraft bags with moist peat around the roots and transported to the planting site. All seedlings lifted after the middle of May had flushed and great care was taken to protect the tender shoots from being damaged during lifting, transport and planting.

The planting site was a former agricultural field that had been plowed and disked in the autumn of 1981. The soil was a Barrien sandy loam (Anon. 1931). The pH of the plow layer was 7.6 and the organic matter content was 2.6%.

The plantation was kept weed free by broadcast applications of 4.4 kg/ha of active simazine shortly after planting and in April of 1983 and 1984, and spot treatments with 2 kg/ha of active glyphosate in each of the first three summers after planting.

Seedlings were machine planted at a spacing of 3 m between rows and 1.5 m within rows in a randomized block arrangement, with 16 trees in each of 10 treatments (cold-stored plus fresh-lifted x five planting dates). Each treatment was replicated three times for a total planting of 480 seedlings per species. Survival and height were recorded at the end of each growing season and the third-year treatment means were tested with Fisher's 'F' and Bonferroni's 't' tests ($p \leqslant 0.05$).

RESULTS

Planting date significantly affected the 3-year survival of fresh-lifted stock of all three species but had little effect on the survival of cold-stored stock (Table 1). Survival of fresh-lifted black walnut and silver maple seedlings was significantly higher for the April and May plantings than for the two June plantings. Survival of fresh-lifted red oak seedlings was significantly higher for the 21 April and 5 May plantings than for the 19 May and 16 June planting dates. The only significant difference in survival among cold-stored stock of all species was the reduced survival of silver maple seedlings planted on 2 June.

Comparison of cold-stored and fresh-lifted stock, planted on the same date, reveals significantly higher survival of cold-stored silver maple seedlings planted on 2 June and of cold-stored stock of all three species planted on 16 June. Planting date significantly affected the 3-year height increment of all three species.

Black Walnut

Height increment of cold-stored black walnut seedlings planted on 5 May was significantly higher than that of cold-stored seedlings planted on the other four dates. The increment of fresh-lifted black walnut seedlings planted on 5 May was significantly different only from that of seedlings planted in June. Cold-stored black walnut seedlings planted on 16 June were significantly taller than fresh-lifted seedlings planted on the same date.

Table 1. Three-year survival and height increment of cold-stored and fresh-lifted black walnut, red oak and silver maple seedlings by planting dates.

	Survival (%)						Height increment (cm)					
	Black walnut		Red oak		Silver maple		Black walnut		Red oak		Silver maple	
Planting date	Cold-stored	Fresh-lifted	Cold-stored	Fresh-lifted	Cold-stored	Fresh-lifted	Cold-stored	Fresh-lifted	Cold-stored	Fresh-lifted	Cold-stored	Fresh-lifted
21 April	98a	100a	77a	85ab	92a	94a	91b	138ab	106a	57a	150ab	172ab
5 May	94a	100a	87a	90a	94a	92a	153a	170a	74ab	65a	201a	237a
19 May	90a	98a	77a	69c	96a	100a	91b	161ab	56ab	44a	188ab	187ab
2 June	88a	73b	65a	79bc	67b	40b	75b	52bc	27b	31a	86b	97b
16 June	90a	42c	84a	11d	81a	61b	57b	34c	32b	15a	99ab	99b

Note: Within species and storage treatments means followed by different letters differ significantly ($p \leq .05$). Within species and planting dates lines connect means that differ significantly ($p \leq .05$).

Red Oak

The greatest increment of cold-stored red oak seedlings was recorded for seedlings planted on 21 April, and this was significantly higher than that of seedlings planted in June. There was no statistically significant difference in height of fresh-lifted red oak seedlings.

Silver Maple

Height increment of cold-stored silver maple seedlings planted on 5 May was significantly greater than that of seedlings planted on 2 June, while height increment of fresh-lifted maple seedlings planted on 5 May was significantly greater than that of seedlings planted in June.

DISCUSSION

With the exception of the April 21 planting date, weather conditions in the spring and early summer of the first year of planting were highly favorable to seedling survival and growth. The last spring frost occurred on 22 April, one day after the first planting. Precipitation was high during the second half of May and two storms on 15 and 18 June, one day before and two days after the last planting, deposited 28 and 25 mm of rain, respectively, on the planting site.

Greatly favored by these conditions, first year-survival of all three species was high and it appeared that this high survival would be maintained in subsequent years. However, this was not the case.

Black Walnut

With survival and height growth combined, the results of this study suggest that the ideal time for planting walnut in southwestern Ontario is in the first half of May. Extension of the planting season into the middle of June appears promising, but requires overwinter cold storage of the stock (Fig. 1). Planting fresh-lifted black walnut seedlings past the end of May is futile because survival and height increment decline drastically, even for seedlings handled as carefully as in this study. In operational lifting and planting even higher losses can be expected.

Red Oak

First-year survival of cold-stored red oak seedlings was very high while survival of fresh-lifted seedlings was extremely erratic (Fig. 2). In the second and third years after planting, survival of cold-stored seedlings was 77% or higher for all planting dates with the exception of 2 June, when survival declined to 67%. Survival of fresh-lifted red oak seedlings in years two and three after planting closely followed the trend set in the first year. Survival remained high for seedlings planted in April and early May, while survival of seedlings planted on 16 June declined to 11% at the end of the third year.

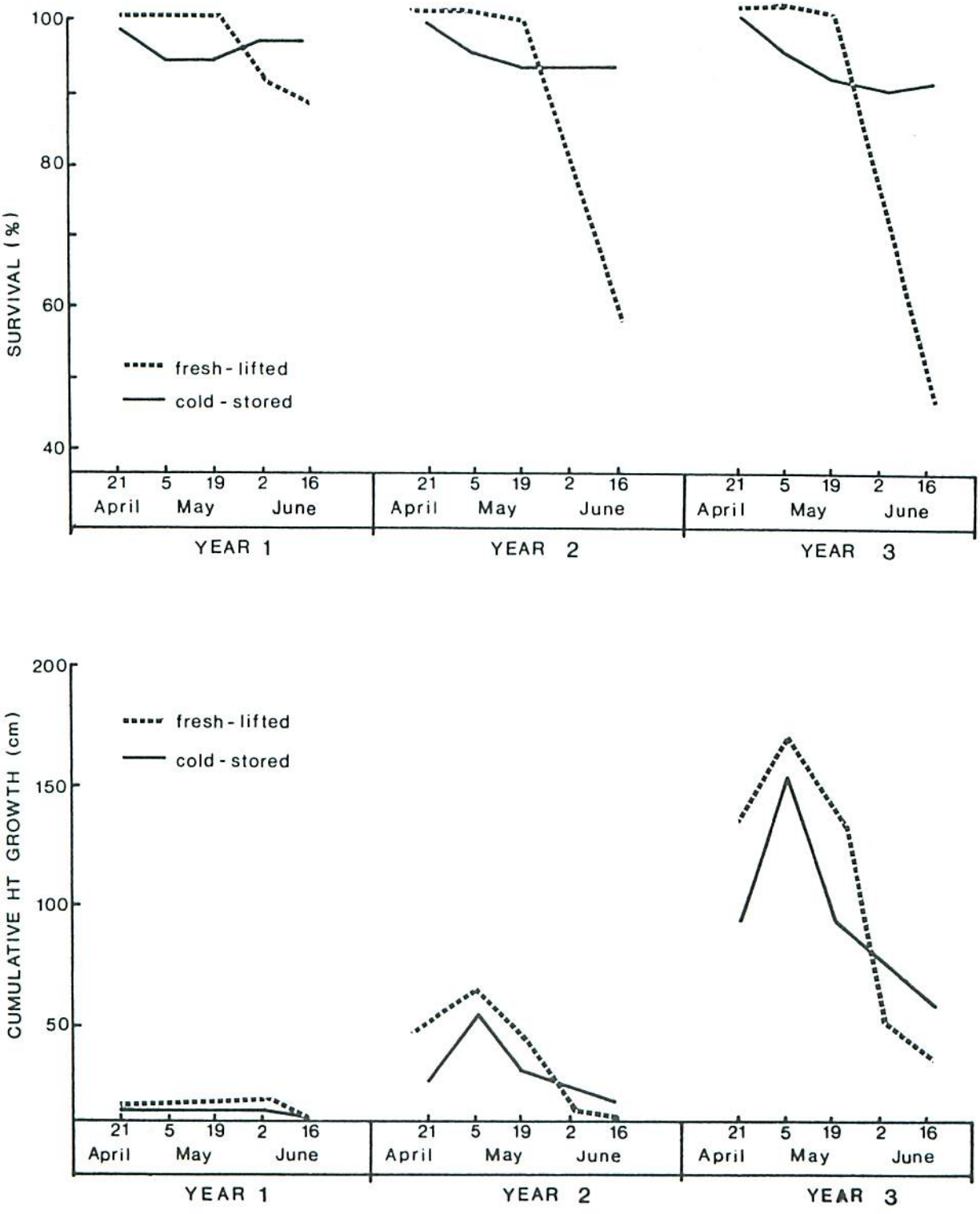

Figure 1. First-, second- and third-year survival and cumulative height increment of cold-stored and fresh-lifted black walnut seedlings planted at 2-week intervals from 21 April to 16 June.

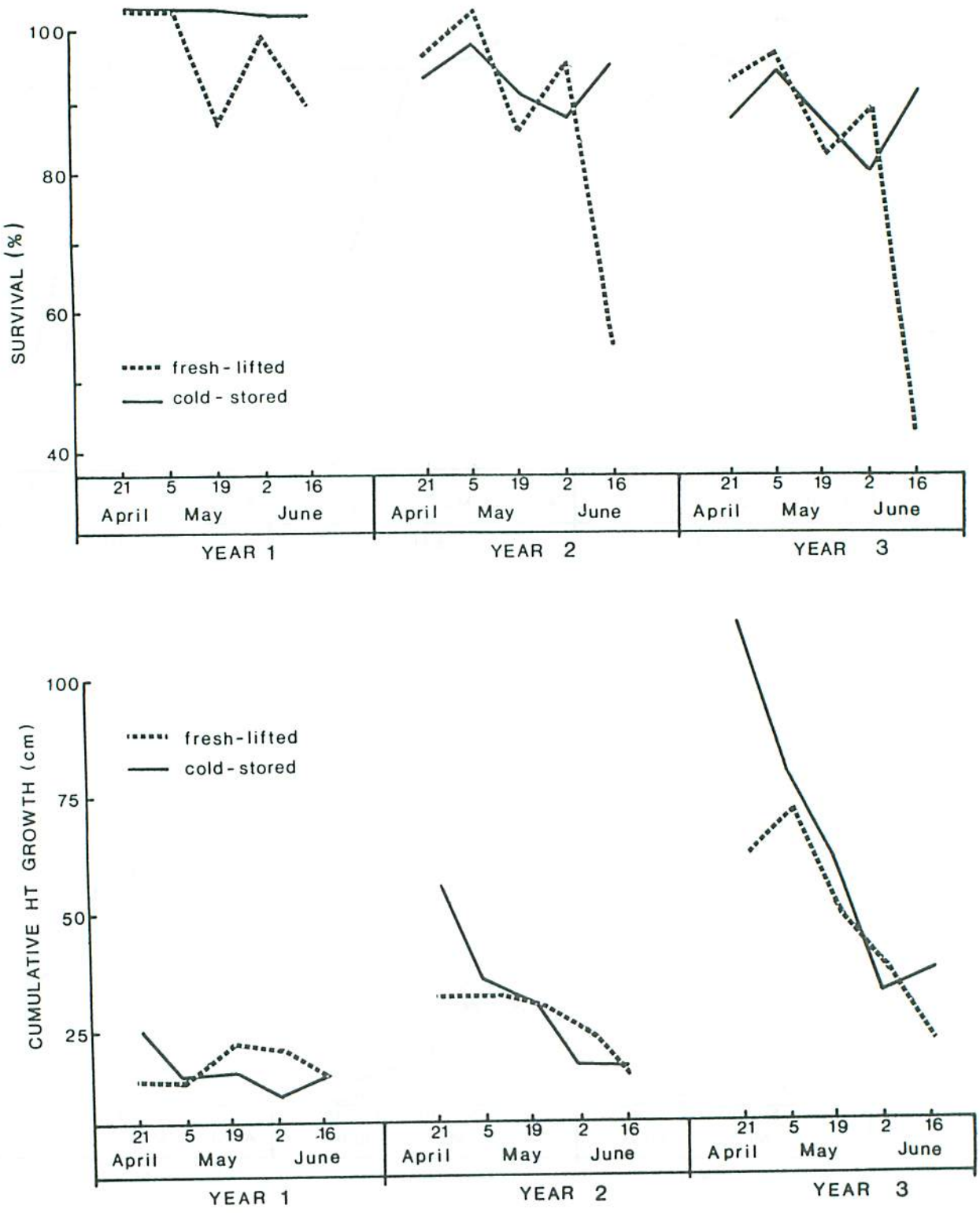

Figure 2. First-, second- and third-year survival and cumulative height increment of cold-stored and fresh-lifted red oak seedlings at 2-week intervals from 21 April to 16 June.

Height increment of cold-stored red oak seedlings was always greater for the earliest planting date and thereafter declined sharply with only a slight improvement for the 16 June planting (Fig. 2). In the first year, height increment of fresh-lifted oak seedlings was fairly similar for all planting dates. Starting in year two, however, and continuing through year three, height increment of fresh-lifted stock was highest for the 5 May planting and thereafter declined sharply.

With survival and height combined, the results of this study suggest that the ideal time for planting red oak is late in April or early in May. Overwinter cold storage greatly improved survival of seedlings planted on 16 June, but height increment of these seedlings was much lower than that of cold-stored and fresh-lifted stock planted in April and early May.

Silver Maple

In response to the very favorable weather conditions in the year of planting, first-year survival of all fresh-lifted and cold-stored silver maple seedlings was very high, regardless of planting date (Fig. 3). However, in the second and third years after planting, survival of fresh-lifted and, to a lesser extent, of cold-stored stock planted in June was much lower than that of seedlings planted earlier. The low survival of cold-stored stock planted on 2 June cannot be explained. However, the improved survival of all seedlings planted on 16 June was, no doubt, in response to the heavy rains one day before and two days after planting.

With the exception of the 21 April planting, height increment of fresh-lifted silver maple seedlings was always greater than that of cold-stored stock (Fig. 3). This is surprising in light of the results obtained with the other species. But it is possible that either the storage regime was less than optimum, or that the very favorable weather conditions in the year of planting assured exceptionally good establishment of fresh-lifted seedlings.

With survival and height increment combined, the results of this study suggest that the ideal time for planting silver maple is in the first half of May. Extension of the planting season into June cannot be recommended at this time because of the greatly reduced height increment of all stock planted in June.

RECOMMENDATIONS

The results of this study and earlier studies with sugar maple (von Althen and Webb 1978) confirm that the ideal planting season for hardwood stock in southwestern Ontario extends from the end of April to the middle of May. Seedlings planted during this period do not require overwinter cold storage for successful establishment and satisfactory early growth. However, overwinter cold storage may improve seedling survival and growth depending on species, storage regime, nursery methods and planting practices.

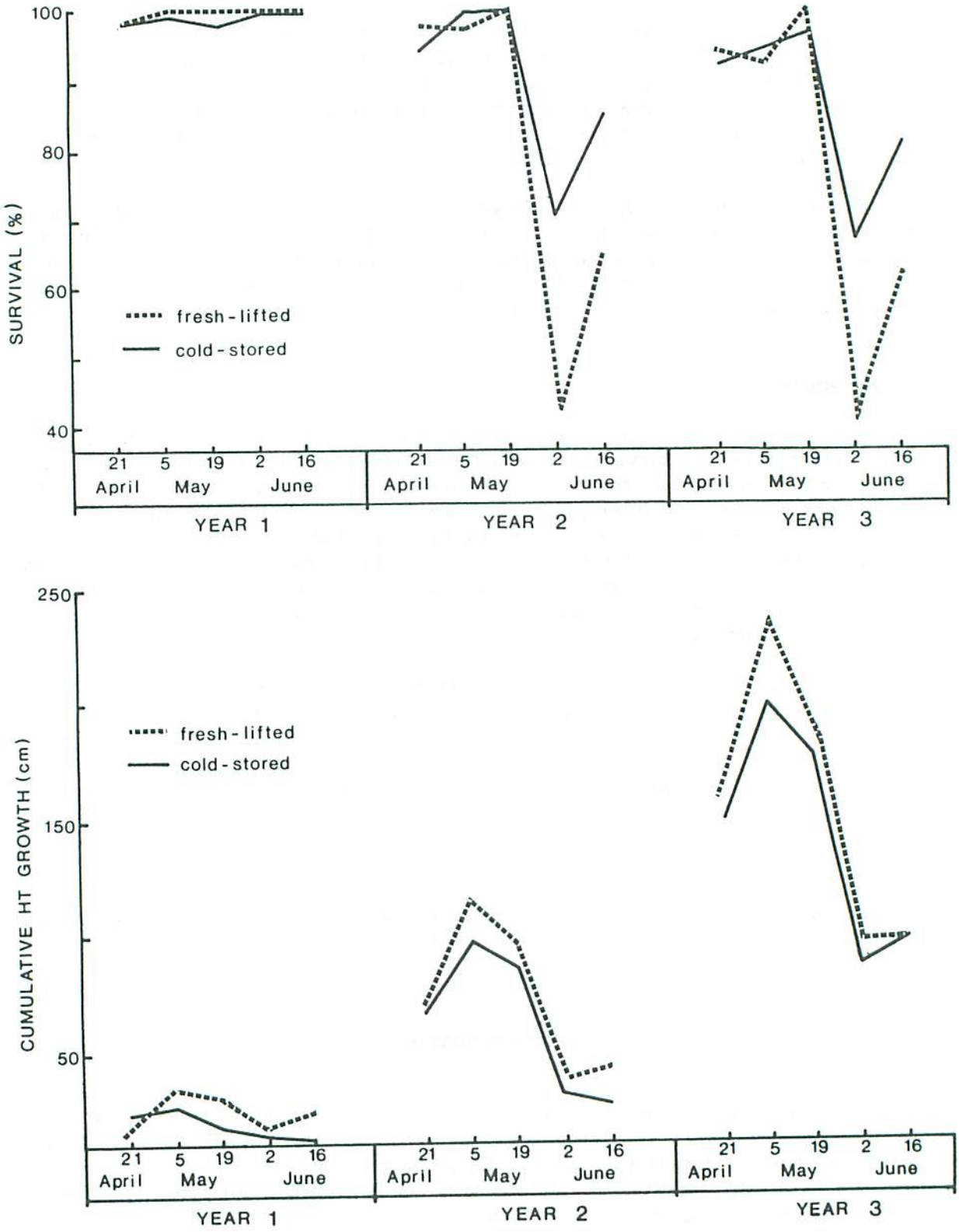

Figure 3. First-, second- and third-year survival and cumulative height increment of cold-stored and fresh-lifted silver maple seedlings planted at 2-week intervals from 21 April to 16 June.

Planting of fresh-lifted stock in June is not recommended because it will result in greatly reduced survival and growth.

Overwinter cold storage of planting stock can extend the planting season for black walnut, red oak, silver and sugar maples without significant loss of survival. However, height increment of cold-stored stock planted in June will most likely be lower than that of fresh-lifted or cold-stored stock planted before the middle of May.

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