SPROUTING AND ROOTING ON HORIZONTALLY PLANTED CUTTINGS OF SYCAMORE

D. D. HOOK

Belle W. Baruch Research Institute of Clemson University, Georgetown, South Carolina, USA

P. P. KORMANIK and R. G. McALPINE

USDA Forest Service, Southeastern Forest Experiment Station, Ga., USA

(Received for publication 13 September 1973)

ABSTRACT

Sycamore (**Platanus occidentalis** L.) cuttings, 1.2 m in length, were planted horizontally at depths of 7 and 15 cm to test this type of placement in the establishment of closely spaced plantings. Sprout origin and survival were observed during the first growing season, and sprout growth and root characteristics were observed in late autumn of the first, second and third year. Sprouting was influenced primarily by bud position. Buds facing downward seldom produced sprouts and most sprouts arose from buds nearest the apex. Neither planting depth nor cultivation affected the amount of sprouting, but both influenced time of sprouting. Cultivation to control competing vegetation was necessary for satisfactory survival and growth of young sprouts. The pattern of root development was influenced by number and position of sprouts, by depth of planting, and by cultivation.

INTRODUCTION

Vegetative propagation of sycamore (*Platanus occidentalis* L.) is easily accomplished by rooting dormant cuttings from young stems or branch segments. This method of regeneration is used extensively throughout the world for propagation of individual species of the genera *Populus* and *Salix*. With species that root easily, one normally inserts a stem or branch segment vertically into the soil or other rooting media and thus multiplies ramets of desired clones. Recently, however, it has been found that planting sycamore cuttings horizontally could possibly offer an advantage of cheapness over the use of vertically placed cuttings for establishing closely spaced plantations and clonal banks (McAlpine *et al.*, 1972).

Root and bud development is usually unsatisfactory when stem cuttings are planted in an inverted position, but little is known of the development of horizontally planted stem segments. We report here on the relationships between bud position, depth of planting, and the effect of cultivation on the sprouting and rooting of horizontally planted sycamore cuttings.

METHODS

Details of treatments and plot layout are given by McAlpine *et al.* (1972). Briefly, the experiment consisted of a factorial arrangement of cultivation versus no cultivation and 7 versus 15 cm depth of planting. In addition, after each cutting was laid end to end in the furrows, bud type (axillary or accessory) and position of the buds around the stem (top, side, or bottom of cutting) were mapped from the base to the tip of each cutting. The 1.2-m cuttings were marked into four 30-cm segments, numbered from 1 to 4 from basal to apical end. A marker was placed at the base of each of the cuttings of the three replications. Location of sprouts on the cuttings was referenced from the marker at the base so that each sprout could be identified as to its origin (bud type) and position on the cutting after the cutting was covered with soil. Sprout height was measured to the nearest 3 cm at approximately weekly intervals from 28 April to 9 June for 3 years. Final height measurements were made in late November of each year and six cuttings in each treatment and replication were excavated to determine the degree and distribution of roots on the cuttings and on the base of the sprouts. Root surface area was estimated by measuring the cross-sectional area of all roots in square centimetres at a point on the root 1.25 cm distal to their connection to the cutting.

A slight bias appeared to occur in mapping the bud positions. It was assumed that in a sufficiently large population of horizontal cuttings the number of buds on the side positions should approximately equal the sum of the buds on the top and bottom of the cuttings. Also the number of buds on the top face should approximately equal the number of buds on the bottom face of the cutting. A summary of number of buds in the three positions showed the first assumption to be close to expected, i.e., 1102 buds on the sides and 1199 buds on tops and bottoms, but there were 695 bottom buds as against 504 top buds. Since we mapped position by inspection, it appears that we were inclined to list a partially hidden bud as being on the bottom rather than on one side or the other.

RESULTS

Sprouting

Analysis of variance showed that fewer buds on the bottom of the cuttings formed sprouts than those on top or on the sides. Cultivation and depth of planting had no significant effect on the percentage of buds that sprouted, but both depth of planting and cultivation affected the time of sprouting (Table 1). Early in the season (28 April-20 May) the percentage of buds sprouting from cuttings planted 15 cm deep was less than that from cuttings covered with 7 cm of soil. However, by 27 May, the percentage of buds sprouting from top and sides was about the same for both planting depths. Percentages of buds sprouting on the lateral sides and top side at the 7 cm depth without cultivation exceeded that with cultivation until 20 May. At the 15 cm depth, cultivation had little effect on the percentage of buds that sprouted from 28 April to 9 June.

Survival of sprouts was significantly affected only by cultivation. Sixty-nine % of the sprouts survived with cultivation as compared to only 22% without cultivation.

Distribution of Sprouts on Cutting

Sprouting was most prolific near the apical end (Segment 4) of the cuttings, decreasing rapidly toward the basal end (Segment 1), as shown in Table 2.

TABLE 1—Percentage of buds that sprouted by bud position, date, cultivation, and depth of planting

Planting depth	Cultivation*	28/4	Assessment date 5/5	13/5	20/5	27/5	9/6	26/11
					Bud position			
(cm)					Sides and top			
7	W	8.6	18.7	34.0	49.8	49.8	44.0	30.6
15	W	1.1	3.2	10.7	31.2	47.4	47.4	35.5
7	WO	1.2	30.2	40.6	49.5	50.9	42.1	16.0
15	WO	1.0	3.9	10.0	41.8	52.8	40.4	13.4
					bottom			
7	W	0.1	2.5	7.5	13.7	16.2	15.0	10.6
15	W	0.0	0.0	1.1	5.4	16.1	13.9	9.7
7	WO	2.3	3.4	7.9	14.7	15.8	8.5	1.1
15	WO	0.0	0.0	2.3	15.0	27.7	22.0	4.6

* W indicates with and WO indicates without cultivation.

TABLE 2—Average number of sprouts per 30-cm cutting segment by year, with and without cultivation

Year	Segment Number 1	2	3	4
		With cultivation		
1	0.7	1.0	1.4	2.9
2	0.8	1.0	1.5	2.9
3	0.5	0.9	1.2	2.9
		Without cultivation		
1	0.2	0.5	0.6	1.2
2	0.3	0.6	0.6	1.0
3	0.1	0.4	0.6	0.6

Height Growth

Although there were more sprouts on the apical end of the cuttings, height growth after three years was best on those arising from basal segments (Table 3). Height growth of all non-cultivated sprouts was reduced.

TABLE 3—Average total height of sprouts by position on cutting, depth of planting, and cultivation

Planting depth	Cultivation*	Segment Number 1	2	3	4
(cm)		(m)			
		First year			
15	W	0.67	0.85	1.04	0.85
15	WO	0.12	0.12	0.24	0.40
7	W	0.76	0.73	0.73	0.61
7	WO	0.21	0.34	0.28	0.37
		Second year			
15	W	2.56	2.87	2.47	2.35
15	WO	0.52	0.79	0.70	0.76
7	W	2.35	2.26	2.20	1.83
7	WO	0.64	0.76	0.76	0.79
		Third year			
15	W	4.76	3.84	3.90	3.39
15	WO	1.10	0.95	1.01	(all dead)
7	W	4.48	3.51	3.05	2.84
7	WO	1.74	1.28	0.95	1.04

* W indicates with and WO indicates without cultivation

Rooting

Root development, both in number and size, was greatest on the basal segment and decreased gradually toward the apex on the cutting in all three years (Fig. 1 and Table 4). The lack of cultivation reduced the number of roots that developed on the cuttings, but depth of planting did not appear to affect rooting on the cutting. Roots also developed at the base of the sprouts. Because there were more sprouts at the apical than the basal end of the cuttings there was thus a greater number of sprout roots at the apical end.

There appeared to be more roots on sprouts from cuttings at 15 cm depth than at the 7 cm depth. The number of roots on sprouts per segment was correlated ($r = .57$)

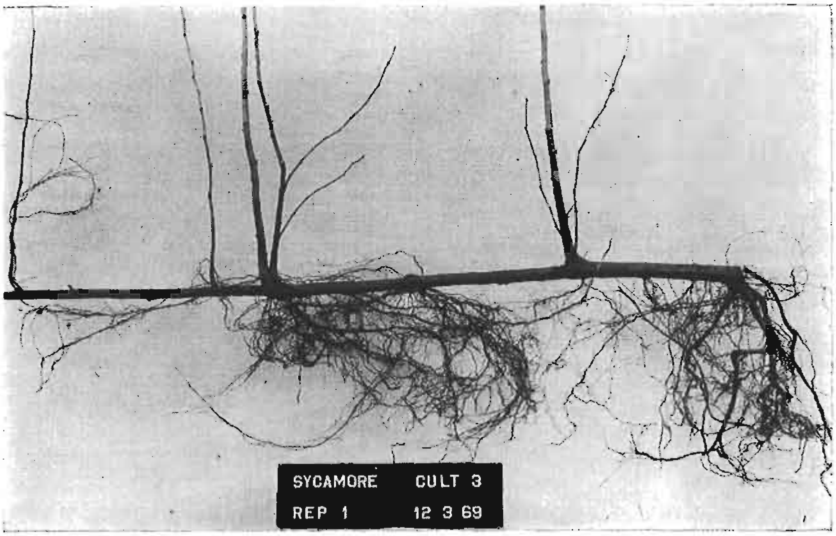

FIG. 1—Sprout and root development on a 1.2-m horizontal cutting at the end of one growing season.

TABLE 4—Average number of roots on 30-cm segments of the cutting and on the base of sprouts after 1, 2, and 3 years at the 15-cm planting depth

Year	Cultivation*	Segment Number 1	2	3	4
		Cuttings			
1	W	12.8	4.0	3.7	1.0
1	WO	7.6	0.9	0.9	0.4
2	W	14.8	7.9	6.9	4.9
2	WO	5.2	0.8	0.9	0.3
3	W	11.5	10.9	10.1	8.3
3	WO	1.4	0.6	1.1	0.8
		Sprouts			
1	W	1.3	2.3	5.0	11.1
1	WO	0.7	0.9	0.3	2.0
2	W	1.6	4.7	6.7	14.4
2	WO	0.8	1.3	4.0	4.5
3	W	1.9	3.0	8.2	19.3
3	WO	0.0	0.6	2.6	6.4

* W indicates with and WO indicates without cultivation

with total length of sprouts per segment. Roots on the cutting occurred directly beneath and basipetal to sprouts, and the lower side of the cutting enlarged basipetally to the sprouts. No roots occurred acropetally to the sprout nearest the cutting apex.

A plotting of height of the dominant sprout nearest the base over cross-sectional root area (square centimetres) in the segment and basipetally to the sprout indicated a parabolic relationship between these two factors (Fig. 2).

In dieback, all of the cutting acropetal to the sprout nearest the apex died and all of the cutting basipetal to the sprouts lived. If no sprouts occurred on the cutting, the entire cutting died before the end of the first growing season.

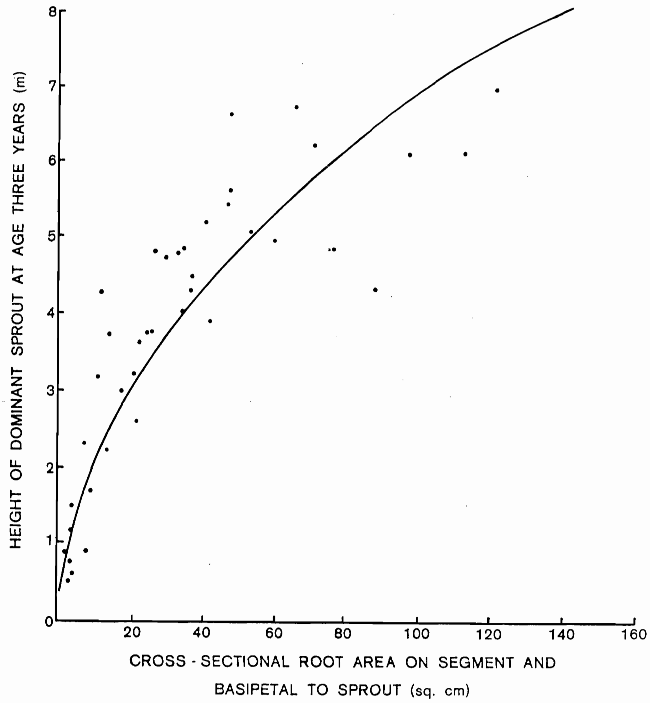

FIG. 2—Relationship between the height of the dominant sprout and the cross-sectional root area in the segment containing the sprout and basipetal to the sprout at 3 years.

DISCUSSION

The most critical factor affecting sprouting of horizontally planted sycamore cuttings appeared to be bud position. Buds which faced down, i.e., on the bottom side, had little chance of reaching the soil surface. Once a sprout erupted through the soil surface, its fate was primarily determined by competition. Without cultivation, few sprouts survived and those that did survive made very little height growth. Also, sprouts without cultivation appeared to depend more on root development from the sprout base than on roots which originated on the cutting itself.

The tendency for sprouting to be more prolific toward the apical end of the horizontal cutting and rooting to be more prolific toward the basal end of the horizontal cutting is similar to the sprouting and rooting response on cuttings placed vertically. This similarity suggests that polar transport of growth hormones remains essentially the same in horizontal as in vertically orientated cuttings. Also, the enlarging of the cutting basipetal to the sprouts is similar to the typical enlargement of roots distal to sprouts or suckers of sweetgum (*Liquidambar styraciflua* L.) (Kormanik and Brown, 1967 and Hook *et al.,* 1970). Apparently the enlargement of the lower side of the cutting basipetal to the sprouts was due to carbohydrate translocation toward the base of the cutting.

There were numerous cases where sprouts originated near the cutting apex and the majority of roots formed at or near the cutting base. Sometimes such sprouts form their own root system and appear to be growing independently of the cuttings. These sprouts appear to have a good chance to survive and make acceptable growth. In other cases the sprouts appear to be dependent on the roots which are 1.2 m distal on the base of the cutting. In such cases the sprouts appear to be poor risks for survival and growth, because it is not anticipated that the cutting will continue to function efficiently as a root.

The parabolic relationship between dominant sprout height and root area basipetal to the sprout indicates the importance of a well-developed root system for rapid growth with this type of vegetative propagation.

Over the whole experiment, only 34% of the buds placed in the ground sprouted. Hence, there is ample opportunity to improve the sprouting percentage on horizontal cuttings. Initially it was assumed that cuttings 1.2 m or longer would be most economical to plant. Although there is less labour in preparing long cuttings, they are unwieldy to handle and are not suited for machine planting. Therefore, efforts are being made to determine the shortest feasible length of cutting that will successfully produce rapidly growing sprouts with well-developed root systems.

REFERENCES

HOOK, D. D., KORMANIK, P. P. and BROWN, C. L. 1970: Early development of sweet gum root sprouts in Coastal South Carolina. U.S. For. Serv., S.E. For. Expt. Sta. Res. Pap. SE-62. 6 pp.

KORMANIK, P. P. and BROWN, C. L. 1967: Root buds and the development of root suckers in sweetgum. **For. Sci. 13:** 338-45.

McALPINE, G.; HOOK, D. D. and KORMANIK, P. P. 1972: Horizontal planting of sycamore cuttings. **Tree Plant. Notes 23 (2):** 5-7.