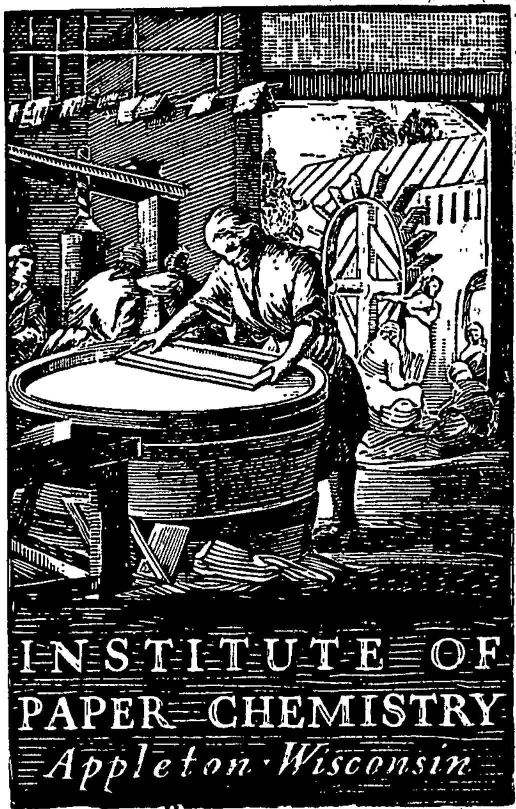

MASS PROPAGATION TECHNIQUES FOR ASPEN CLONES

Project 2987

Report One

A Progress Report

to

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
NORTH CENTRAL FOREST EXPERIMENT STATION

November 11, 1971

THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

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SUMMARY

The possibility of mass propagation of aspen clones was investigated using as a starting point roots from a triploid hybrid aspen and an "alba x bigtooth" aspen hybrid. The procedures involved included fall collection of the roots, storage of the roots until February, March, and April, forcing root sucker production, rooting the root suckers and, finally, transplanting the rooted root suckers into the nursery. The influence of species, storage time, holding time, and date of transplanting were evaluated.

The triploid hybrid aspen produced a greater number of suckers (9 vs. 6) per lineal foot than the "alba x bigtooth" hybrid. Fall and winter storage apparently had little influence on the suckering ability of the two test materials. Holding the rooted suckers was feasible for five to six weeks but is not recommended beyond eight to nine weeks. The date of transplanting into the nursery did not affect survival. From 60 to 80% of the excised root suckers were successfully rooted and transplanted.

Experience gained in the study indicates that rooted root sprout production could have been improved by: (1) producing longer root suckers for use in rooting, (2) use of a deeper layer of rooting media, (3) modifying the watering system to improve moisture conditions, (4) reducing the holding period prior to transplanting to six to eight weeks, and (5) improving nursery fertility levels to assure a rapid start for the transplanted individuals.

INTRODUCTION

Those who prophesy of future forest land use and wood product utilization speak of a growing need for wood products that must be supplied from a shrinking land base for commercial forests. The figures accompanying these predictions indicate an annual consumption figure exceeding the present annual growth in the near future or before 2000 A.D. Those who would avert the eventuality of these predictions generally look toward improved utilization, improved yields through use of improved trees, use of intensive silvicultural techniques, and product substitution. In truth, the ultimate answer to the problem lies in a combination of all these potential developments.

The efforts of this project are concentrated on a portion of work having to do with improved trees and intensive silvicultural techniques. Specifically, the objectives of this project are to develop techniques for mass propagation of clones of improved aspen in a manner which would allow production on an enlarged scale. The Institute of Paper Chemistry was contracted for this research because of its past experience and success in clonally propagating aspen. The basic approach of this program involves the techniques presented by Benson and Schwalbach (1) who suggest fall collection of roots of desirable clones, storage through all or part of the winter, forcing the roots to sucker in the greenhouse, excising and rooting the suckers, and finally growing the rooted sprouts in a nursery to a suitable size for field planting. The two major phases of this program include: (1) using the basic technique to implement spring and summer mass propagation of superior aspen clones and (2) innovating modifications of the technique to allow continuous production throughout the year. The second phase involves rooting sprouts in the late fall and hardening them off for dormant storage through the remaining winter until they may be grown in the nursery in the spring.

This report is concerned with the first year's work in this program which pertains primarily to Phase 1 above. The "PLANS" section of this report discusses the program outlined for the coming year which will concern itself with tying up loose ends of Phase 1 and describing the work plan to meet the needs of Phase 2.

MATERIALS

Two clones were selected for use in this project. The first is an "alba x bigtooth" clone, AG-1-60 — a naturally occurring P. alba x P. grandidentata hybrid. The original tree was found and described by Einspahr (2). The clone has been field tested extensively by The Institute of Paper Chemistry on a number of sites throughout a number of years. The clone has proven to have exceptional growth on both sandy and heavy soils and has shown better than average response to intensive culturing. The disadvantage of the clone is its above normal susceptibility to sunscald.

The second clone, XT-Ta-14-58-S-3, is a selected individual from a triploid interspecific hybrid progeny group, a controlled cross between a P. tremuloides diploid and a P. tremula tetraploid, which has demonstrated exceptional growth characteristics and improved wood quality in field plantings. For more detailed descriptions of the progeny group see the writings of Benson and Einspahr (3) and Einspahr, et al. (4). The roots used for producing the sprouts of these two clones came from excess roots trimmed from one-year-old lineout stock and roots from one- to six-year-old trees in a root arboretum. Both materials were and will be used for all work throughout this program. For this phase of the project roots were collected in the fall, placed in sand, wrapped in polyethylene and stored in an unheated building.

METHODS

One objective of this project was to demonstrate that roots could be collected in the fall and stored until they were forced in February, March, or April without any adverse effects. To do this, approximately 400 feet of root of each of the two materials was cut into 1-foot sections, dipped in captan, and the ends sealed with wax. The pieces were then sorted into thirds and each third placed in sand and the roots and sand wrapped in polyethylene. These bundles were then put in an unheated building and stored until the scheduled time to start the roots.

From past experience in clonally propagating aspen from root sprouts at The Institute of Paper Chemistry it was known that the two most important factors needing modification before successful mass production techniques can be realized are the consolidation of greenhouse space necessary to meet mass production needs and the control of moisture levels in the rooting containers. To do this, several types of growth containers were investigated and clear plastic shoe boxes, approximately 6-1/2 inches by 12 inches by 3-1/2 inches tall were chosen. The advantages of the containers were several. They let in light, had covers to keep moisture conditions ideal when excised suckers are rooting, were small enough to prevent infections from becoming too widespread, could be stacked without covers for easy storage or stacked with covers in place when transporting rooted suckers to the nursery. The boxes were modified with six 1/8-inch holes in the bottom to facilitate drainage and one 0.8-inch hole in the top to allow air exchange. Both the roots and root suckers were started in these containers.

The moisture was added to these containers automatically. An electric switch activated a solenoid valve allowing water to go through a restricted line to a feed line which ultimately fed the drop lines going to each container (see Fig. 1). The electrical switch is operated by one of the rooting containers, that is placed upon a spring balance. When the container loses a predetermined amount of moisture, the switch closes and water is added. Different switches controlled the moisture in the containers having suckering roots and the containers having suckers which were being rooted. Both "suckering" and "rooting" containers were filled with sand-vermiculite to a prespecified level for the type of material involved. For the rooting containers this amounted to approximately 1-1/2 inches of sand-vermiculite and for the suckering containers to within 1 inch of the top. Figure 1 shows the system in operation.

At the prescheduled time (Feb., March or April) the bundles of roots were taken out of cold storage and the root section ends and any necrotic sections trimmed, the pieces cut in half, again dipped in captan, and the cut ends sealed with microcrystalline wax. The root sections were then layered in the suckering containers with each layer covered with sterilized sand-vermiculite. Containers were watered automatically and retreated with captan once a week to reduce the possibility of infections developing.

The technique for rooting the suckers is basically that described by Benson and Schwalbach (1) which involves placing the excised suckers in sterilized sand and vermiculite, keeping them moist and covered for two weeks until they root and then holding them in the containers until they can be transplanted into the nursery beds. The ends of the freshly excised root suckers were dipped into Rootone F (a commercially prepared formulation of rooting hormones in talc

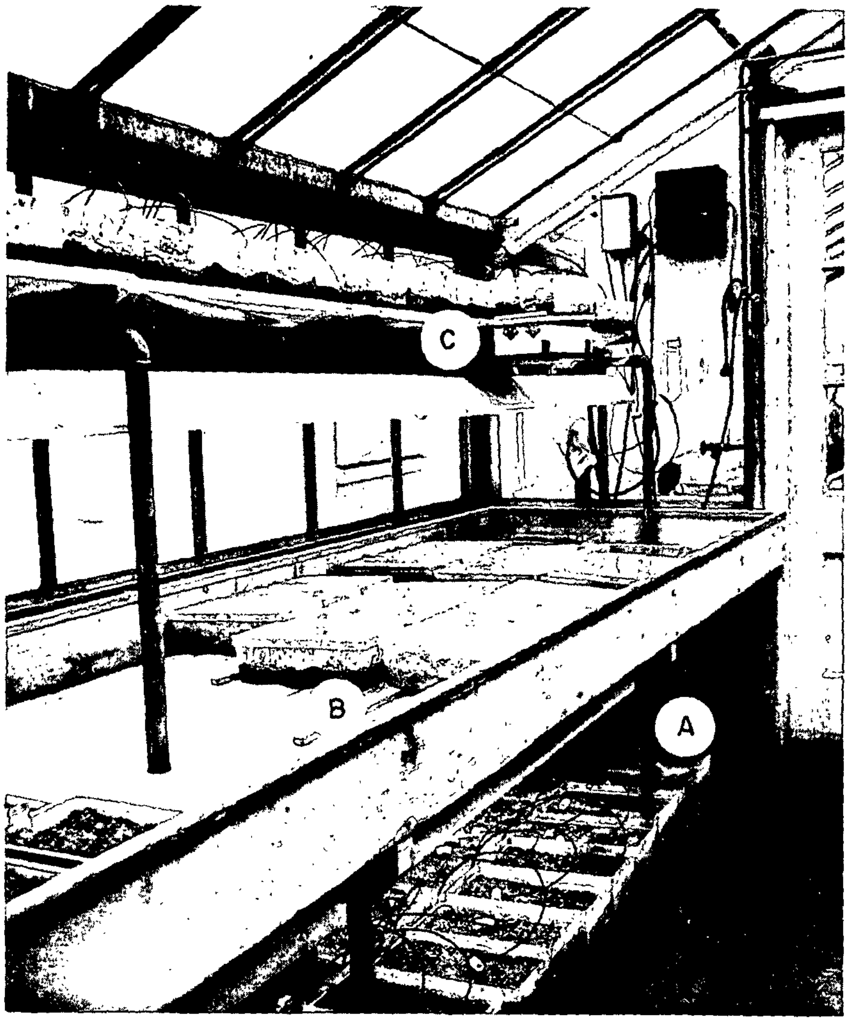

Figure 1. Above is Pictured the Greenhouse Arrangement for the Rooting Work. Level A, on the Bottom, Holds the Roots Which are Producing Suckers. The Covered Containers at Level B Contain 80 Suckers Each in the Initial Stages of Rooting. The Top Shelf (C) Holds the Containers of Rooted Suckers Being Held for Transplanting. To the Right of C is the Switch Controlling the Automatic Watering Device. The Black Tubes (A & C) with the Light-Colored Cylinders on the End are the Drop Lines Which Water Each Individual Container

offered by Amchem Products, Inc.) before placing them in the sterilized sand-vermiculite rooting media (see Fig. 2). Records were kept on the amount of roots started, the date started, the number of excised suckers started each week and the number of those rooting, the date they were transplanted, their survival — weekly from the time excised until transplanted, and their survival at three weeks after transplanting. Survival and height at the end of the growing season was also recorded.

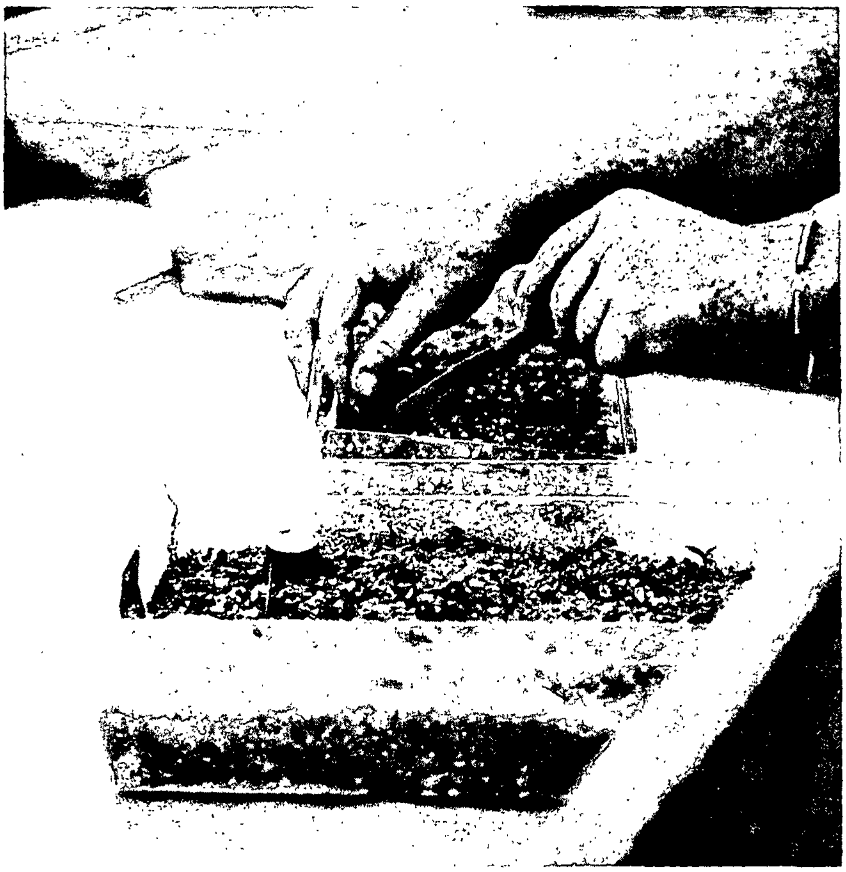

Figure 2. Shown Above are Aspen Suckers Being Excised from the Roots in the Container in the Foreground and Planted in Sand-Vermiculite in the Rooting Containers in the Center

Another determination to be made in this study was the effect of storing rooted suckers in the original rooting containers with no nutrient supplement until a week before transplanting. This was desired because the efficient use of greenhouse space requires the size of the rooted suckers be kept as small as possible until they are to be moved into the nursery. It is also an aid in transplanting if the size of the plants is small.

A fertilization schedule had been planned to optimize plant growth during the growing season. Aspen bark had been incorporated into the nursery soil the previous fall as a soil amendment. As an aid to the decomposition of the bark, ammonium nitrate was added to the soil at the time of the bark application and again in the spring. Plans were to continue application of fertilizer throughout the growing season to prevent nitrogen deficiencies from developing. However, unforeseen complications developed which prevented the planned schedule from being carried out. The result was atypical nursery performance which is further described later in this report.

RESULTS

In the third week after the roots started the first suckers were excised from the roots. Throughout the following week the additional suckers were excised and the numbers recorded. Tables I, II, and III give summaries of the unrooted aspen sucker production. Shown in the tables are the number of suckers excised from the roots during each week of the particular start (February, March, and April) and the accumulated number of suckers excised as of the end of the indicated week. Also presented is sucker production per lineal foot of the roots by the week and the accumulation by the end of the week.

The data in the tables indicate several things. First of all, there is a difference in the suckering ability of the two materials, with the "alba x bigtooth" hybrid having an accumulated total of 6 suckers per lineal foot of root and the triploid hybrid clone developing 9 suckers per lineal foot of root. This is consistent with observations made on these two types of materials in the field, that is "alba x bigtooth" materials sucker less than the trembling aspen types. It also appears that root storage had little or no effect on the ability of the roots to sucker. The accumulated sucker production per lineal foot of root for the starting months of February, March, and April are 9.4, 8.9, and 8.0, respectively, for the triploid hybrid 13 weeks after starting, and 5.9, 6.3, and 5.3, respectively, for the "alba x bigtooth" hybrid 12 weeks after starting.

Both materials exhibited an early surge of suckering that dropped off about the 7th week after the start for the triploid hybrid and between the 5th and 6th week for the "alba x bigtooth" hybrid. Suckering was allowed to continue

U.S. Department of Agriculture
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TABLE I

SUCKER PRODUCTION[a]
"ALBA x BIGTOOTH" HYBRID
(AG-1-60)

Weeks Since Roots Started	February				March				April			
	Additional Suckers Excised	Accumulated Suckers Excised	Sucker Prodn. per Lineal Foot of Root		Additional Suckers Excised	Accumulated Suckers Excised	Sucker Prodn. per Lineal Foot of Root		Additional Suckers Excised	Accumulated Suckers Excised	Sucker Prodn. per Lineal Foot of Root	
			by Week	Accumulated			by Week	Accumulated			by Week	Accumulated
3	94	94	0.7	0.7	160	160	1.51	1.51	160	160	0.98	0.98
4	180	274	1.3	2.0	150	310	1.41	2.92	130	290	0.80	1.78
5	60	334	0.4	2.5	80	390	0.75	3.67	80	370	0.49	2.28
6	60	394	0.4	2.9	80	470	0.75	4.43	157	527	0.97	3.24
7	70	464	0.5	3.4	0	470	0.00	4.43	80	607	0.49	3.74
8	60	524	0.4	3.9	92	562	0.87	5.29	71	678	0.44	4.17
9	90	614	0.7	4.5	40	602	0.38	5.69	0	678	0.00	4.17
10	78	692	0.6	5.1	0	602	0.00	5.69	100	778	0.62	4.79
11	27	719	0.2	5.3	63	665	0.59	6.26	0	778	0.00	4.79
12	93	802	0.7	5.92	--	--	--	--	80	858	0.49	5.28

[a] Expressed as total number of suckers excised per lineal foot of root. Root sizes 1/8-3/8 inch diameters. Amount of root started was 135.4 feet in February, 106.2 feet in March, and 162.5 feet in April.

TABLE II

SUCKER PRODUCTION[a]
TRIPLOID HYBRID
(XT-Ta-14-58-S-3)

Weeks Since Roots Started	February				March				April			
	Additional Suckers Excised	Accumulated Suckers Excised	Sucker Prodn. per Lineal Foot of Root		Additional Suckers Excised	Accumulated Suckers Excised	Sucker Prodn. per Lineal Foot of Root		Additional Suckers Excised	Accumulated Suckers Excised	Sucker Prodn. per Lineal Foot of Root	
			by Week	Accumulated			by Week	Accumulated			by Week	Accumulated
3	24	24	0.19	0.19	51	51	0.38	0.38	36	36	0.30	0.30
4	119	143	0.92	1.11	270	321	2.03	2.41	194	230	1.59	1.88
5	140	283	1.08	2.19	300	621	2.25	4.66	300	530	2.46	4.34
6	220	403	1.70	3.12	170	781	1.28	5.86	0	530	0.00	4.34
7	160	563	1.24	4.36	60	841	0.45	6.31	190	720	1.56	5.90
8	190	753	1.47	5.83	77	918	0.58	6.89	0	720	0.00	5.90
9	132	885	1.02	6.86	80	998	0.60	7.49	0	720	0.00	5.90
10	70	955	0.54	7.40	0	998	0.00	7.49	160	880	1.31	7.21
11	0	955	0.00	7.40	140	1138	1.05	8.54	0	880	0.00	7.21
12	30	985	0.23	7.63	50	1188	0.38	8.91	50	930	0.41	7.62
13	98	1083	0.76	8.39	0	1188	0.00	8.91	43	973	0.35	7.97

[a]Expressed as total number of suckers excised per lineal foot of root. Root sizes 1/8–3/8 inch diameters. Amount of root started was 129.1 feet in February, 133.3 feet in March, and 122.1 feet in April.

TABLE III

TOTAL SUCKER PRODUCTION

Weeks Since Roots Started	"Alba x Bigtooth" Hybrid (AG-1-60)				Triploid Hybrid (XT-Ta-14-58-S-3)			
	Additional Suckers Excised	Accumulated Suckers Excised	Sucker Production per Lineal Foot of Root		Additional Suckers Excised	Accumulated Suckers Excised	Sucker Production per Lineal Foot of Root	
			by Week	Accumulated			by Week	Accumulated
3	414	414	1.02	1.02	111	111	0.29	0.29
4	460	874	1.14	2.16	583	694	1.52	1.81
5	220	1094	0.54	2.71	740	1434	1.92	3.73
6	297	1391	0.74	3.44	390	1824	1.01	4.74
7	150	1541	0.37	3.81	410	2234	1.07	5.81
8	223	1764	0.55	4.37	267	2501	0.69	6.51
9	130	1894	0.32	4.69	212	2713	0.55	7.55
10	178	2072	0.44	5.13	230	2943	0.60	7.65
11	90	2162	0.22	5.35	140	3083	0.36	8.02
12	173	2335	0.43	5.78	130	3213	0.34	8.36
13	37	2372	0.09	5.87	141	3354	0.37	8.72

into the 16th week for specific starts of both materials but for most practical purposes, producing suckers beyond the 12th or 13th week is of questionable merit.

Tables IV and V show the data concerning the percentage of excised suckers which developed roots and were transplanted as well as the survival percentages of the materials at 3 weeks. Slightly higher numbers rooted than were transplanted. The losses sustained resulted while the individuals were being held prior to transplanting. The data are listed by material, month roots were started, and the totals for all months. While a wide range may be found for both the percentage of excised suckers transplanted and the percentage of excised suckers transplanted and surviving, any large variation shown is generally due to specific handling conditions and is not related to the time the suckers were excised.

Three factors were evident in the basic data used to put these tables together: fewer suckers were produced per lineal foot of root than anticipated; the largest loss of excised suckers, before transplanting, occurred in the 3rd and 4th week after the suckers had been excised; and, larger mortalities than were anticipated occurred after transplanting.

The reduced sucker production per lineal foot of root can be explained by the fact that the root sizes used were of smaller diameter (1/8-3/8 inch) than the roots used in previous studies from which the original estimates were made. The loss of suckers in the 3rd and 4th week after being excised is of more interest and perhaps needs further study. Fifty percent of all the loss prior to transplanting time took place in the 3rd and 4th weeks. The period involved is the two weeks after the suckers are uncovered. The suckers lost are those which had not rooted

TABLE IV

SUCKER ROOTING AND SURVIVAL BY WEEK SUCKERS EXCISED
"ALBA x BIGTOOTH" HYBRID
(AG-1-60)

Weeks Since Roots Started[a]	February			March			April			Total		
	No. Suckers Excised	% of Excised Suckers		No. Suckers Excised	% of Excised Suckers		No. Suckers Excised	% of Excised Suckers		No. Suckers Excised	% of Excised Suckers	
		Trans-planted	Surviving[b]		Trans-planted	Surviving[b]		Trans-planted	Surviving[b]		Trans-planted	Surviving[b]
3	94	59.6	45.7	160	87.0	27.5	160	31.2	27.5	414	59.3	32.7
4	180	20.0	13.3	150	68.7	51.3	130	35.4	34.6	460	47.4	60.6
5	60	66.7	35.0	80	71.3	61.3	80	53.8	46.3	220	63.6	48.6
6	60	66.7	56.8	80	70.0	52.5	157	92.4	48.4	297	81.3	51.2
7	70	80.0	41.4	0	--	--	80	93.7	93.3	150	86.5	69.4
8	60	65.0	45.0	92	46.7	39.1	71	83.2	57.8	223	63.4	46.7
9	90	75.6	51.1	40	87.5	75.0	0	--	--	130	79.4	58.5
10	78	85.9	51.3	0	--	--	100	78.0	48.0	178	81.5	49.5
11	27	55.6	51.9	63	90.5	46.1	0	--	--	90	80.0	47.8
12	93	66.7	59.1	0	--	--	80	Not used here		93	66.8	59.2

[a]Represents interval between when the roots were started and when the specific suckers were excised.

[b]Survival is percentage of excised suckers surviving three weeks after being transplanted.

TABLE V

SUCKER ROOTING AND SURVIVAL BY WEEK SUCKERS EXCISED
TRIPLOID HYBRID
(XT-Ta-14-58-S-3)

Weeks Since Roots Started[a]	February			March			April			Total		
	No. Suckers Excised	% of Excised Suckers		No. Suckers Excised	% of Excised Suckers		No. Suckers Excised	% of Excised Suckers		No. Suckers Excised	% of Excised Suckers	
		Trans-planted	Surviving[b]		Trans-planted	Surviving[b]		Trans-planted	Surviving[b]		Trans-planted	Surviving[b]
3	24	66.7	66.7	51	55.0	35.3	36	0.0	0.0	111	39.7	30.7
4	119	21.9	18.5	270	56.0	52.3	194	81.0	75.9	583	57.4	60.1
5	140	50.0	39.3	300	52.4	51.7	300	71.3	62.3	740	59.6	28.4
6	220	63.3	60.5	170	74.8	44.1	0	--	--	390	71.0	89.8
7	160	71.8	65.7	60	33.3	25.0	190	87.4	74.7	410	73.5	29.3
8	190	36.8	23.7	77	96.2	94.8	0	--	--	267	53.9	43.3
9	132	71.2	63.6	80	75.0	58.8	0	--	--	212	72.7	61.8
10	70	82.9	50.0	0	--	--	160	73.8	65.0	230	76.6	60.5
11	0	--	--	140	96.5	78.7	0	--	--	140	96.5	78.7
12	30	70.0	60.0	50	76.0	89.5	50	Not used here		130	45.4	13.8

[a]Represents interval between when the roots were started and when the specific suckers were excised.

[b]Survival is percentage of excised suckers surviving three weeks after being transplanted.

in that time or had infections. It is felt that the containers and the watering systems used were less than optimum for best rooting success. Rather than controlling the amount of water applied with the drop line system, it is felt that a system which allows the rooting media to be saturated with water periodically and then uniformly drained to the proper moisture level would insure more uniform moisture conditions and better rooting. An increase in the rooting media depth to 2 inches is also felt to be advantageous as this would allow deeper placement of the suckers and better buffering of moisture conditions. A certain part of the rooting failures were observed to be due to short suckers which could not be placed deep enough in the rooting media. This can be minimized by being sure that the roots from which the suckers were taken were buried deep enough when they are forced for suckering so that longer shoots will develop. Also, short suckers could be eliminated from the rooting work. Pathogens were, for the most part, believed to be under control. Some of the losses during the 3rd and 4th week mentioned above were due to infections. Only one application of captan was made during the first two weeks. A second application of captan during that period may reduce infections further.

The rooted suckers were kept in the original containers with no nutrients added other than what might be in the water until one week before transplanting. Some nutrient deficiency symptoms occurred after 6 weeks, the leaf margins yellowed and some turned reddish after 8 to 10 weeks. A water-soluble greenhouse fertilizer (20-20-20) solution at one ounce per two gallons of water was applied at about 1/4-cup per rooting container one week before the plants were to be transplanted. Most of the suckers started a new flush of growth with a lush green color in the week's time before transplanting. Table VI shows performance of the suckers

TABLE VI

SUCKER ROOTING AND SURVIVAL BY NUMBER OF WEEKS
SUCKERS HELD BEFORE TRANSPLANTING

	Number of Weeks Suckers Held Before Transplanting											
	3	4	5	6	7	8	9	10	11	12	14	Total	Average
AG-1-60													
·. suckers excised	0	160	194	284	427	160	90	80	220	60	180	1855	--
·. suckers transplanted	--	117	172	199	263	50	68	57	159	40	36	1161	--
Percentage of excised suckers transplanted	--	73	89	70	62	31	76	71	72	67	20	--	63
ırvival percentage of ·ansplants at 3 weeks	--	--	57	72	77	96	68	86	67	85	67	--	75
ırvival percentage of ·ansplants in Oct.	--	34	29	67	73	88	50	83	61	50	67	--	60
XT-Ta-14-58-S-3													
·. suckers excised	330	160	178	407	194	0	432	270	160	220	119	2470	--
·. suckers transplanted	301	118	146	309	157	--	251	151	115	150	26	1724	--
Percentage of excised suckers transplanted	91	74	82	76	81	--	58	56	72	68	22	--	68
ırvival percentage of ·ansplants at 3 weeks	84	--	98	90	94	--	95	93	91	89	85	--	91
ırvival percentage of ·ansplants in Oct.	64	88	80	79	73	--	57	76	71	66	58	--	71

in relation to the length of time they were held between excising and transplanting. As the data indicate, no detrimental effects appear evident from the holding action for the "alba x bigtooth" hybrid. The occasional low percentage of excised suckers transplanted generally resulted from events in the early weeks of rooting. The triploid hybrid, on the other hand, appears to have had a significant drop in survival of plants held without nutrient supplement beyond eight weeks.

Some problems arose in the nursery part of the study due to the addition of bark to the nursery soil the fall before. Nutrient deficiency symptoms developed and could not be corrected in spite of fertilizer applications in alternate weeks from late June until mid-August. This was not due to holding the suckers in growing containers as it was nurserywide, in seedlings, cuttings, and sucker beds. Also, all suckers whether transplanted at 3 weeks or 14 weeks showed the symptoms. For this reason the information gathered from the nursery is confounded and atypical. Heights at the end of the season averaged around 0.8 foot with not more than 200 plants of the two materials combined being field plantable. Plans are to leave the materials in the nursery one more year to obtain plantable sizes.

The data that follows for the nursery performance have some significance as far as survival is concerned but the full information is masked by the bark supplement nutrient deficiency effect. Rooted suckers were transplanted at four different times: May 5, May 13, June 14, and July 8. Suckers held 3-10 weeks were used in the May 5 transplant, 4-10 weeks in the May 13 transplanting, 3-14 weeks in the June 14 transplanting, and 4-7 weeks for the July 8 transplanting. Table VII gives the tabulation of the data for the performance of the suckers from rooting through fall survival by transplanting dates and material. The

TABLE VII

SUCKER ROOTING AND SURVIVAL BY TRANSPLANT DATA

Material	Date Transplanted	Number of Suckers: Excised	Number of Suckers: Transplanted	Percentage of Excised Suckers Transplanted	Survival as a Percent of Number Transplanted at: 3 Weeks	Survival as a Percent of Number Transplanted at: In Oct.
AG-1-60	May 5, 1971	292	202	69.3	64.9	50.0
	May 13, 1971	240	195	81.3	44.1	33.7
	June 14, 1971	1446	826	57.1	75.3	65.7
	July 8, 1971	349	296	84.8	--	58.4
XT-Ta-14-58-S-3	May 5, 1971	334	214	64.2	55.0	43.0
	May 13, 1971	281	175	62.3	61.7	60.0
	June 14, 1971	2110	1620	76.8	90.2	69.4
	July 8, 1971	210	156	74.2	--	88.5

survival and growth in the nursery is considerably below what might be expected from past experiences. It is not unreasonable, under more normal nursery nutrient conditions, to expect average heights between two and four feet for the materials used, regardless of the time started. Survival for May transplants was and still is in question. Early transplanting, before the danger of frosts has passed, always is a risk. The extent of the risk can only be assessed with experience. Past experience with transplanting rooted suckers in late May through mid-July has indicated survival in the nursery should be considerably higher than that obtained in this study. The data in Table VII is atypical and without enough of a pattern to find significant trends.

PLANS

Phase 2 of the program, which involves fall and early winter production of rooted root sprouts is well under way. If successful, this will allow propagation for a major part of the year. Four to six-inch rooted suckers are being held in rooting containers and will be hardened off, stored, and ultimately lined out in the nursery early in the spring. Roots have been collected and suckering initiated in order to produce additional rooted suckers in the winter with plans to grow them to size, give them short days to encourage dormancy and finally store them under cold conditions until they can be lined out in the spring.

New rooting containers have been obtained from Beaver Plastics, Ltd. of Edmonton, Alberta. The containers are called Styroblocks and are of molded plastic. Plans for the blocks, which have individualized compartments, call for the root suckers to be rooted in the blocks. Then, after the suckers reach proper size, they will be hardened off and held for spring planting.

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