Soil Modification Methods to Relieve Compaction for Existing Trees

Project Update for a Demonstration Conducted
by the

Michigan State University Grounds Maintenance Department
J. Paul Swartz
Tree/Grounds Maintenance Supervisor
(517) 355-7750

in cooperation with the
Michigan Department of Natural Resources
Forest Management Division

Community Forestry Grants Program

Cosponsored by:
USDA Forest Service State & Private Forestry and
Michigan Urban Community Forestry Council

March 5,1997

Table of Contents

Introduction

Project Rationale and Overview

Urban trees improve the quality of life for city and suburban residents. They also can enhance the economic value of property and provide help in conserving energy. But these important roles can only be played when they are healthy. In an unhealthy state, they are eyesores, maintenance headaches, and a point of frustration for all concerned. The apparent decline of many of our urban trees is obviously due to a variety of factors.

Soil compaction, water stress, and insects affect new and established trees alike. Yet it is well documented that a healthy tree is much more capable of fighting off these and other environmental stresses. Decline or even death will all too often follow.

Even with adequate moisture, the best varieties of trees cannot thrive and ward off potential insect and disease problems without adequate oxygen. Roots need oxygen to take up moisture and nutrients. Proper soil structure is necessary to allow space for oxygen to be available in the root zone. Proper drainage is necessary to pull away excess moisture to allow space for oxygen in the soil profile.

Our urban clay soils are increasingly being abused through compaction. One valid approach is to treat the planting sites as below ground containers using amended soil and positive drainage systems. Unfortunately the expense prohibits this application on a large scope. It is the primary goal of this study to show cost effective/ growth effective techniques that can be applied to established urban trees which will solve the primary issue of oxygen availability.

Materials and Methods

Tree Selection

Eighty-four trees were randomly selected around the Michigan State University campus: Forty-two white pines, and forty-two sugar maples. The seven treatments were then administered to six of each species. In 1993 data was gathered in the following categories:

- dbh (trunk diameter at 4.5 feet)
- color (according to the "ColorBank" plant health rating and diagnostic guide)
- soil compaction level
- the distance to the nearest hard surface (sidewalk, street, or building)
- the treatment applied
- a soil sample

- a color photo
- twig length for the last five growing seasons (distance between nodes)

Three twig samples were taken from each subject tree. Where possible, strong, undamaged leaders were measured. In February 1995, additional data was collected for dbh, and twig growth for 1993 and 1994.

Techniques Used

The following seven different treatments were used in this study.

Control

These trees will have no treatment, and will be used for comparison.

Vertical Aeration

In this treatment, two inch diameter holes were drilled into the surrounding soil in concentric circles 2.5 feet apart starting at a distance of five feet from the trunk, continuing out to the drip line. The holes along each of the concentric circles were spaced 2.5 feet apart, and were made to a depth of eighteen inches.

Radial Trenching

Using a "TrenchMaster" trenching machine, eight trenches were made to a depth of approximately eleven to twelve inches in radial lines radiating outward from the trunk to the dripline, one at each main compass point. Trenches were then backfilled with topsoil.

Grow Gun

First, several two inch holes were augured to a depth of eighteen inches equally spaced at four foot intervals inside the drip line. Water and high pressure air were injected into the holes with the Grow Gun to fracture the soil.

The last three treatments were the Vertical Aeration, Radial Trenching, and Grow Gun injection, where the holes were backfilled with a mixture of 75% topsoil, and 25% Isolite. **Isolite** is a porous ceramic soil additive which can be used to modify soil characteristics to create a more favorable environment for plant growth. Diatemaceous earth is combined with natural binders and the extruded uniform granules are rotary-kiln fired at 1800°F. The result is an extremely stable porous ceramic which will not decompose in soil.

Results

We found that Radial Trenching was the fastest method as far as time spent per tree, with the Grow Gun and Vertical Aeration coming in second and third, respectively. It also appears to be in the same order regarding cost per treatment. The plant response to the different treatments is still being observed, and it is too soon to come to any definite conclusions. This can be attributed to the fact that root response is not instantaneous, and it will take at least two to three years to show any visible results in crown characteristics.

Discussion

We have embarked on a very interesting demonstration. From the growth data from 1994, (Figures 1 and 2), we have what appears to be some beneficial results from all the treatments compared with the control trees. These findings are very preliminary, and we will need to analyze the next four years of growth to come up with something conclusive. We will continue to collect and refine our data during this time.

Figure 1.

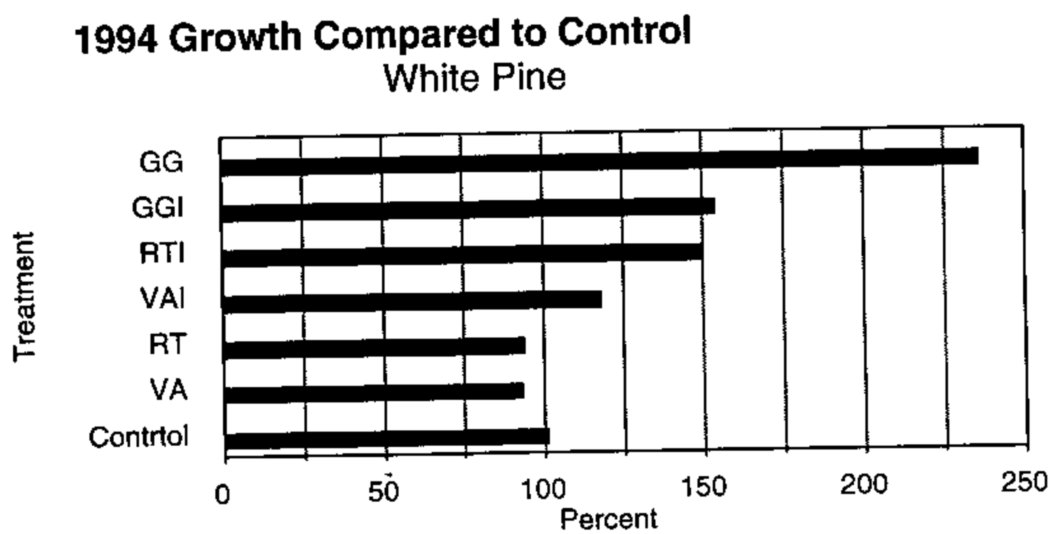


Figure 2.

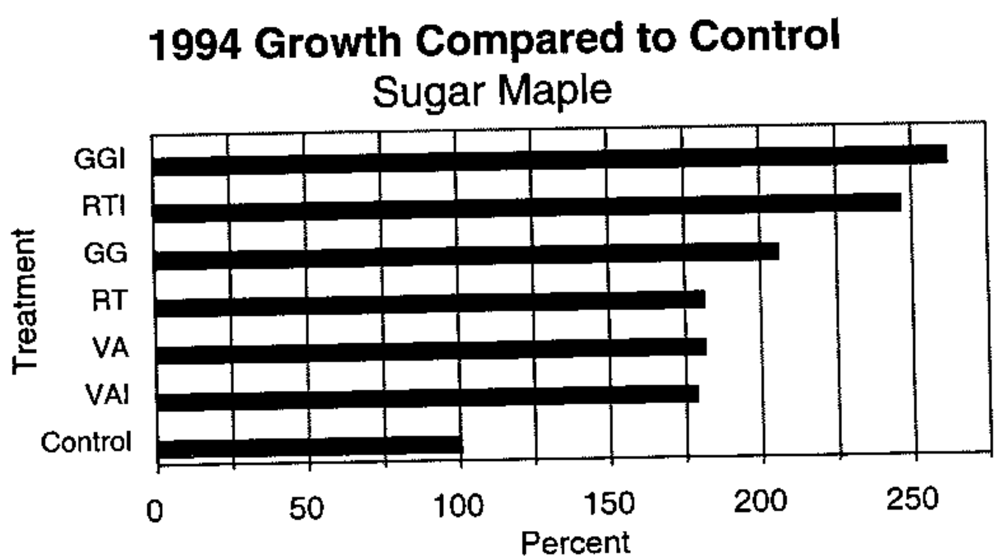


Figure 3.

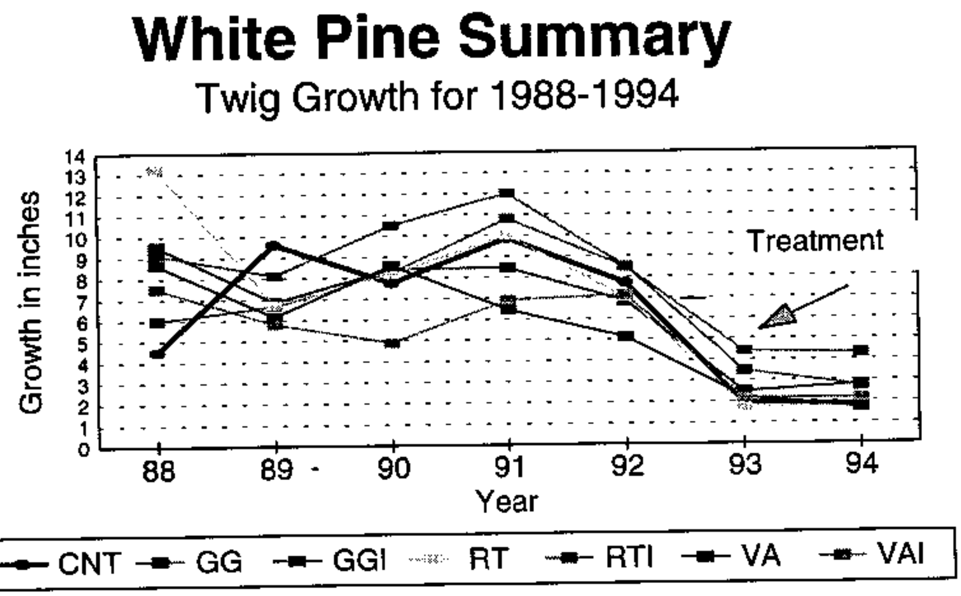


Figure 4.

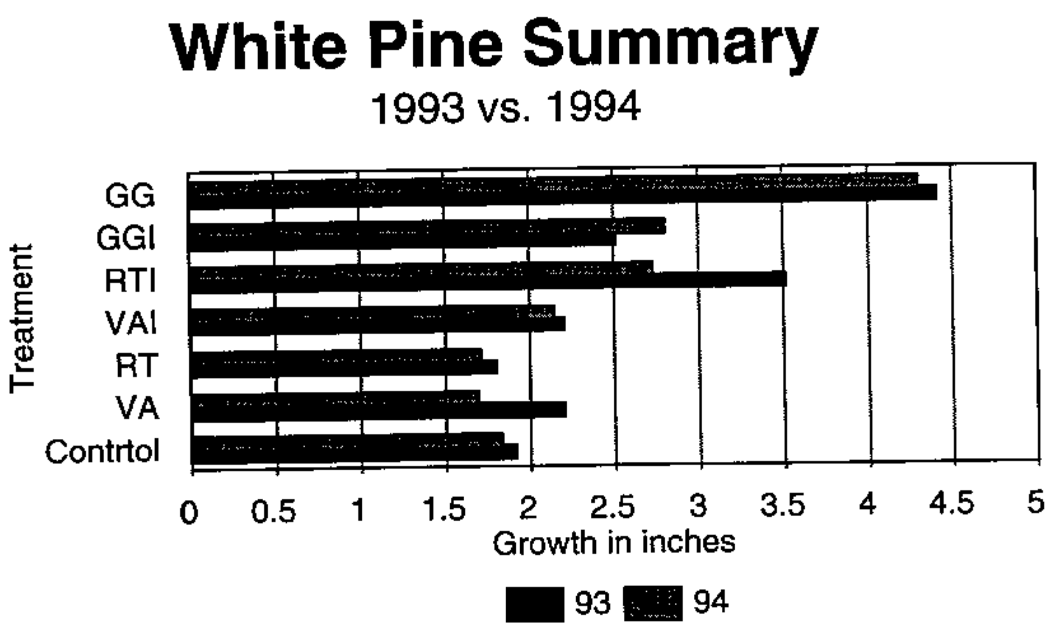


Figure 5.

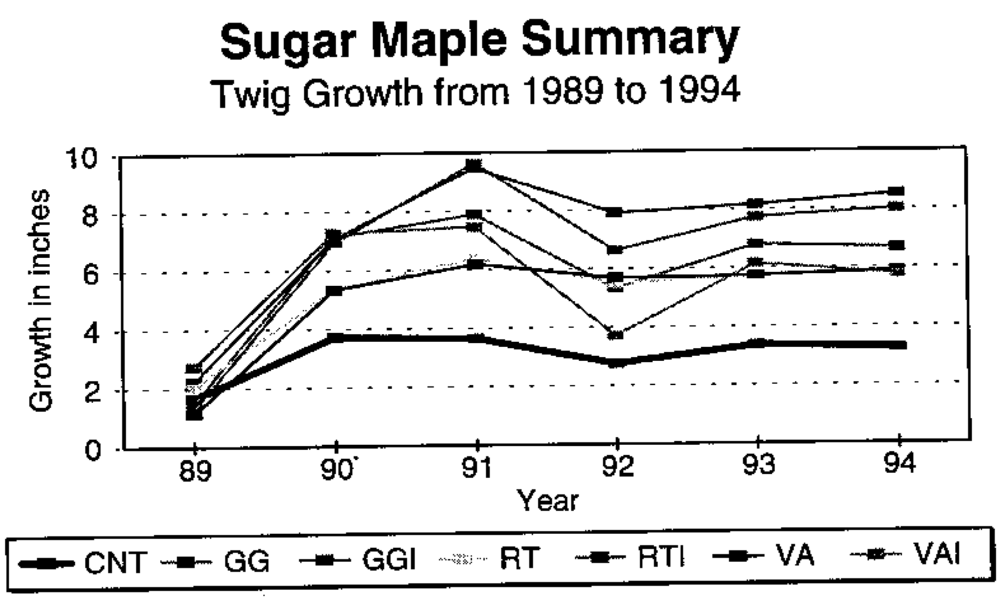
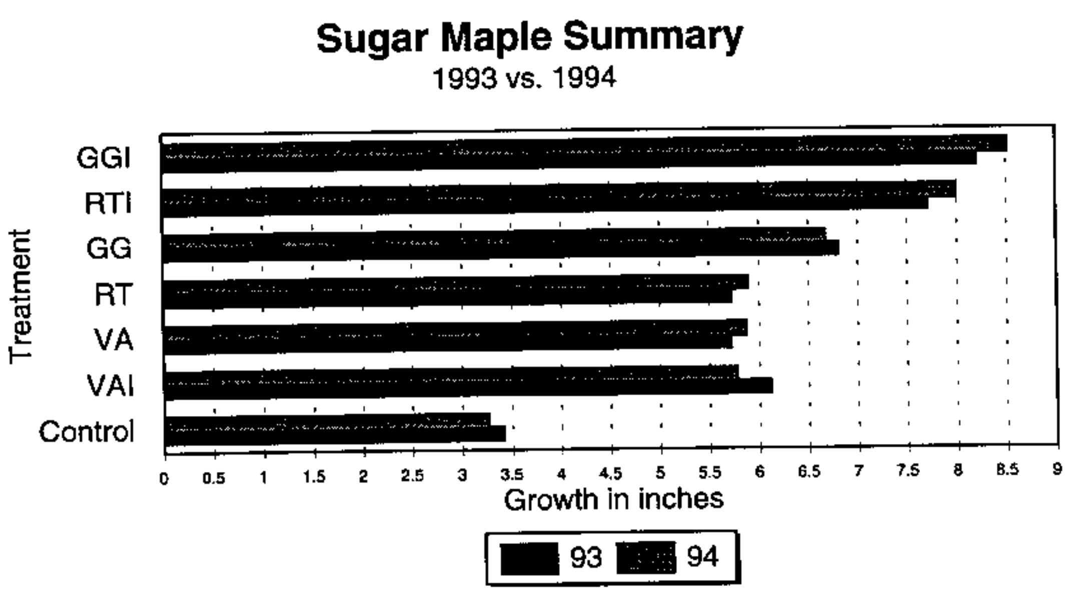
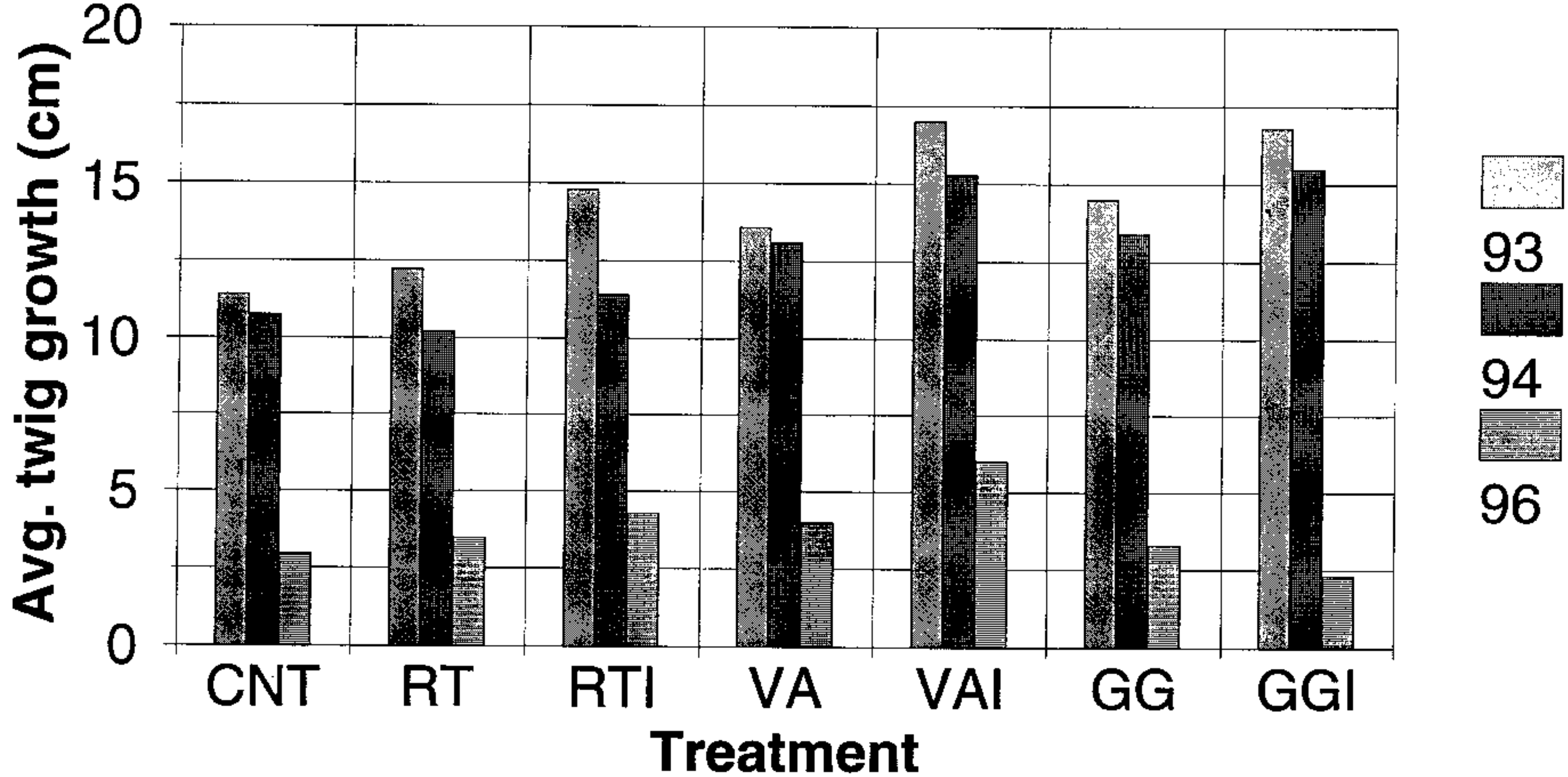


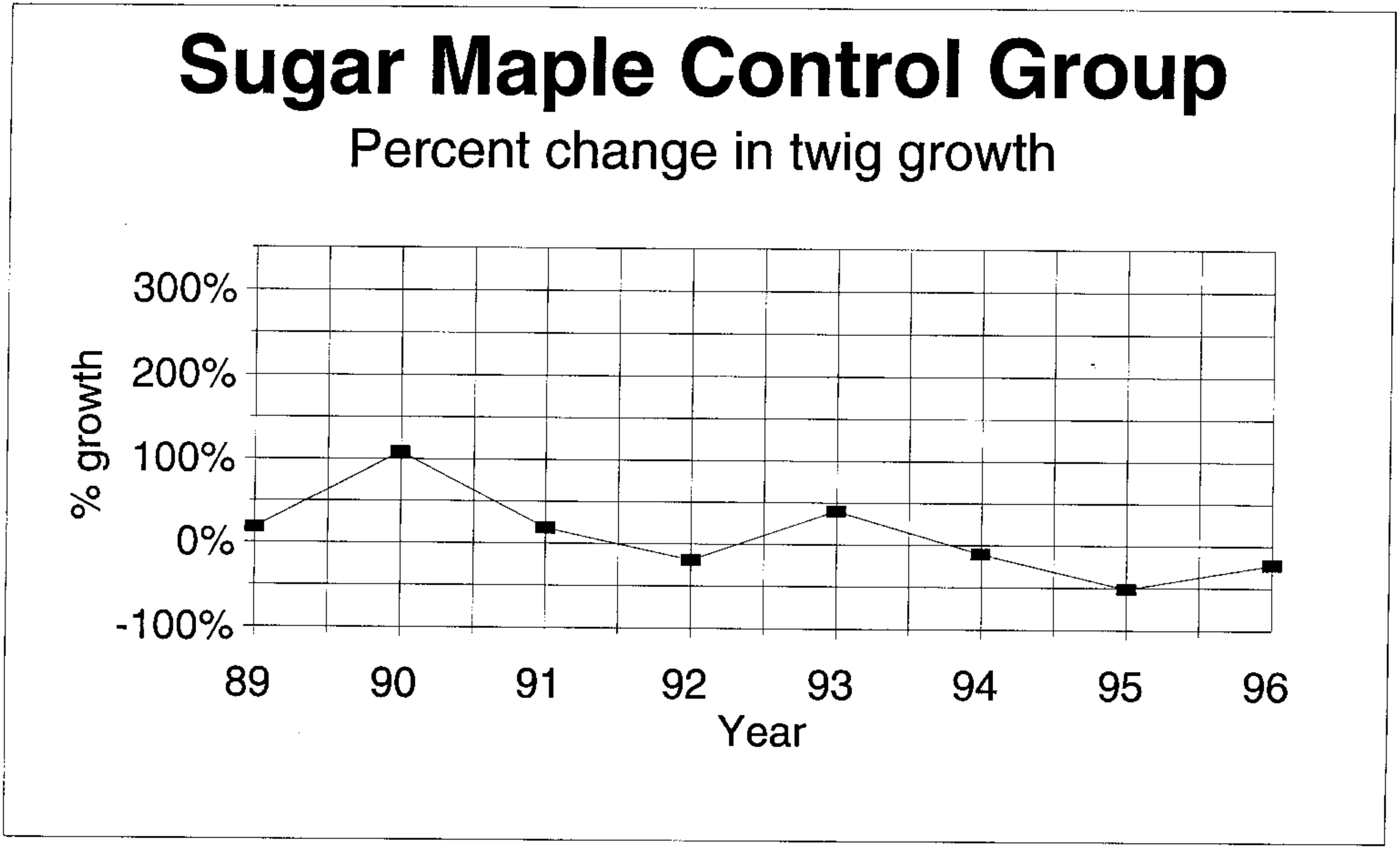
Figure 6.



Sugar Maple Summary

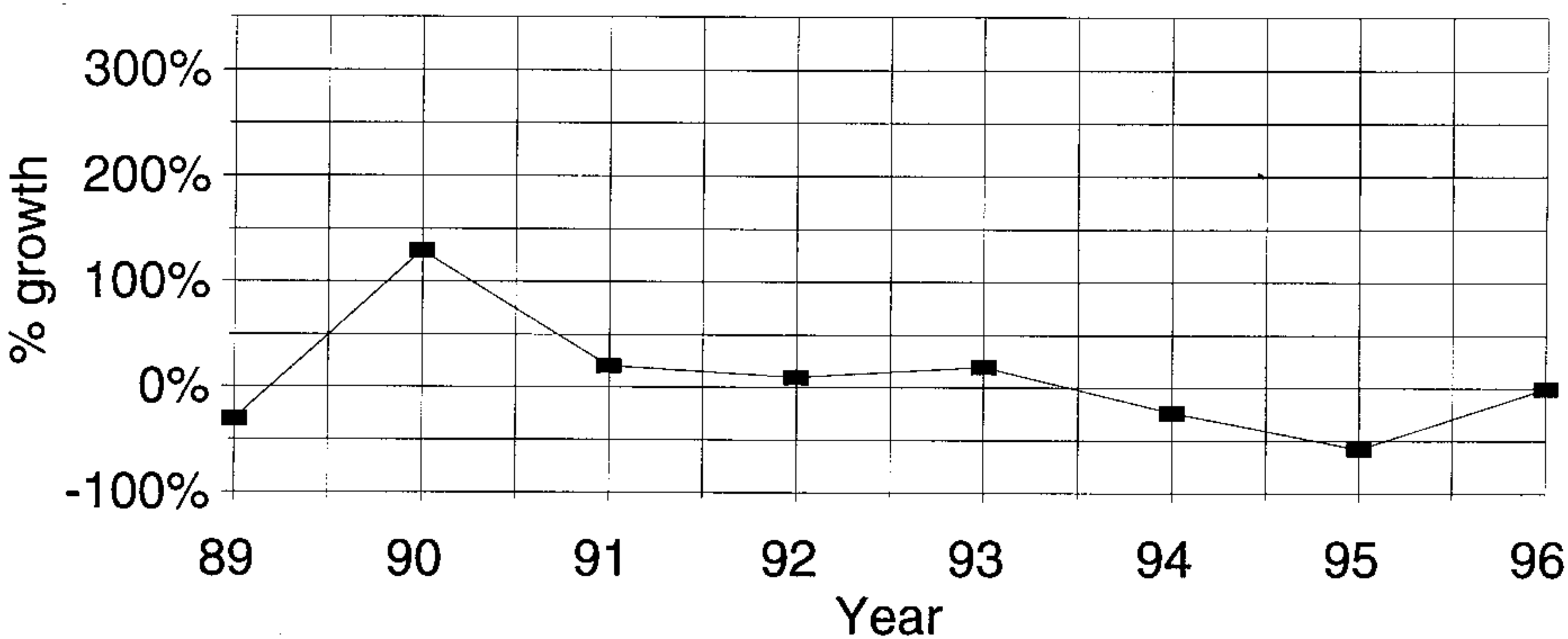
'93 - '94 - '96




Sugar Maple Control Group
Percent change in twig growth
% growth
300%
200%
100%
0%
-100%
89
90
91
92
93
94
95
96
Year

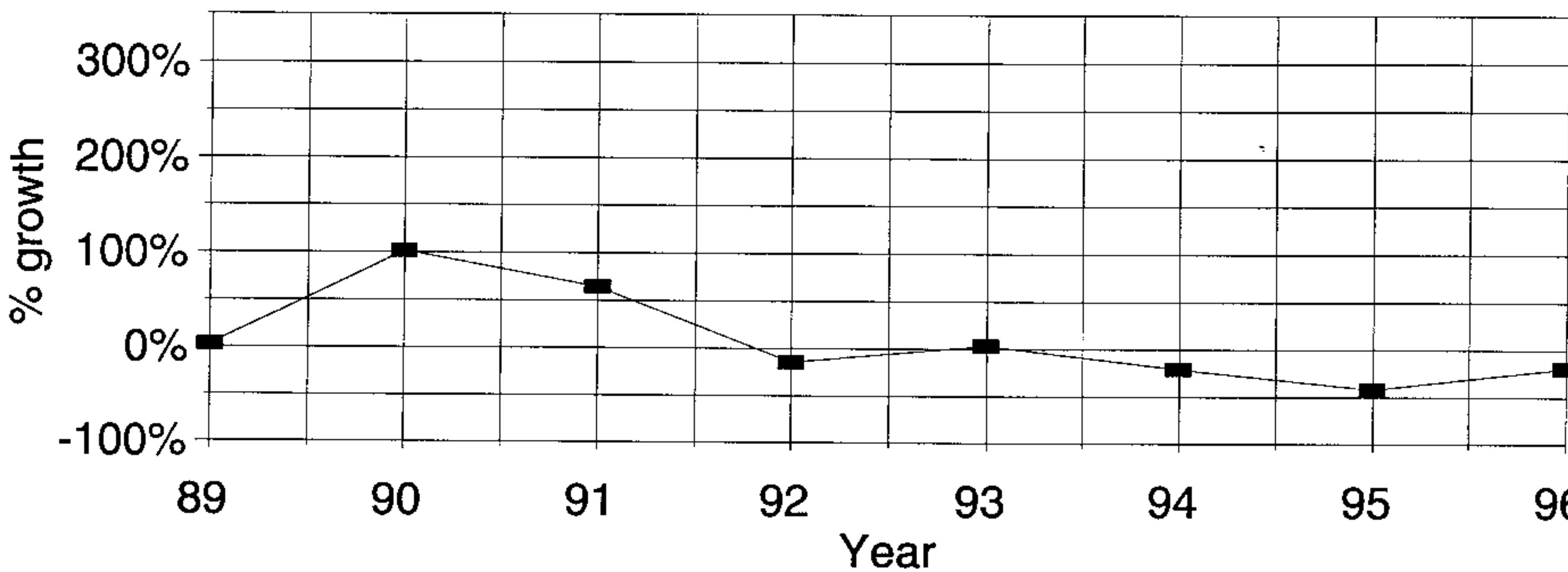
Sugar Maple, Radial Trenching

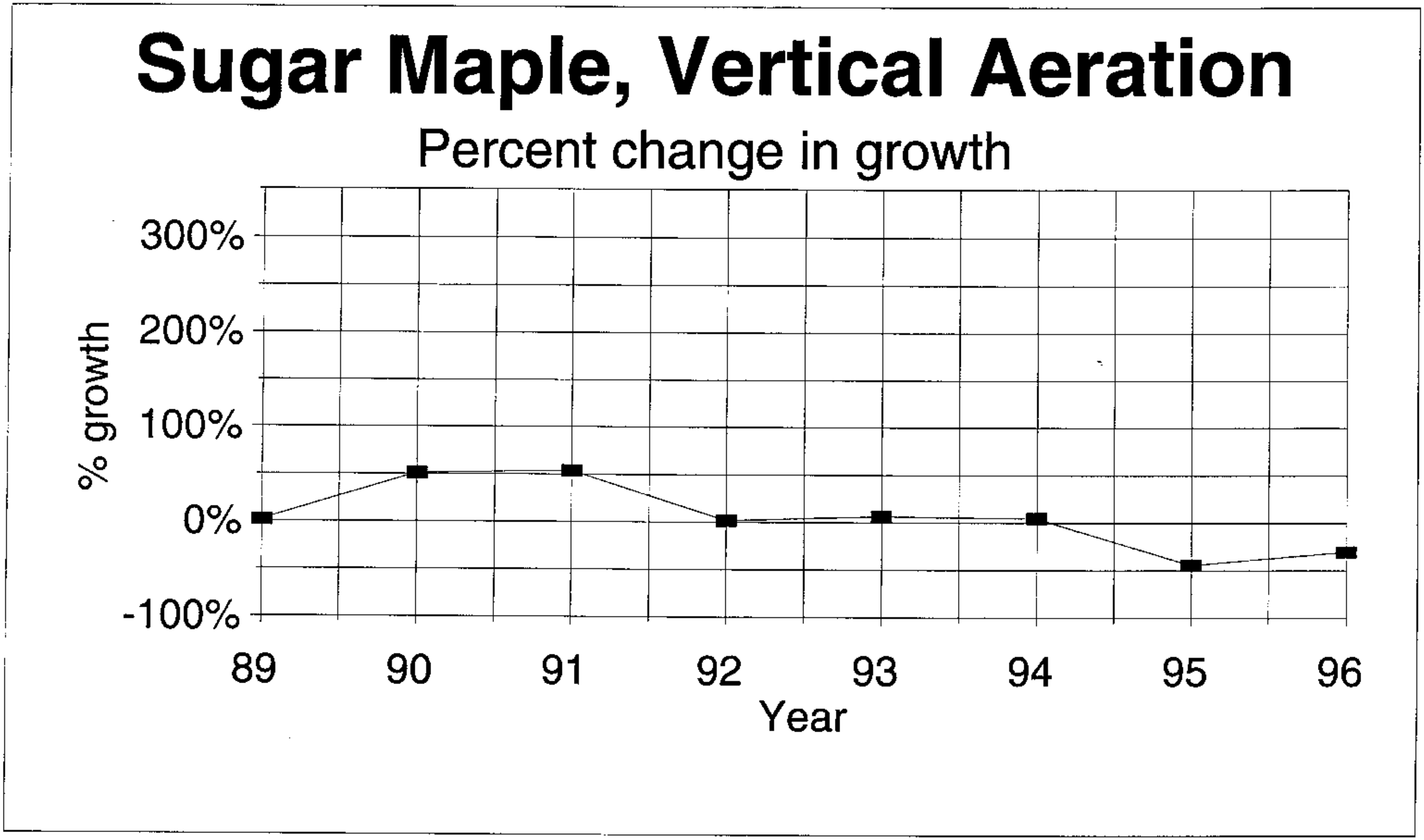
Percent change in growth



Sugar Maple Radial Trenching w/Isolite

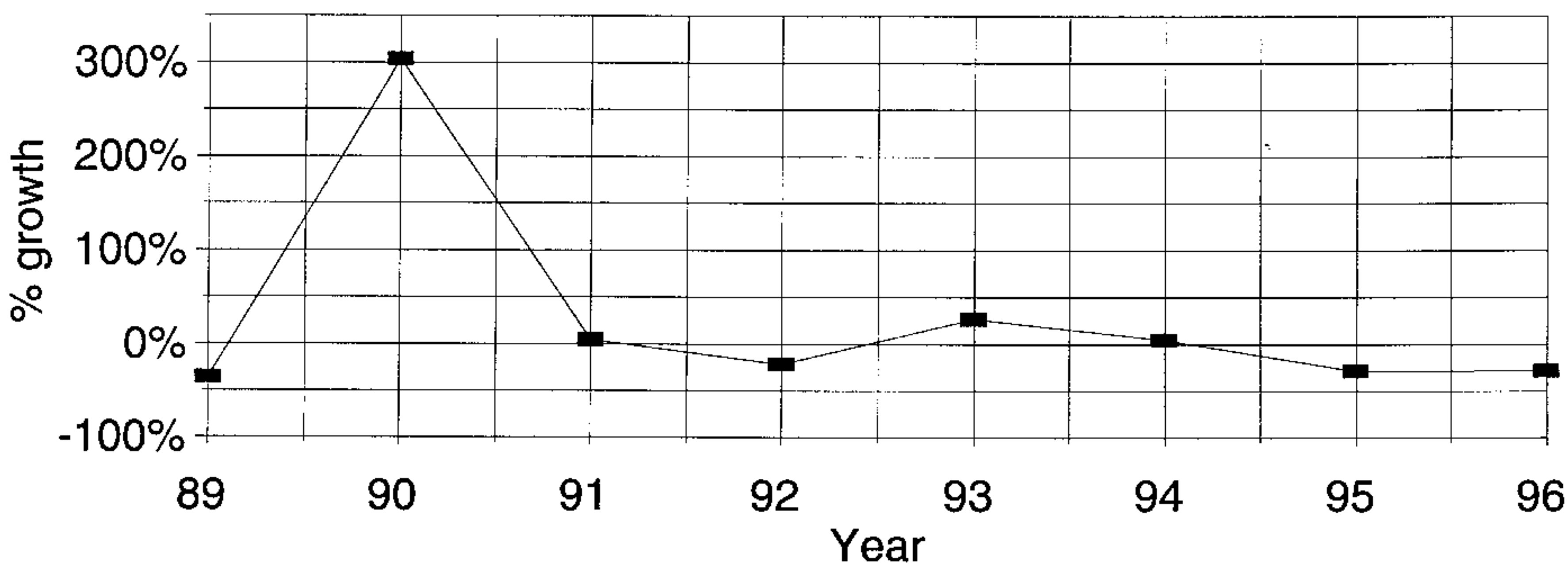
Percent change in twig growth

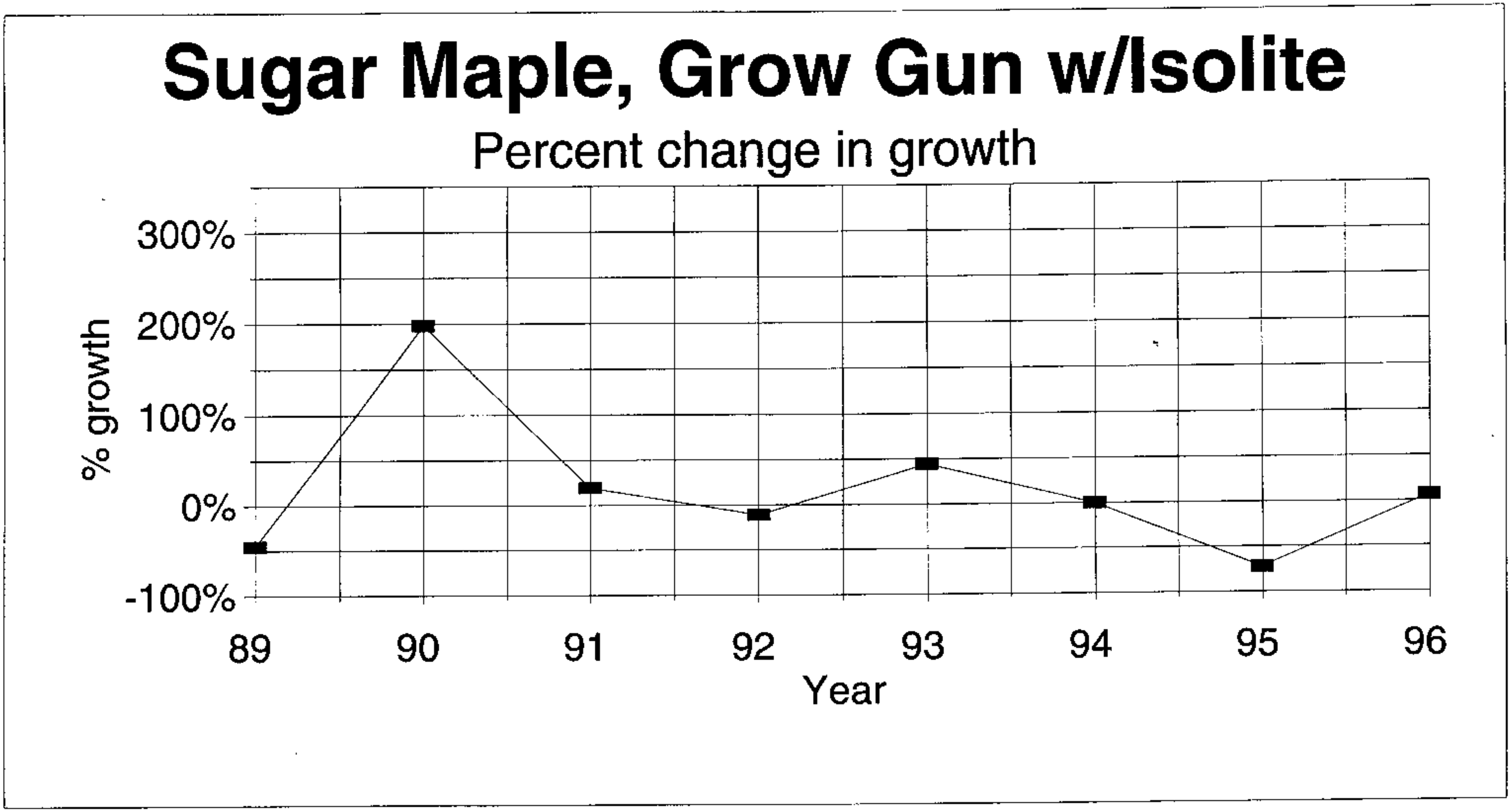


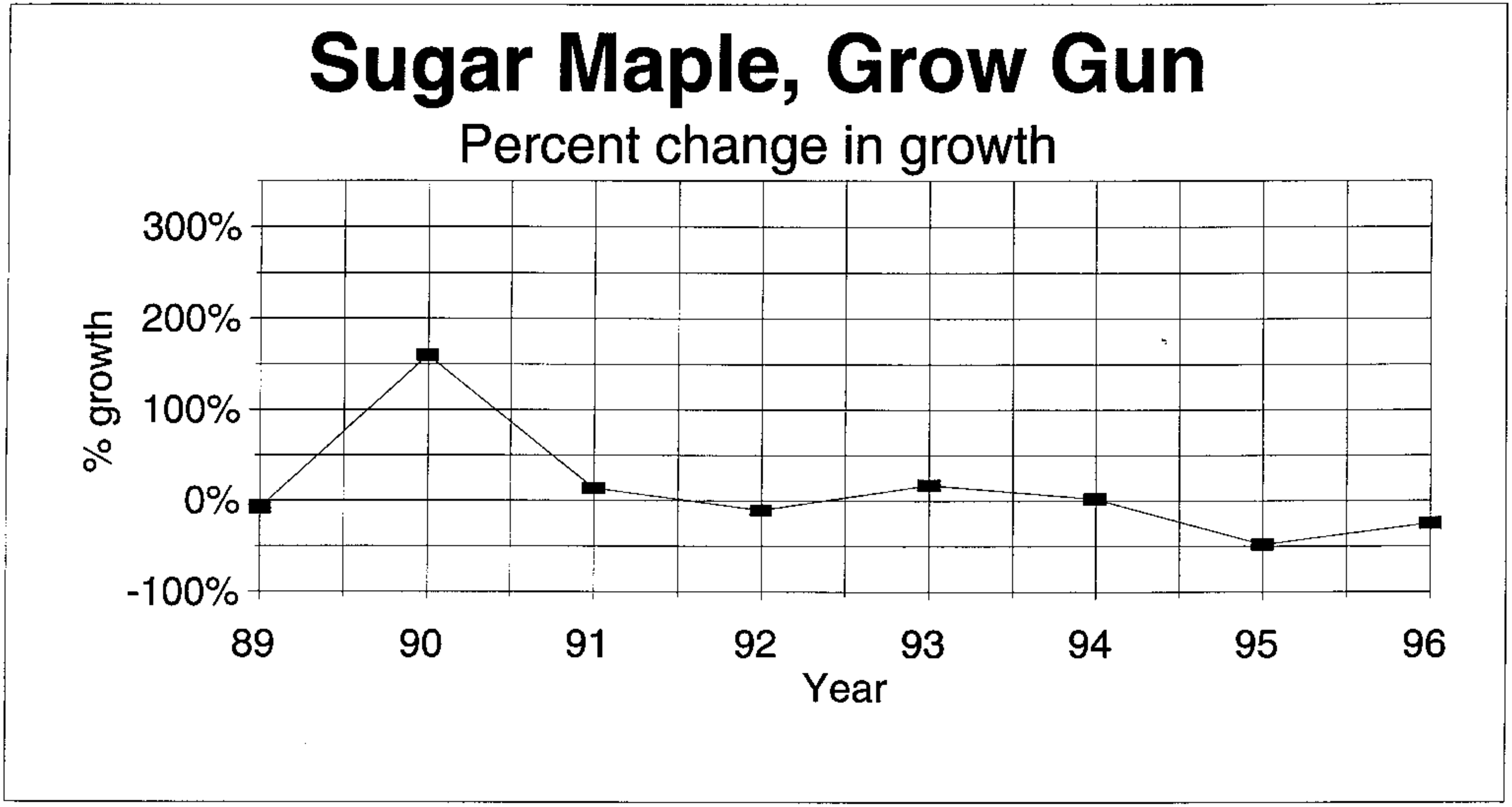

Sugar Maple, Vertical Aeration
Percent change in growth
300%
200%
100%
0%
-100%
% growth
89
90
91
92
93
94
95
96
Year

Sugar Maple, Vert. Aeration w/Isolite

Percent change in twig growth




Sugar Maple, Grow Gun w/Isolite
Percent change in growth
300%
200%
100%
0%
-100%
% growth
89
90
91
92
93
94
95
96
Year


Sugar Maple, Grow Gun
Percent change in growth
% growth
300%
200%
100%
0%
-100%
89
90
91
92
93
94
95
96
Year

PRECIPITATION (inches) LANSING, MICHIGAN

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1966	0.87	1.52	2.40	3.01	1.88	2.56	1.59	2.38	1.22	0.88	4.60	2.46	25.37
1967	2.18	1.41	1.16	3.81	1.05	6.77	1.15	2.90	2.53	3.45	2.27	3.45	32.13
1968	1.46	1.56	1.49	2.96	4.16	7.94	3.03	2.98	2.73	1.56	3.26	2.62	35.75
1969	1.91	0.22	1.06	4.02	4.47	4.03	4.89	0.17	1.67	2.74	2.32	0.53	28.03
1970	0.91	0.66	2.20	3.13	2.89	3.02	3.37	2.36	4.61	3.77	2.85	2.48	32.25
1971	0.68	2.40	2.33	1.50	1.93	5.13	4.82	2.50	5.25	2.29	1.61	4.24	34.68
1972	1.51	1.19	2.82	4.56	2.86	3.28	3.27	5.06	2.65	3.30	2.72	4.16	37.38
1973	1.17	1.44	3.59	2.22	3.78	3.62	2.04	1.77	2.81	2.07	4.22	3.09	31.82
1974	3.00	2.58	4.36	2.07	4.07	2.81	1.21	2.67	2.60	1.44	2.50	2.39	31.70
1975	2.77	2.08	2.43	4.76	2.96	2.93	2.47	9.81	1.65	0.95	3.43	3.32	39.56
1976	1.59	2.54	3.85	3.55	2.52	4.50	2.56	0.58	1.66	2.32	1.02	0.96	27.65
1977	0.95	0.66	2.65	2.53	0.62	3.50	2.00	1.60	4.46	1.20	2.17	2.30	24.64
1978	2.60	0.46	1.91	1.55	2.06	2.73	1.23	3.69	3.80	1.98	2.58	2.85	27.44
#1979	2.13	0.56	1.78	2.69	1.35	5.53	1.86	2.30	T	1.99	3.25	2.30	25.74
1980	0.70	0.99	1.94	2.41	1.84	3.20	3.56	4.76	3.22	2.02	0.90	3.06	28.60
1981	0.39	1.39	1.10	5.16	4.69	3.22	1.71	1.98	8.01	1.28	1.50	1.10	31.53
1982	1.55	0.55	2.98	1.07	2.52	3.00	3.00	1.99	3.51	0.43	4.21	3.54	28.35
1983	1.00	0.81	3.25	4.10	3.97	4.27	2.54	2.70	3.74	2.57	3.22	1.83	34.00
1984	0.49	0.89	2.54	3.02	4.05	0.32	2.64	3.16	2.69	3.09	2.54	3.79	29.22
1985	2.04	3.03	3.53	2.90	2.14	2.17	3.06	4.36	3.34	3.25	3.08	1.29	34.19
1986	0.89	2.62	1.56	1.96	1.97	10.21	1.69	2.88	8.34	2.66	1.21	1.13	37.12
1987	1.00	0.35	0.97	1.58	1.37	3.30	3.35	5.64	4.88	1.77	2.89	3.40	30.50
1988	1.53	1.10	1.52	3.95	0.63	0.20	2.56	5.08	5.97	3.35	4.26	1.26	31.41
1989	1.15	0.67	2.13	1.44	6.57	3.61	0.93	4.90	3.49	1.29	3.65	0.86	30.69
1990	1.55	2.65	1.40	2.36	3.43	2.50	3.61	2.40	4.00	5.58	5.40	2.79	37.67
1991	1.28	0.79	3.76	4.41	1.75	2.60	2.41	3.83	1.05	3.80	3.02	2.13	30.83
1992	1.38	1.36	2.68	4.64	2.09	2.07	6.43	2.79	3.21	2.18	3.88	2.16	34.87
1993	3.22	1.17	1.74	4.86	1.37	6.50	2.94	3.80	4.80	2.99	1.39	0.70	35.48
1994	1.87	1.10	1.95	3.60	1.12	5.54	3.90	5.30	2.99	2.63	3.87	1.55	35.42
1995	2.34	1.18	2.01	2.85	2.83	0.95	2.04	2.87	1.06	2.55	3.37	1.05	25.10
Record Mean	1.71	1.58	2.39	2.88	3.22	3.46	2.72	3.03	3.09	2.42	2.43	2.02	30.97

(!!) See Reference Notes on Page 6B

SUGAR MAPLE

The **VERTICAL AERATION / ISOLITE**, exhibited a significant INCREASE in Twig growth compared to the control and all other treatments, following a trend first expressed in 1995.

Also **RADIAL TRENCHING/ ISOLITE**, twig growth appears to be improving with time although not significant

This could indicate that the treatments require time to improve soil conditions and for root growth to take advantage of and grow into the surrounding improved soils. The improved growth and benefits to the crown may not at this time (3 years from treatment) be readily apparent.

It might be useful to look at the actual root development in the areas of treatment during the next year.

WHITE PINES

White pine growth data was not conclusive at this time as to which treatments if any had a **significant** impact on improving the growth of the trees. The variability of growth at different sites was difficult to address in this study.

However, if the change in growth calculated as the total growth increment for the four years after treatment minus the total twig growth for four years prior to treatement is calculated:

GG, RTI, and VAI had a **positive** influence compared to the control.
GGI and **VA** had a **negative** influence compared to the control.
RT had no apparent influence on twig growth compared to control.

This is a study conducted under "real" existing urban conditions. Therefore there is a fair amount of variation between treatment groups.

Acknowledgments

I would like to Thank the following people for their help and support on this demonstration study:

Gary Parrott, Manager of The MSU Grounds Maintenance Dept.

Cara Boucher, Michigan Dept. of Natural Resources, Forest Mgt. Div.

Dr. Frank Telewski, Assistant Professor, Dept. of Botany and Plant Biology and Curator of W.J. Beal Botanical Garden, MSU

Dr. James Kielbaso, Professor of Forestry, MSU.

Richard E.Close, Forestry Graduate Student, MSU.

Daniel Kurkowski, Forestry Graduate Student, MSU.

Joseph Sulak, Forestry Graduate Student, MSU.

All the **Tree Crew** and **Staff** at Michigan State University's Grounds Maintenance Dept. who helped during this project.