FOURTEEN YEAR GROWTH RESPONSE OF SLASH PINE PLANTATIONS TO COMPETING VEGETATION CONTROL

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INTRODUCTION

This paper presents the 14 year results of the Slash Pine Competing Vegetation Study. The study was installed in 1976. Paired permanent plots were established in 36 existing 9 to 15 year old site-prepared slash pine plantations in the flatwoods of Georgia and North Florida. Thirty-two of the 36 pairs were in the 9 to 11 year age range. To be eligible for inclusion in this study, the plantations must have contained a considerable amount of competing vegetation and at least 400 well-distributed trees per acre.

The description and design of the study may be found in PMRC Technical Report 1998-2, "Ten Year Response of Slash Pine Plantations to Competing Vegetation Control," by Oppenheimer, Shiver and Rheney. Oppenheimer later discovered that it is informative to group the sites into eight modified CRIFF (MCRIFF) soil groups. The procedure used to group the sites into MCRIFF soil groups is described in PMRC Technical Report 1989-3, "Effect of Site Factors on Growth Response of 9 to 15 year-old Slash Pine Plantations Following Understory Vegetation Removal," by Oppenheimer, Shiver and Rheney.

At the time of the 1990 remeasurement, eleven of the installations were lost due to various reasons. The 14 year responses are based on the remaining 25 installations. The stand age on some of the study sites is approaching 30 years. Therefore, it is likely that the number of available installations will continute to decrease in subsequent years.

ANALYSIS

The response variables analyzed in this study include:

* Height growth (feet per tree)
* Basal area growth (square feet per tree)
* Total outside bark volume growth (cubic feet per tree)
* Merchantable inside bark volume to a 4 inch top (cubic feet per tree)
* Total volume per acre growth (cubic feet)
* Merchantable inside bark volume growth per acre (cubic feet)
* Mortality (percent of the 1976 trees which died)

The tree growth variables were adjusted by a simple linear regression procedure. Parameters were estimated in a model of the form:

$$Y_{i,j,k,l} = \alpha_{i,j,k,l} + \beta_{i,j,k,l} X_{i,j,k,l}$$

* i = Index of the independent tree growth variable (see list above)
* j = 1, 2 . . . N represents the installation
* k = 1, 2 represents control or treated plots
* l = 1, 2, . . .T index of the trees within the plot.

Thus, $Y_{i,j,k,l}$ represents the response in dependent variable *i* at installation *j*, with treatment *k* on tree *l*. The independent variable, X, is the pre-treatment or 1976 value for the variable. Simple linear regression coefficients were estimated separately for trees in the control plot and the treated plot. These equations were used to adjust the tree growth response to the mean pretreatment (1976) value for the installation. That is, the tree response variables were adjusted by covariance to the grand mean of the control and treated plots at each installation. These adjusted values were used for all subsequent analyses. Total volume growth and merchantable volume growth were calculated for each tree and an average total volume and merchantable volume per tree were calculated for each plot. These figures were transformed to per plot values by multiplication by the number of trees per plot. The per acre estimates were obtained by dividing the plot estimates by the plot size expressed in fraction of an acre. An analogous procedure was used to calculate total volume per acre. Mortality was the percentage of the pretreatment (1976) trees which died in each remeasurement period. Since the 2, 4, 6, 8, and 10 year results were presented in Technical Report 1989-3 and the 12 year results were reported in Technical Report 1991-1, this report will deal primarily with the 1990 or 14 year results.

As seen in Table 1, an analysis of variance for the 1990 data revealed that the treatment effect continues to be significant for all variables except mortality. Treatment had a significant effect on mortality after 10 years, but no significant effect is noted after 12 or 14 years. Apparently, the removal of competing vegetation resulted in increased mortality during the first 10 years after treatment. In the subsequent 4 years, mortality increased on the control plot to the extent that by age 12 there was no significant mortality effect for treatment. As shown in Table 2, after 14 years, mortality averages 17% for the control plots and 18% for the treated plots, a difference of only 1%. After 10 years, the difference was 2.6%.

Table 2. Least Square Adjusted Mean Mortality by Treatment for the 10, 12 and 14 Years Growth Periods.
(10 and 12 year means based on 32 installations, 14 year means based on 25 installations.

	PERCENT MORTALITY		
Growth Period(years)	Control %	Treated %	Difference %
10	10.3	12.9	2.6
12	13.4	15.3	1.9
14	17.1	18.2	1.1

Drainage Class' did not have a significant effect on total volume per acre, merchantable volume per acre or mortality. We conclude from this analysis that there is so much variation among plots in a drainage class that drainage class is of limited utility as a source of variation in this model.

'Drainage Classes used in this study are:
VP: Very poorly and poorly drained
WD: Well drained
SP: Somehwat poorly and moderately well drained
ED: Somewhat excessive and excessive drained

Table 1

F Statistics for Adjusted Response Variables

25 Installations, 14 Year Growth

	Drain Class	Plot(Drain)	Treatment	Treat*Drain
	D	P(D)	T	T X D
Height Growth/Tree	2.1	34.8**	20.2**	2.6*
Basal Area Growth/Tree	3.5*	9.2**	17.0**	0.8
Total Volume Growth/Tree	4.5**	13.8**	17.6**	0.7
Merch Volume Growth/Tree	4.7**	26.2**	19.4**	0.4
Total Volume Growth/Acre	1.4	7.2**	3.1*	0.7
Merch Volume Growth/Acre	1.8	8.3*	49 . **	0.7
Percent Mortality	0.8	4.2**	02 .	01 .

** significant at 5%
* significant at 10%

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The most important response variable in this study is merchantable volume per acre. Undoubtedly, the primary purpose of growing trees is to generate cash flow, and cash flow is a function of merchantable volume per acre. As seen in Table 3 and Figure 1, the increase in merchantable volume resulting from removing competing vegetation continues to increase with time.

Table 3. Average Merchantable Volume (cubic feet), by Growth Period for the Control and Treated Plots.
(25 installations)

	YEAR							
TREATMENT	**76**	**78**	**80**	**82**	**84**	**86**	**88**	**90**
CONTROL	450	706	980	1,346	1,653	1,966	2,271	2,553
TREATED	450	724	1,057	1,475	1,827	2,157	2,472	2,787
INCREASE	0	18	77	129	174	191	201	234

The finding that the average treatment effect is increasing after 14 years is interesting, but an analysis by MCRIFF soil group is more revealing. Two of the MCRIFF groups exhibit a negative response to the removal of understory competition. Consider MCRIFF groups 3 and 5. Both are in CRIFF soil group B. Fourteen years after treatment the per acre merchantable yield for the treated plots on MCRIFF group 3 was 10.1% below that of the control plots. MCRIFF soil group 5 shows the treated plots having a 5% increase in merchantable volume (Figures 2,3).

The plots in MCRIFF groups **8** and 9 exhibit a similar response. By controlling understory vegetation on MCRIFF group 9, the merchantable volume per acre increased by 1,107 cubic feet ... a dramatic 43%. This is an average annual increase in growth of almost one cord per year. But MCRIFF group 8 showed a negative response of 7.9%. Recall that MCRIFF groups 8 and 9 are both in CRIFF group 9. The major apparent difference is depth to spodic. The plots responding negatively (group 8) have a spodic < 20 inches, while the plots responsing positively (group 9) have a spodic > 20 inches.

If soils in MCRIFF groups 3 and 8 can be identified, control of understory competition is not recommended for these soil groups. The treatment response becomes more significant on an overall basis. As seen in Table 4 and Figure 4, when the negative responding soil groups are not included in the analysis the control of competing vegetation increased the yield by 410 cubic feet after 14 years.

Table 4. Average Merchantable Volume (cubic feet) by Growth Period for the Control and Treated Plots, MCRIFF Groups 3 and 8 are excluded.
(18 installations)

	YEAR							
	76	78	80	82	84	86	88	90
TREATMENT	369	574	807	1133	1397	1690	1965	2254
CONTROL	369	612	941	1350	1704	2042	2359	2665
INCREASE	0	39	135	217	307	352	394	410

If a factor of 83 is used to convert the increase in growth to cords, the result is 4.9 cords or about .35 cords per acre per year. While the increase in merchantable

volume is impressive on the sites responding positively, it pales in comparison to the increase observed on sites identified as MCRIFF group 9. The increase in growth resulting from control of competing understory vegetation on this soil group was 1107 cubic feet or about .95 cords per acre per year (see Table 5). While there were only three installations in this soil group, the enhanced growth on each of the three installations was 1008, 1431 and 886 cubic feet respectively.

RESULTS

Analysis of the data indicate that control of competing vegetation when trees are 9- 15 years of age will produce a significant increase in volume growth. For reasons not well understood, the increased growth is not evident at all installations. Control of competing vegetation apparently does not increase merchantable volume growth on MCRIFF groups 3 and 8. Given this fact, it would be unwise to expend funds which would earn a negative rate of return. If soil groups 3 and 8 are excluded from computation, the average increase in merchantable volume after 14 years is 410 cubic feet or approximately 4.9 cords. The present value of this increase om merchantable volume is $7 1, assuming a 4% discount rate and a $25 stumpage rate. There is some doubt that mid-rotation understory competition can be controlled at a cost of $71 per acre (Table 5). The present value of the benefits, however, exceed the cost for MCRIFF group 9. With a discount rate of 4% and a $25 stumpage rate the present value of the treatment for MCRIFF group 9 is $192, making the investment attractive.

What we have attempted to do is present you with alternatives. Ultimately, you must choose the optimum alternative for your firm. We hope to have helped by identifying soil groups on which the control of competiting vegetation is most beneficial.

CONCLUSIONS

On average, controlling understory competition at mid-rotation increases merchantable volume growth. Increased merchantable volume growth does not, however, occur on all sites. For reasons not well understood, control of competing understory vegetation reduces merchantable volume growth on MCRIFF soil groups 3 and 8. The pattern of response appears to be discemable early on. The relative position of each of the soil groups is identifiable 4 years after treatment. Results show that the increased growth on all soil groups, except MCRIFF groups 3 and 8, will persist for at least 14 years. The increase in growth as a result of controlling understory vegetation is most dramatic on MCRIFF group 9, .95 cords per acre per year, and is uniform for each of the 3 installations in this group.

It is recommended that the PMRC consider installing additional plots in MCRIFF groups 8 and 9 to validate the preliminary results found in this work.

FIGURE 1

Average Merchantable Volume

All MCRIFF Groups (25 Installations)

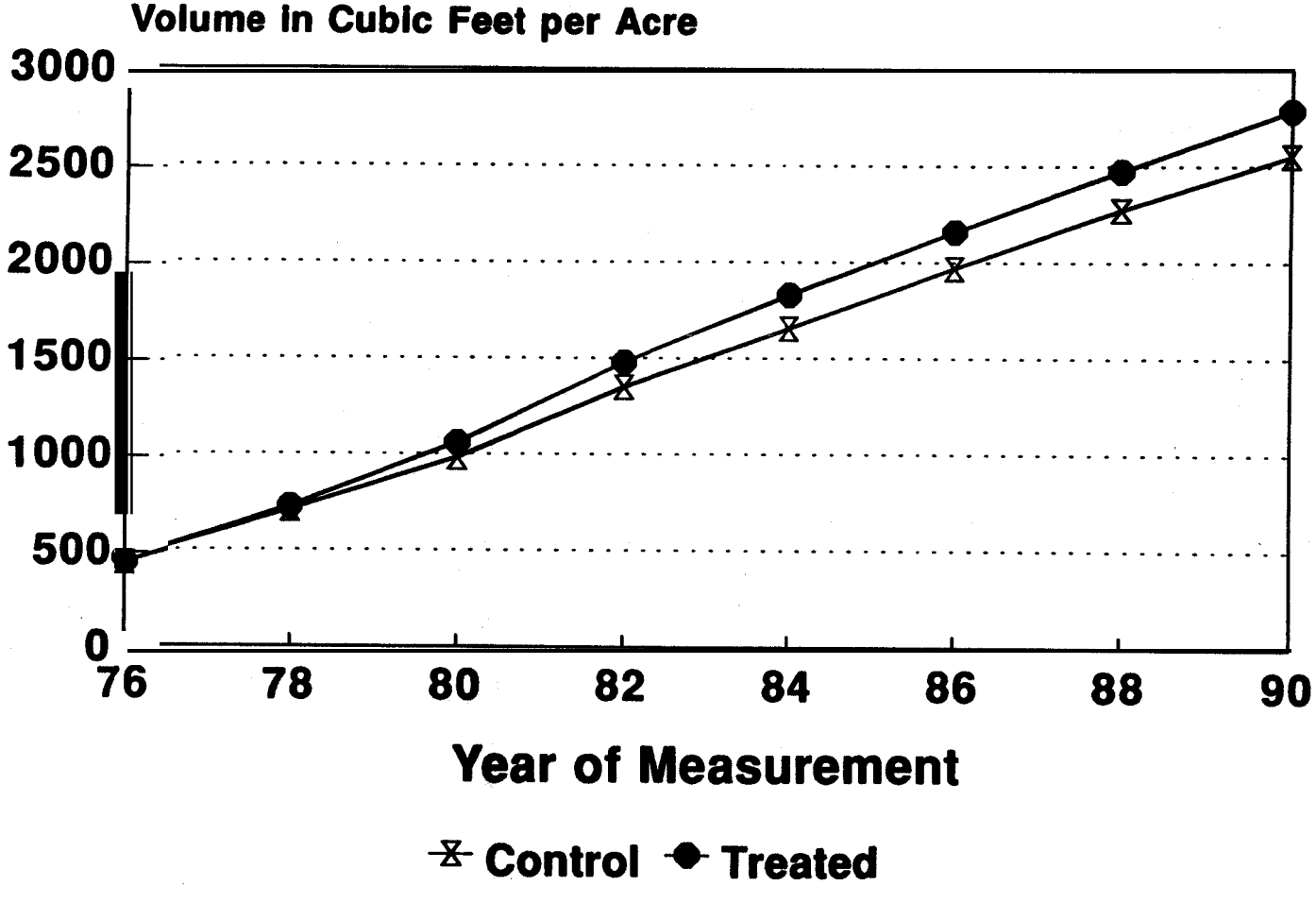

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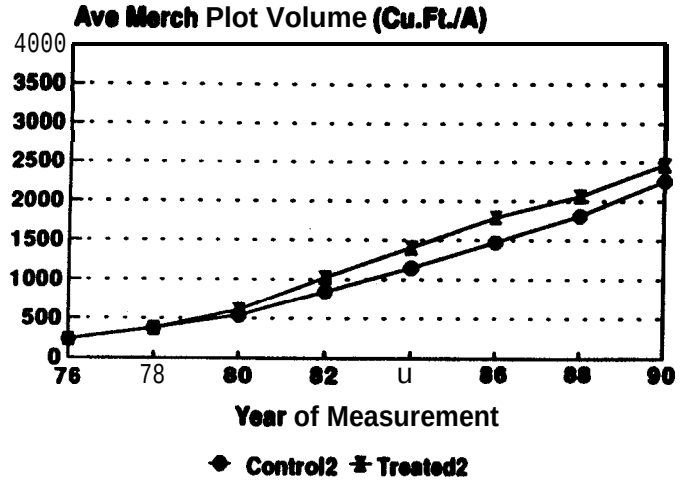
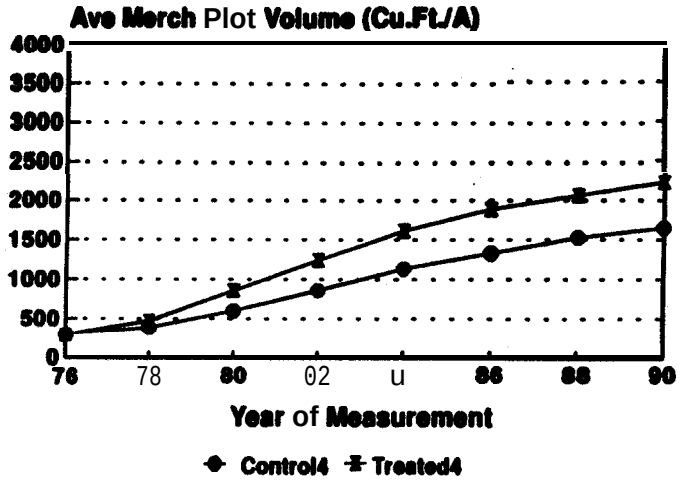
FIGURE 2

Mod CRIFF Soil Group 2 - CRIFF A



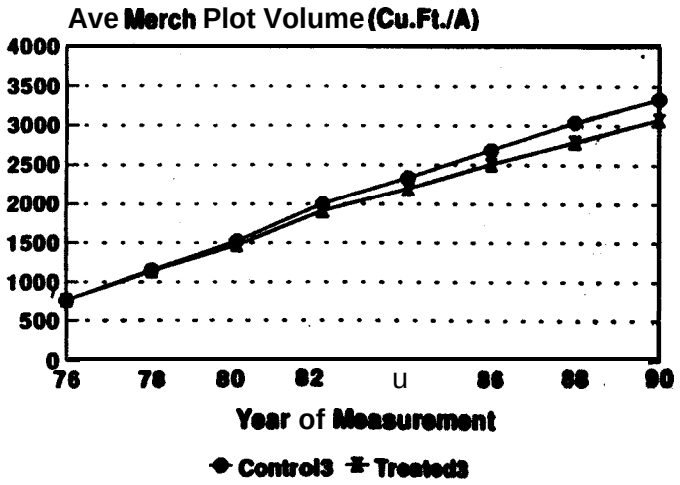
Argillic<20 Dminage VP P SP

Mod CRIFF Soil Group 4 - CRIFF F



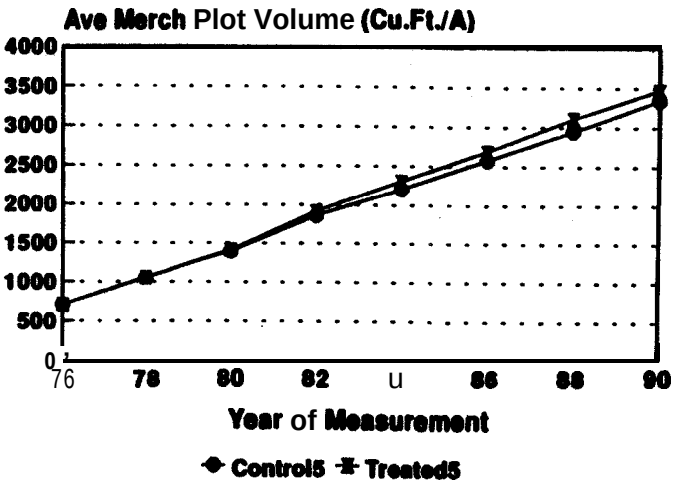
Argillic>20 Drainage MW W SE

Mod CRIFF Soil Group 3 (Part of) CRIFF B



Argillic>20 Dmlnage VP P SP

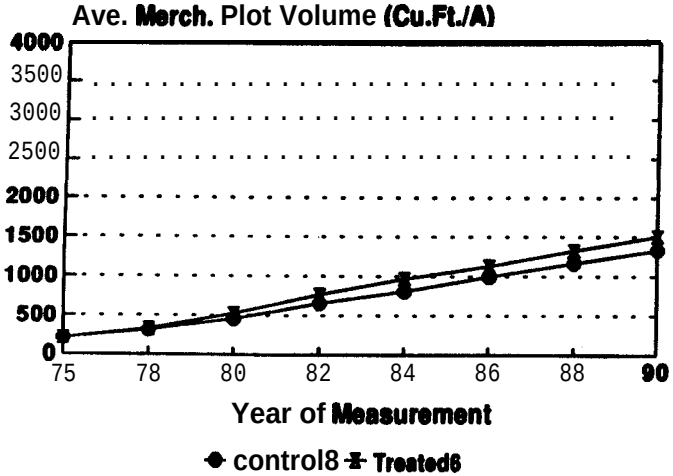
Mod CRIFF Soil Group 5 (Part of) CRIFF B



No Agillic Drainage VP P SP

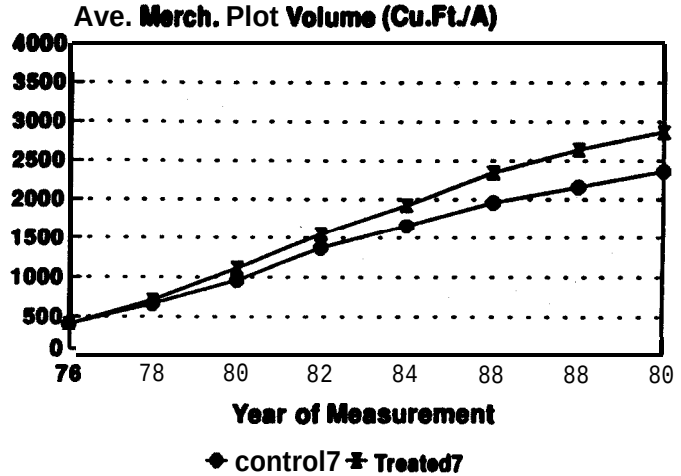
FIGURE 3

Mod CRIFF **Soil** Group 6 - CRIFF G



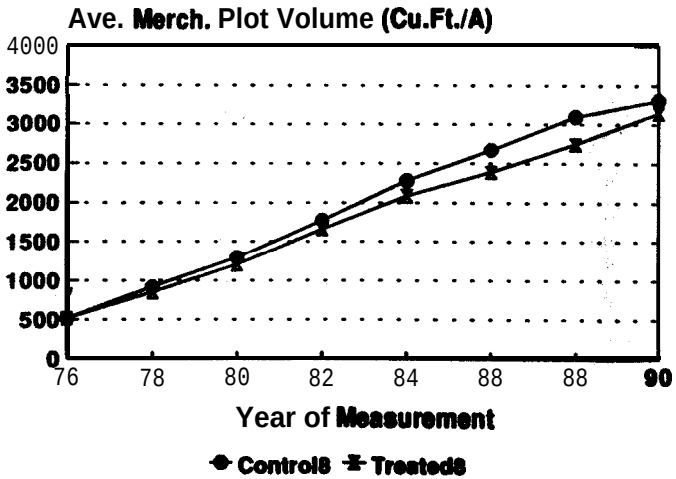
No Argiiiic **Drainage MW** W SE E

Mod CRIFF **Soil** Group 7 - CRIFF C



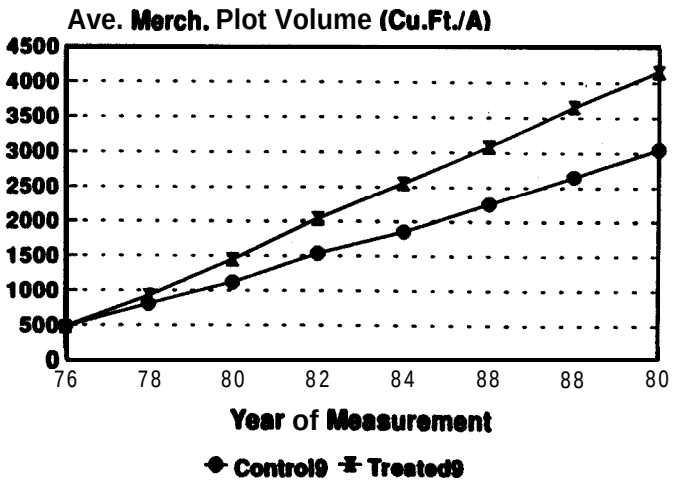
Argillic>20 Spodic<20 Drainage VP P SP

Mod CRIFF **Soil** Group 8 (Part of) CRIFF D



Spodic<20 Drainage VP P SP

Mod CRIFF **Soil** Group 9 (Part of) CRIFF D

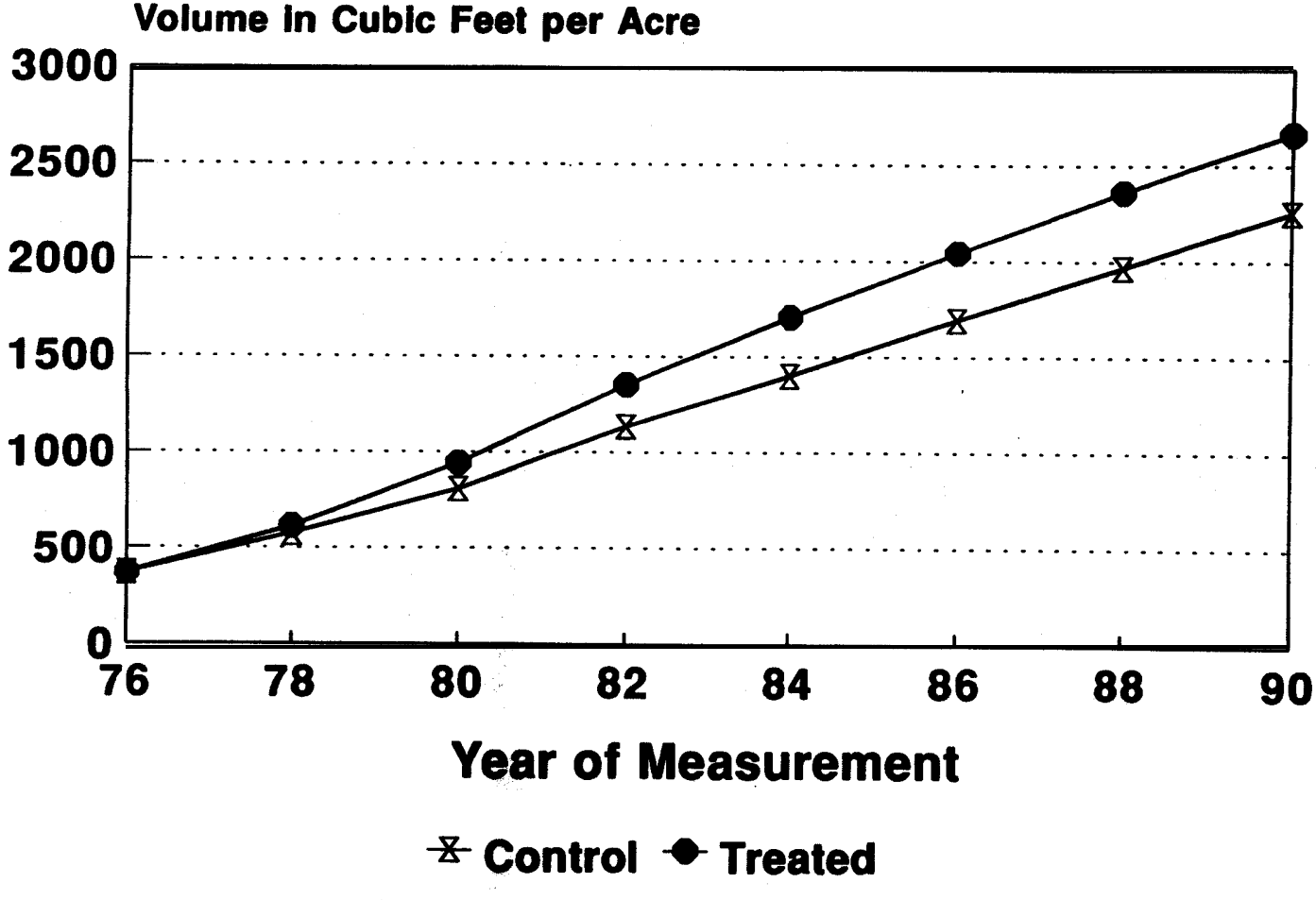


Spodic>20 Drainage VP P SP MW

FIGURE 4

Average Merchantable Volume

MCRIFF Groups 3 and 8 Excluded (18 Installations)



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