Theme:

IMPLEMENTING WATER REUSE

WATER REUSE SYMPOSIUM IV

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PROCEEDINGS

THE UNIQUE BENEFITS/PROBLEMS WHEN USING RECLAIMED WATER IN A COASTAL COMMUNITY

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In the early 1970's, because of rapid growth, the City of St. Petersburg faced both water supply and wastewater treatment capacity problems. At that same time, regulations were being adopted by the State of Florida requiring that effluent from wastewater treatment plants in the Tampa Bay area be treated to advanced levels (maximum 5 mg/L BOD; 5 mg/L SS; 3 mg/L total N; 1 mg/L total P) prior to discharging to surface waters or the discharge must cease. Also, impending regional water supply problems were requiring the City to investigate methods to reduce the potable water demand.

In order to resolve St. Petersburg's water-related problems, the City chose to expand and upgrade the wastewater treatment plants. Nutrients would not be removed and discharging to surface waters would cease. The highly-treated effluent would be utilized to provide irrigation water to large commercial and recreational land tracts throughout the City by means of a secondary or "reclaimed water" piping network. Deep injection wells would be constructed whereby effluent could be pumped into a saltwater aquifer when the demand for reclaimed water fell below the plant discharge rate.

Between 1976 and the present time, three plants have been upgraded, expanded and connected to the reclaimed water system. Improvements to the fourth and final plant are scheduled for completion by early Fall 1987. After that date, none of the city's four wastewater treatment plants will be discharging to surface waters.

As indicated in Table 1, since the previous review of St. Petersburg's reclaimed water program at Water Reuse Symposium III in 1984, there has been a dramatic increase in the use of reclaimed water and especially the number of residential users.

In 1981, only 18.7% of the total number of customers were residential users, accounting for less than 0.5% of the total acreage under irrigation.

Today, residential customers represent 96.1% of the total number of users, accounting for over 33% of the total acreage under irrigation.

Thus, over the past three years, the program has changed from a non-residential, commercial-oriented system to one which must now recognize and respect the needs of the smaller residential homeowner.

During this same period, climatic conditions in the St. Petersburg area were somewhat abnormal. The area experienced a severe drought during the Spring of 1985; severe freezes occurred in December 1983 and February 1985; and a hurricane brushed coastal St. Petersburg in September 1985. These factors contributed to the death of many delicate plant species and seriously damaged many others in the area.

In 1985, the City experienced a significant increase in the number of complaints from homeowners regarding damage to ornamental plants and trees. Many of those complaints claimed that the damage was directly caused by the use of reclaimed irrigation water.

The complaints were received by the St. Petersburg Environmental Laboratory. In turn, many were referred to the Pinellas County Cooperative Extension Service as there was a lack of horticultural expertise within the Department of Public Utilities.

Subsequent consultations between the Reclaimed Water Section of Public Utilities and the Pinellas County Extension agent eventually resulted in the City's employment of an horticulturist with extensive research experience to investigate complaints. The City realized it was also an opportune time to conduct a thorough investigation of the affects of reclaimed water on a variety of ornamental plants and trees.

Thus, in early 1986, Project Greenleaf was initiated.

RECLAIMED WATER QUALITY

A major concern in recycling treated wastewater has been the possible public health problems which may arise from the use of reclaimed water in public access areas. The levels of bacteria, viruses and other disease-causing organisms in the treated effluent have been the prime focus of attention for researchers in this rapidly developing new technology. (1) Increasing efficacy of filtration techniques and disinfection practices have, hopefully, reduced these health risks to minimum levels. It is now time to turn our attentions to an analysis of the added benefits derived by the use of this newly developed resource for the irrigation of residential landscaping.

All wastewater treatment plant influents contain high concentrations of dissolved organic and inorganic substances. Advanced wastewater treatment processes remove most of the organic material, but the resultant reclaimed water has a much higher concentration of dissolved chemical substances than potable water. Most of these chemicals are beneficial and can be directly assimilated by plants so that reclaimed water can be regarded as a dilute fertilizer.

Although considerable research has been carried out on the use of reclaimed water on agricultural and fodder crops (2), especially in the California area, little emphasis has been placed on the possible benefits to be derived from the use of this resource on ornamental landscape plants and annuals. (3)

The chemical composition of the effluent is obviously of major importance to vegetative growth and maturation. (4) Table 2 shows the mean composition of the effluent produced by each of the three treatment plants that supply the distribution system in St. Petersburg.

Regular treatment plant records for BOD, nitrogen, phosphorus, chloride and other parameters have been included since July 1986 when vegetative growth experiments began. Records of the concentrations of the various other elements shown in Table 3 have been compiled from intermittant evaluations taken over the past four years.

The effluents from the three treatment plants are remarkably similar in composition with the exception of the Southwest Plant, #4. The plant consistently produces an effluent with lower sodium and chloride levels than the other two. High concentrations of iron at this plant are due to the use of ferrous sulfate for odor reduction. The Northeast Plant, #2, produces an effluent with consistently low total nitrogen levels and the Northwest Plant's, #3, effluent components show the greatest monthly fluctuation in concentration levels, especially chlorides and total nitrogen.

There is very little mixing of the effluents within the distribution system so that different residential areas of the City will be influenced by the treatment plant closest to them as far as the composition of the irrigation water is concerned.

GREENPLANT GROWTH STUDIES

To assess the impact of reclaimed water on plant growth and maturation, a total of ten experimental plots were prepared. Eight of these were located at the City nursery which is served by the "low chloride" effluent of the Southwest Plant, #4, and the remaining two were positioned in the grounds of the "high chloride" Northwest Plant, #3. Twelve replicates of each of ten species of plants were used in each experimental plot. As shown in Table 4, both drip and overhead irrigation systems were compared, and potable water plots were set-up as controls. Four plots at the nursery were located inside the greenhouse where exact quantities of irrigation water could be applied. The open air plots received equal quantities of experimental irrigant water. The extra rainfall amounts were continuously monitored.

Initially, there were no significant differences ($p > 0.05$) between the sizes of plants of similar species. All plants were grown in 3 gallon plastic pots containing identical potting soil. Equal amounts of fertilizer were added to each pot at the beginning of the experiment.

Individual plant growth and damage assessments were made monthly, and compared with the control plots, irrigated with potable water. Analyses of variance and multiple range tests were used to distinguish between the Null hypothesis and significant growth differences at the 95% level of confidence.

After one year of study, the results for some species are highly encouraging.

Hibiscus (Hibiscus rosa-sinensis), continues to grow all year round in direct correlation with the mean temperature. In open air conditions, when "low chloride" reclaimed water is applied by a drip system, there is a highly significant 2.6 fold increase in the growth of the Hibiscus plants when compared with the controls. There is also a significant 2.5 fold growth increase when "low chloride" reclaimed water is applied as an overhead spray. There is no significant difference in plant growth between overhead and drip irrigation methods using potable water (Figure 1).

Inside the greenhouse where temperatures average 12°F higher than outside, there is a highly significant 2.5 fold growth increase with drip and a significant 2.2 fold increase with overhead irrigation when reclaimed water is compared with potable water. Once again, there is little difference in growth between overhead and drip irrigation using potable water. (Figure 2)

There are also significant differences in growth between "low chloride" and "high chloride" effluents in both drip and overhead spray treatments. In the "high chloride" plots, plant growth was approximately 40% less than in the "low chloride" plots in both irrigation treatments. (Figure 3)

Differences between "high chloride" plots and potable water plots were just significant for drip irrigation with a 1.6 fold increase in growth, but were insignificant for overhead spray treatments where there was only a 1.4 fold increase in growth. (Figure 4)

To sum up, (Figure 4), the Hibiscus grows significantly faster when irrigated with "low chloride" reclaimed water either by drip or overhead spray methods than it does when irrigated with potable water.

As the sodium and chloride levels increase in the irrigation water, growth is significantly retarded without any visible external damage to the plant. This phenomenon has been observed for many plant species and many lists of "salt tolerant" plants have been produced (5,6).

Regardless of chloride levels, all Hibiscus plants irrigated with reclaimed water bore significantly more flowers and the leaves appears greener and healthier than plants grown with potable water. Provided damage is non-existent or minimal, reduction in growth rate is not necessarily a disadvantage in ornamental species and may, in fact, be an advantage in reducing the amount of trimming that is required.

Similar results for other plant species are now being evaluated and will soon be available. In some salt-sensitive species, there is significant plant damage or death when overhead sprays are used, but many of these species grow well in drip irrigation systems.

Samples of the soil from a representative series of the experimental containers are now being analyzed at the IFAS Soils Laboratory in Gainesville and data on any accumulation of elements will also soon be available.

Project Greenleaf is also conducting a survey of the growth rates of over 200 species of ornamental plants growing in sixty randomly selected residential gardens using reclaimed water throughout the City. Once again, these growth rates will be compared with those of similar species irrigated with potable water.

In addition, all customer complaints concerning reclaimed water and ornamental plants are investigated and very often alternative solutions to these problems are identified.

Soil studies are also in progress and a complete map of soil pH, chloride levels and total soluble salts will shortly be produced for the St. Petersburg area.

GOALS OF "PROJECT GREENLEAF"

The ultimate aim of this study is to produce a set of guidelines for the successful use of reclaimed water on ornamental plant species. It will establish acceptable nutrient levels for reclaimed water and list necessary management practices for more sensitive plant species. Suggestions for continuously monitoring the production of reclaimed water to maintain quality at wastewater treatment plants will be included, and both scientific articles and public information booklets will be produced.

It is now time to abandon the idea of reclaimed water as an "ugly duckling" to be disposed of as a waste product of civilization. It should be acclaimed as the "swan" of tomorrow and recognized as a manufactured, marketable product which should, if properly managed, have a consistency of quality and quantity in order to maintain its credibility.

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TABLE 1. ST. PETERSBURG RECLAIMED WATER SYSTEM
GROWTH FROM 1981 THRU JULY 1987

CUSTOMERS	1981	1982	1983	1984	1985	1986	1987
PARKS	39	39	44	44	50	50	50
SCHOOLS	36	36	36	36	39	39	39
COMMERCIAL	38	38	54	55	86	93	105
GOLF COURSES	6	6	6	6	6	6	6
INDUSTRIAL	0	0	0	1	1	1	1
TOTAL NON RESIDENTIAL	100	119	140	142	182	189	201
RESIDENTIAL HOMEOWNERS	23	307	666	1242	3157	4595	4913
TOTAL CUSTOMERS	123	426	806	1384	3339	4784	5114
TOTAL ACREAGE	1791	2092	2850	3050	3615	3986	4526
RESIDENTIAL ACREAGE (%)	0.3	3.5	5.7	10.3	25.1	36.1	33.3

TABLE 2. Effluent Quality Data from the Three Treatment Plants Supplying St. Petersburg's Reclaimed Water Distribution System. (Means of monthly data from July 1986 to June 1987)

Parameter	Units	Northeast Plant #2	Northwest Plant #3	Southwest Plant #4
B.O.D.	mg/l	2.70	2.87	3.39
Susp. Solids	mg/l	2.42	2.26	2.58
pH	Units	7.35	7.53	7.41
Conductivity	Umhos/om	1342.00	1438.40	873.50
Tot.Sol.Salts	mg/l	939.40	1006.80	611.45
Alkalinity	mg/l	157.20	208.05	151.65
Kjel-Nitrogen	mg/l	3.70	11.32	12.97
NH3-Nitrogen	mg/l	1.53	8.10	9.51
NO2-Nitrogen	mg/l	0.13	1.16	1.24
NO3-Nitrogen	mg/l	2.66	0.65	0.47
Total Nitrogen	mg/l	6.49	13.13	14.68
Ortho-Phosphorus	mg/l	3.00	3.08	2.33
Total Phosphorus	mg/l	3.27	3.44	2.70
Chloride	mg/l	337.17	367.18	167.56
Sulfate	mg/l	47.73	48.42	44.80
Tot. Org.Carbon	mg/l	9.80	9.48	10.83

TABLE 3. Effluent Quality Data from the Three Treatment Plants Supplying St. Petersburg's Reclaimed Water Distribution System. (Means of discontinuous data from 1983 to 1987)

Parameter	Units	Northeast Plant #2	Northwest Plant #3	Southwest Plant #4
Aluminum	ug/l	200.00	200.00	352.00
Boron	ug/l	280.00	360.00	235.00
Calcium	mg/l	72.00	59.86	61.02
Chromium	ug/l	13.00	20.00	13.60
Copper	ug/l	11.00	3.60	6.33
Iron	ug/l	58.60	79.00	229.17
Lead	ug/l	64.00	<10	26.00
Magnesium	mg/l	22.50	14.80	12.35
Manganese	ug/l	17.60	16.80	22.33
Molybdenum	ug/l	<100	<100	50.00
Nickel	ug/l	12.00	<10	28.40
Potassium	mg/l	14.50	12.00	11.22
Silver	ug/l	---	<1	10.00
Sodium	mg/l	166.00	187.00	103.80
Strontium	ug/l	---	440.00	300.00
Zinc	ug/l	27.88	19.60	29.78

TABLE 4. LAYOUT OF 10 EXPERIMENTAL PLOTS FOR "PROJECTS GREENLEAF" PLANT GROWTH STUDY. JULY 1986 THRU AUGUST 1987

PLOT #	IRRIGANT WATER	SPRAY SYSTEM	OPEN AIR OF INSIDE GREENHOUSE	NURSERY OF NORTHWEST PLANT
1	Potable	Overhead	Open air	Nursery
2	Potable	Drip	Open air	Nursery
3	Potable	Overhead	In Greenhouse	Nursery
4	Potable	Drip	In Greenhouse	Nursery
5	Reclaimed	Overhead	Open air	Nursery
6	Reclaimed	Drip	Open air	Nursery
7	Reclaimed	Overhead	In Greenhouse	Nursery
8	Reclaimed	Drip	In Greenhouse	Nursery
9	Reclaimed	Overhead	Open air	Northwest Plant
10	Reclaimed	Drip	Open air	Northwest Plant

Figure 1.

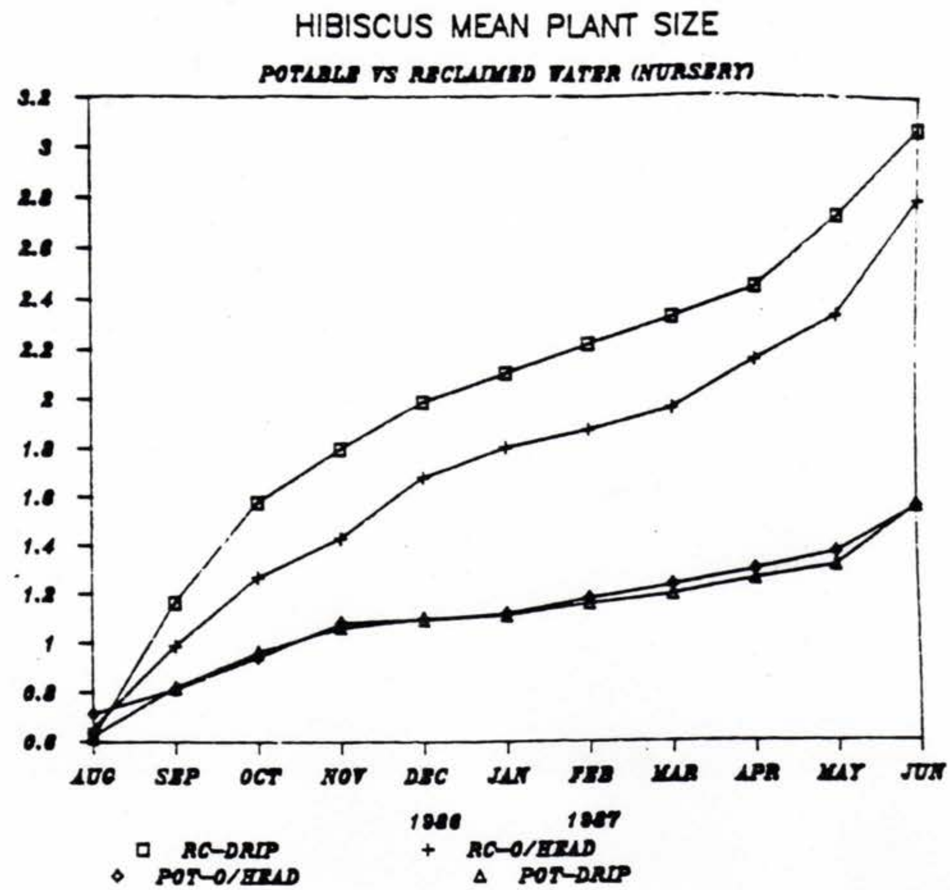


Figure 2.

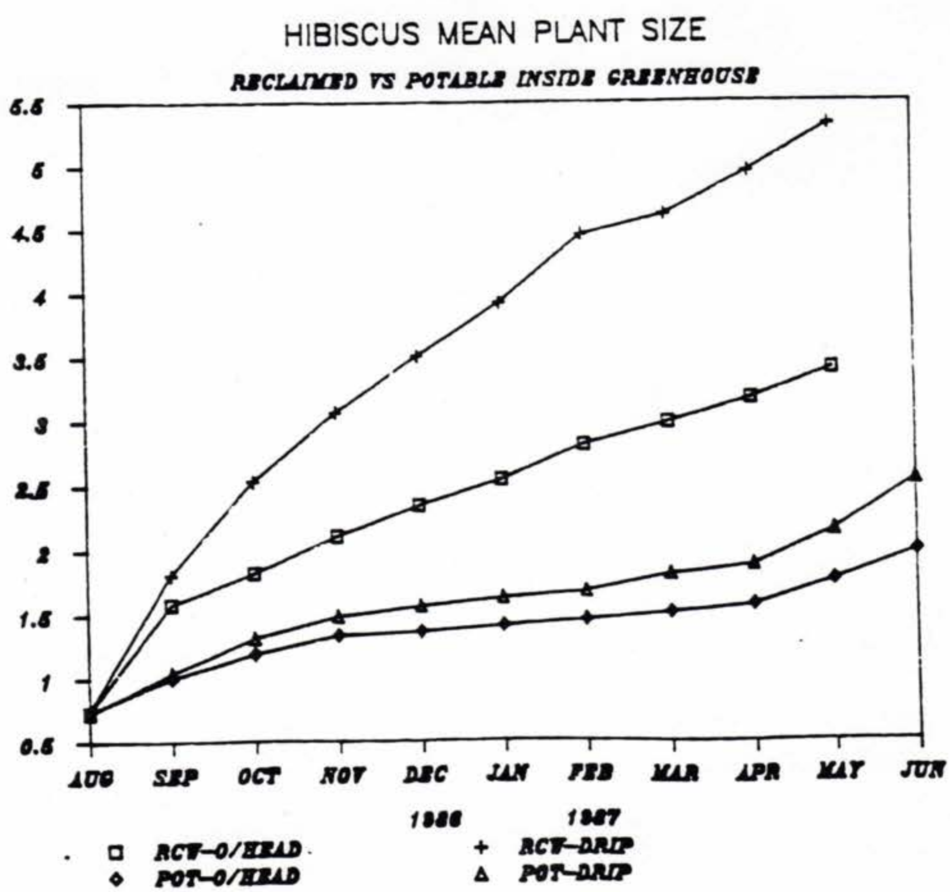


Figure 3.

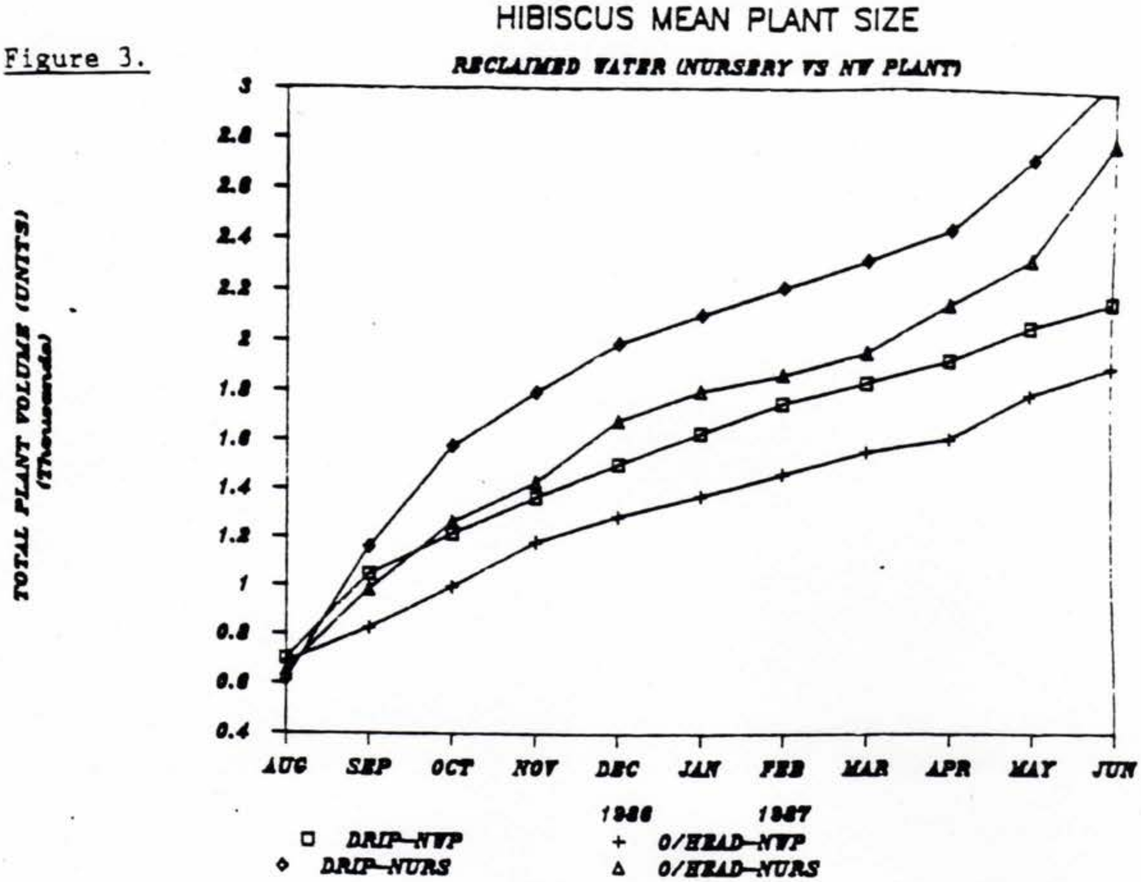


Figure 4.

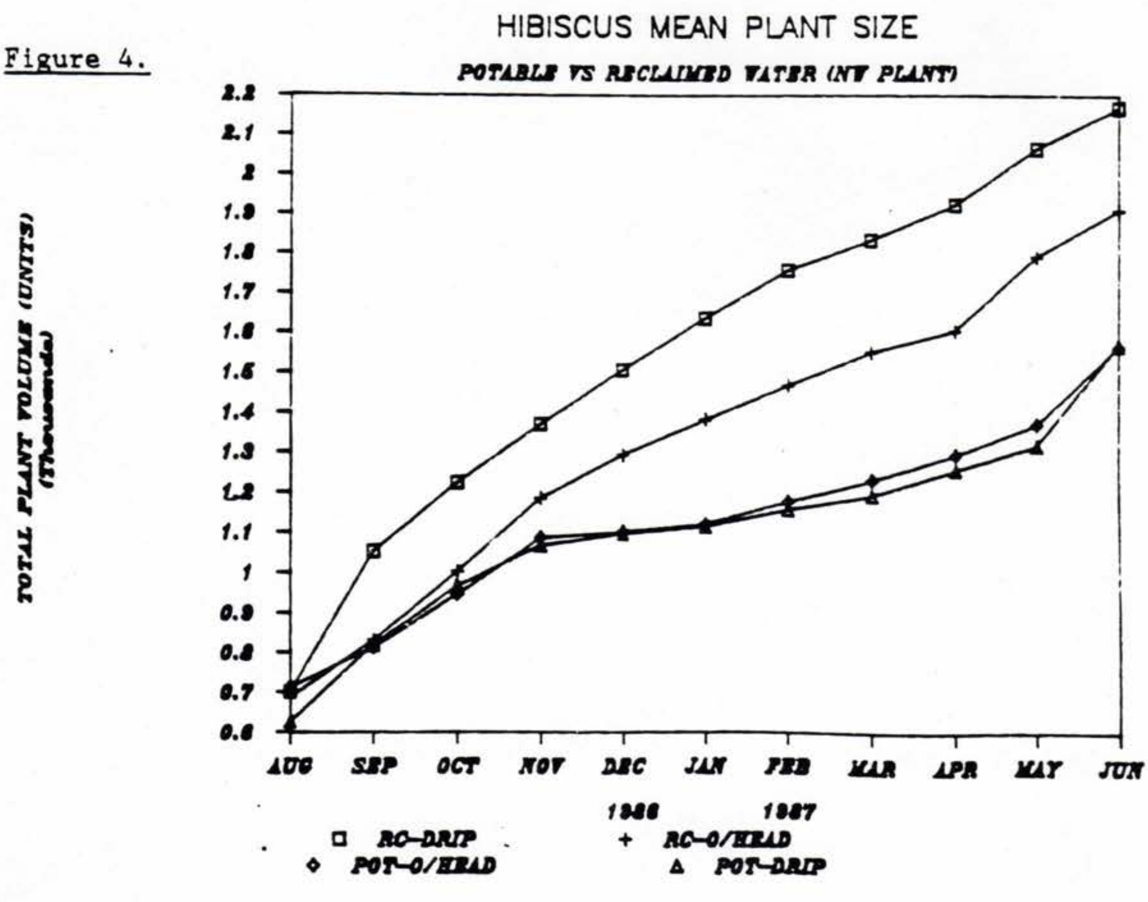
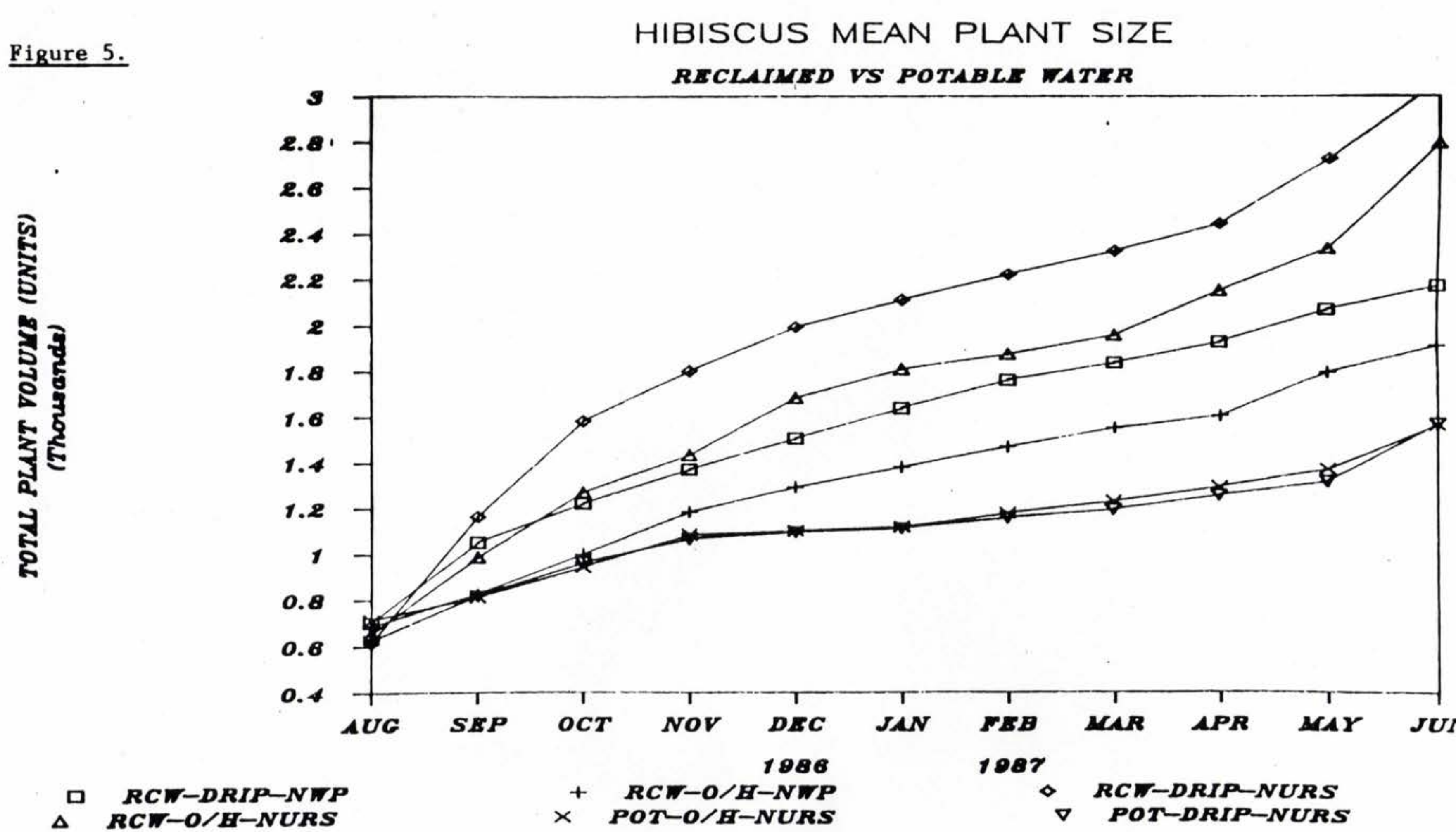


Figure 5.



HIBISCUS MEAN PLANT SIZE
RECLAIMED VS POTABLE WATER
TOTAL PLANT VOLUME (UNITS)
(Thousands)
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
1986
1987
RCW-DRIP-NWP
RCW-O/H-NURS
RCW-O/H-NWP
POT-O/H-NURS
RCW-DRIP-NURS
POT-DRIP-NURS