Reports of the Effects of the FRE-FLO™ Scale Prevention Equipment/Soil Amendment Tool In Agricultural Applications

Below are summaries, see the following pages for details.

WALNUTS - HAMMOND RANCH, FIREBAUGH, CA

The FRE-FLO™ treated crop of walnuts needed 25% less water to increase overall yield by 22% and large select grade by 68% compared to the control walnuts. The huge increase in the large select grade is important because **the large select grade largely determines the profit picture** for the grower's season.

WATERMELONS - SUNDANCE FARMS, COOLIDGE, AZ

Using FRE-FLO™ to treat irrigation water with moderately high concentrations of sodium and other minerals, the **sodium level was decreased by 56%** within the top 8" of soil during the growing of just one crop. The result was a **12% increase in yield** with an **increased annual gross income of $1,091 per acre.**

GRAPES - COLONY VINEYARD, SACRAMENTO COUNTY, CA

The FRE-FLO™ caused more water to enter the soil and there was less water standing under the grapevines. The **yield in the FRE-FLO™ area was 16% greater** than in the non-FRE-FLO™ area, even though less water was delivered to the FRE-FLO™ area during part of the growing season. **The grape sugar content was 7% greater, and the grapes had firmer, healthier skin**.

DRIP IRRIGATION – UC RIVERSIDE – CA

A researcher at the University of California, Riverside tested the impact of FRE-FLO™ on water delivery through drip irrigation systems. He found:

- Tubing using **FRE-FLO™ treated water containing fertilizer delivers 230% more water** per hour to the plants' root systems than the tubing without FRE-FLO™.
- There was **greater yield of the broccoli crop using FRE-FLO™.**

ROOT PROPAGATION TESTS - CALIFORNIA

A series of experiments on the rooting of various plants found the **plants irrigated with FRE-FLO™ conditioned water develop far faster with much healthier root systems** than those irrigated with normal water.

GREENHOUSE - MESA COMMUNITY COLLEGE – AZ

The Agriculture Department of Mesa Community College found the following differences using FRE-FLO™ in their greenhouse operation:

- **Increased growth of plants**.
- **Faster establishment and stronger root system**.
- Much **less salt accumulation on the leaves** of the cuttings.

RHODODENDRON NURSERY – OCCIDENTAL, CA

A rhododendron nursery had an unsightly calcium carbonate residue on their plants from the overhead sprinkler systems. **After installation of FRE-FLO™ they have dark green, shiny foliage. And they report it is simple and easy to maintain.**

Results of FRE-FLO™ project:
WALNUTS - HAMMOND RANCH, FIREBAUGH, CALIFORNIA

The Hammond Ranch is located in West Fresno County, California. In the fall of 1991, a FRE-FLO™ was installed and used for the fall irrigation on a 94 acre block of Payne walnuts. Directly north of the 94 acre block was a 91 acre block of Ashley walnuts. The two blocks are separated by a blacktop road and records indicate that both blocks were planted in 1981.

Whereas these blocks of walnuts are irrigated with gated pipe in the summer, the fall irrigation is accomplished with movable sprinklers. Irrigation for both blocks runs from north to south. During the 1992 season, 25% less water was used on the Payne block (the treated water block) than on the Ashley block (the control block).

TABLE 1 gives the total yield in lbs. per acre, as well as lbs. per acre of large select grade, and the "% large select grade yield" of the total yield for each variety. (Large select grade are the "in shell" walnuts which are 1-1/8" in diameter or greater and it is these walnuts which determine the profit picture for the grower's season.) **The size of the walnuts, it should be noted, is related to the availability of soil moisture throughout the growing season.** It is logical to deduce that any increase in "large select grade" nuts found in the FRE-FLO™ acreage, but not the untreated acreage, would be the result of beneficial aspects of the FRE-FLO™, as shown in the table below:

TABLE 1

	PAYNE WALNUTS with FRE-FLO™			ASHLEY WALNUTS without FRE-FLO™		
	1991	1992	Change	1991	1992	Change
Total Yield lbs/Acre	2974	3161	**+6%**	4160	3504	**–16%**
Large Select lbs/Acre	1517	1982	**+31%**	2267	1423	**–37%**
% Total Yield as Lg. Select	51.0	62.7	**+23%**	54.5	40.6	**–26%**

Note in TABLE 1 the 6% increase in yield in the Payne variety, while there was a 16% drop in the Ashley crop, a difference of 22%. It is important to draw attention to the fact that **statewide, the average yield in walnuts dropped about 20% that year.**

More important was that, on the FRE-FLO™ treated block of Payne walnuts, the increase in large select grade yield was a remarkable improvement of 465 lbs. per acre (31%). However, the Ashley walnuts (not having the benefit of FRE-FLO™ treated water), not only had a decrease in total yield, but a decrease of 844 lbs. per acre (37% loss) of the large select grade. Thus the difference was a **net increase of 68% in the highest quality and most profitable product.**

To account for the increases in total yield, as well the increased yield of large select for the Payne walnuts, there apparently was less moisture stress, as a result of FRE-FLO™, in the Payne block compared to the Ashley block which allowed the trees to produce such an increase.

Although detailed water analyses were not made in 1992, the irrigation district data states that the water quality was 600 to 800 ppm of TDS, rather poor quality water.

Results of FRE-FLO™ project at:
WATERMELONS - SUNDANCE FARMS, COOLIDGE, AZ

When Sundance Farms initiated a test of FRE-FLO™ on seedless watermelons, their operation consisted of 4,000 irrigated acres; approximately 2,000 acres were surface irrigated and the other 2,000 acres were drip irrigated. Principals Howard Wuertz (an owner) and Scott Tolfson (Managing Agronomist) managed the test and provided the data below on a portion of the drip irrigated crop.

A 6" FRE-FLO™ was installed on an existing valve manifold so that FRE-FLO™ conditioned water would be supplied to an 11 acre field designated C-Base Block #5. The adjacent fields, C-Base Blocks #3, #4 and #9, totaled 32 acres and were irrigated with unconditioned water. **All other factors were equal.** TABLE 1 is the analysis of the well water supplied to all 43 acres and TABLE 2 indicates the seedless watermelon yields of these various test blocks.

TABLE 1
Analysis of Well Water Supplies to C-Base Blocks #3, #4, #5 and #9

General properties of the water

ECw 2.4, pH 9.0, SAR adj. 37.8, Total of 2,844 lbs of salt applied per Acre/ft of water.
USDA Classification C4-S4.

Mineral Content

Mineral	ppm	Mineral	ppm	Mineral	ppm
Calcium	7.5	Carbonate	4.8	Sulfate	52.0
Magnesium	0.0	Bicarbonate	43.9	Nitrate	2.0
Sodium	396.0	Chloride	420.0	Boron	1.3

The USDA classification of C4-S4 indicates a **high** sodium and salinity hazard. Although crop irrigation is possible with this water, copious amounts of additional water (referred to as "the leaching fraction") must be used to leach the salts out of the root zone to assist crop production.

TABLE 2
Seedless Watermelon Yield
Sundance Farms' 1989 Spring Crop

Location	Tons/Acre	% Increase Over Control
Block C-5 (FRE-FLO™ Treated Water)	36.32	12%
Blocks C-3, 4 & 9 (Untreated Water)	32.45	----

The 12% yield increase with FRE-FLO™ represents a $12,000 increase in annual gross income for the 11 acres ($1,091 per acre) over the yield on the other 32 acres used as Control. Sundance Farms personnel reported that although they were looking for any differences in plant growth, tissue analysis and fruit analysis during the growing season, the only difference noted was the 12% increase in yield. Otherwise the produce was comparable.

When a post-harvest soil analysis was conducted on the top 8" of soil from each of the blocks, Sundance Farm personnel recorded the data as evidenced in TABLE 3 below.

TABLE 3
Post-Harvest Soil Analysis, Seedless Watermelons
Sundance Farms / October 1989

FRE-FLO™ Treated Water - Soil Source: Block C5 (Stated in ppm)

Na	Ca	Mg	K	Fe	Zn	Mn	Cu	S	NO_3	PO_4	ECs
565	7900	340	400	7.5	0.64	11	0.7	170	32.8	11	6.0

Control Area - Soil Source: Blocks C3, 4 & 9:

Na	Ca	Mg	K	Fe	Zn	Mn	Cu	S	NO_3	PO_4	ECs
1220	8000	430	550	8.1	0.57	13	1.1	220	32.1	10	7.3

Note that on the FRE-FLO™ block the **salt level was decreased by 54%** within the top 8" of soil! This dramatic improvement of conditions in the growing medium could partially explain the 12% increase in yield because the ready availability of water during fruit sizing is very important in the yield of fresh fruit.

The reduction of sodium in the upper level of the soil profile as just seen, means that the plants in the FRE-FLO™ treated water block could more readily extract water from that portion of the soil profile. **Removal of the salt concentration from the root zone allowed the fruit to absorb more water and thus produce a larger yield than usual in the same soil**. Also evident is the reduction of potassium – and it is logical to assume that this happened because as the fruit was being produced in the larger quantity, it was doing so by drawing off and utilizing the potassium present in the soil. The EC of the soil decreased as would be expected with the decrease of the sodium concentration.

Results of FRE-FLO™ project at:

GRAPES - COLONY VINEYARD, SACRAMENTO COUNTY

Summary

The FRE-FLO™ caused more water to enter the soil and there was less water standing under the grapevines. The **yield in the FRE-FLO™ area was 16% greater** than in the non-FRE-FLO™ area, even though less water was delivered to the FRE-FLO™ area during part of the growing season. **The grape sugar content was 7% greater, and the grapes had firmer, healthier skin**. In summary, FRE-FLO™ provides:

1. Capacity to use less water
2. Capacity to use less power
3. Better soil permeability
4. Better leaching of salts
5. Healthier plants
6. Less stress on plants
7. Increased yields
8. Better quality of crop

Study Methodology

A demonstration project using a FRE-FLO™ as an aid for more efficient water use in irrigated Pinot Noir grapes was conducted from the Spring of 2001 to the Spring of 2002 at the Colony Vineyard located in Sacramento County, California. The FRE-FLO™ was installed at the sub-main, which supplied the water for the seven acres of the most southerly irrigation set in the field. An adjacent seven-acre irrigation set where there was no FRE-FLO™ will be referred to as the no FRE-FLO™ control block.

The water from the well used for irrigation was analyzed for irrigation suitability. The analysis figures indicated the water would cause sodium to accumulate in the surface of the soil. The accumulated sodium would cause the soil to seal up over time and restrict the infiltration of the irrigation water.

Sites to monitor the soil moisture for the season were installed. A Nuclear Pacific neutron probe, DR 503 was used to measure the soil moisture. Soil moisture was measured at one-foot increments to a depth of five feet. Readings were taken once a week (sometimes twice a week) starting on March 31, 2001. The last reading was made on December 4, 2001. The E.C.e and soluble salts were higher in the one-foot level in the FRE-FLO™ area at the beginning of the test but decreased during the test. This decrease in salt content of the top layer of soil is expected from the ability of the FRE-FLO™ to keep ions in solution which allows the movement of water to move sodium and other ions deeper in the soil profile. The deeper the salt moves into the soil profile the less impact the salt will have on yield and quality. The E.C.e and soluble salts were the same at the one-foot level at the beginning and end of the test in the no FRE-FLO™ area. The no FRE-FLO™ water did not move the salts out of the top foot of soil.

On June 26, 2001 it was noticed that the drip emitters on the FRE-FLO™ block were delivering 26 drops per 64 seconds while the drip emitters on the no FRE-FLO™ block were delivering 40 drops

per 64 seconds. A spring had broken and was reducing the flow. It was repaired on June 27th, and the flow rate was checked and was found to be the same on both blocks.

That difference in drops per unit time indicated as much as 35 percent less water was delivered to the FRE-FLO™ block up to June 27th. However, there was no indication of moisture stress exhibited by the grapes at that point.

The FRE-FLO™ did seem to cause more water to enter the soil and there was less water standing under the grapevines. The ranch foreman commented several times that the amount of standing water was clearly less where the FRE-FLO™ was installed even after the flow rate was the same.

Resulting Yields

The hand harvested samples indicated the FRE-FLO™ treated area had a 16% higher yield than the no FRE-FLO™ test area:

Yield For FRE-FLO Treated Area in Tons per Acre	**6.31**
Yield For No FRE-FLO™ Control Area in Tons per Acre	**5.42**

The fruit in the FRE-FLO™ test area was different from the fruit in the no FRE-FLO™ control area. The grapes in the FRE-FLO™ test area were larger and the skin of the grape was firmer. The larger grapes meant bunches from the FRE-FLO™ test area weighed more even if the bunches had the same number of grapes. The larger grapes were probably the major cause of the difference in yield between the FRE-FLO™ test area and the no FRE-FLO™control area.

The firmer skin of the grapes from the FRE-FLO™ test area meant they did not break while being picked, while the skin of the grapes in the no FRE-FLO™ test area broke easily and often while they were being picked. The grapes from the FRE-FLO™ area certainly would have a better chance of producing a wine with the desired depth and richness of color.

Measurement of the percent sugar, commonly called brix, was made five different times. The dates of measurements and readings are given in the following table.

Date	FRE-FLO™	No FRE-FLO™
7/29/01	18.0	17.0
8/07/01	22.0	18.0
8/14/01	24.0	22.0
8/18/01	24.0	22.0
8/22/01	24.0	22.5

The data indicate a quicker formation of sugar in the FRE-FLO™ treated grapes. The grapes in the no FRE-FLO™ control area were slower in developing sugar and only reached a brix level of 22.5, 7% short of the desired brix level of 24.

The grapes from the FRE-FLO™ treated area had less disease than the grapes from the no FRE-FLO™ treated area. Less disease in the grapes also will contribute to a higher quality wine.

The firmer skin of the grapes has importance in the disease resistance of the grapes. It is known that, if more calcium is available to the plant, the cell walls have a greater integrity and are less prone to be infected by disease. The literature in plant nutrition also mentions that when more

calcium is available for plant uptake, then more potassium is available for uptake by the plant. The more potassium the plant has available, the more efficient the movement of photosynthate from the leaves to the fruit. This would help explain the larger grape berries observed in the FRE-FLO™ test area. It would also partially explain the higher brix readings seen in the FRE-FLO™ test area compared to the no FRE-FLO™ control area. In addition, grapes under less stress produce sugar faster than grapes under stress.

The basic premise of the action of water passing through the FRE-FLO™ unit is it keeps more ions in solution. The ability to keep calcium ions in solution is a reasonable explanation for the observed better quality grape skin of the grapes in the FRE-FLO™ test area.

This Colony Vineyard demonstration project was:

- Planned by C. David Lakeman, Edith R. James, and Allan L. James, Ph.D.
- Supervised by Edith R. James and Allan L. James, Ph.D.
- Funded by Sacramento Municipal Utility District (SMUD).
- Location graciously provided by Pacific Agrilands.
- Report written by Allan L. James, Ph.D.

Results of FRE-FLO™ project:

DRIP IRRIGATION - UNIVERSITY OF CALIFORNIA, RIVERSIDE, CA

Objective:
Test impact of FRE-FLO™ on water delivery through drip irrigation systems.

Study Design:
The approach was to compare the delivery of water with and without FRE-FLO™, using subterranean tubing on a crop of broccoli.

Results:
Delivery of water with medium duty tubing on Monday, March 22, 1982

Using FRE-FLO™ with a neutral fertilizer:	0.83 gallons per hour
Without FRE-FLO™ with low pH fertilizer:	0.25 gallons per hour
Without FRE-FLO™ with no fertilizer:	0.57 gallons per hour

Observations:
We noticed the tubing without FRE-FLO™ with low pH fertilizer seemed to have a sludge build-up at the end of the tubes, while there was no such buildup in the tubes using FRE-FLO™. We also observed a greater yield of the broccoli crop.

Conclusions:
The tubing using FRE-FLO™ treated water with a neutral fertilizer delivers **230% more water per hour** to the plants' root systems than the tubing without FRE-FLO™ and a low pH fertilizer. Compared to the tubing without Fre-Flo™ and without fertilizer, FRE-FLO™ still delivers **46% more water,** plus the beneficial impact of the fertilizer. This impact was reflected in the greater yield of the broccoli crop using FRE-FLO™

Report prepared by Dr. Jack Rible, University of California, Riverside, 1982.

Results of FRE-FLO™ project:
ROOT PROPAGATION - MT. SAN ANTONIO COLLEGE, CA

Executive Summary

A series of experiments on the rooting propagation of various plants found the **plants irrigated with FRE-FLO™ conditioned water develop far faster with much healthier root systems** than those irrigated with normal water.

Detailed Report

Steven Cohan, Ph.D. ran a series of experiments on the rooting of various plants. The plants irrigated with the FRE-FLO™ conditioned water showed consistent patterns of faster rooting. The only difference in the two samples was that the irrigation water in the experimental group was run through a FRE-FLO™ water conditioner, while the control was not. All other growing conditions were identical.

Rapid Root Initiation: The speed of rooting of the Arctostaphylos Manzanita plant was measured using FRE-FLO™ conditioned water compared with untreated water as a control. The dramatic results are shown in Table 1 below and on the next page. After 10 weeks none of the untreated plants had initiated roots, while a third of those growing in FRE-FLO™ conditioned water had started roots. After 16 weeks, only a quarter of the untreated plants had initiated roots compared to two-thirds irrigated with FRE-FLO™.

Table 1: Percent of Root Initiation in Arctostaphylos Manzanita

Time	FRE-FLO™ Water	Control (untreated water)
10 weeks	33%	0%
12 weeks	58%	8%
16 weeks	66%	25%

As shown in the picture below, the FRE-FLO™ treated plant on the right had a much more developed root system in the same length of time

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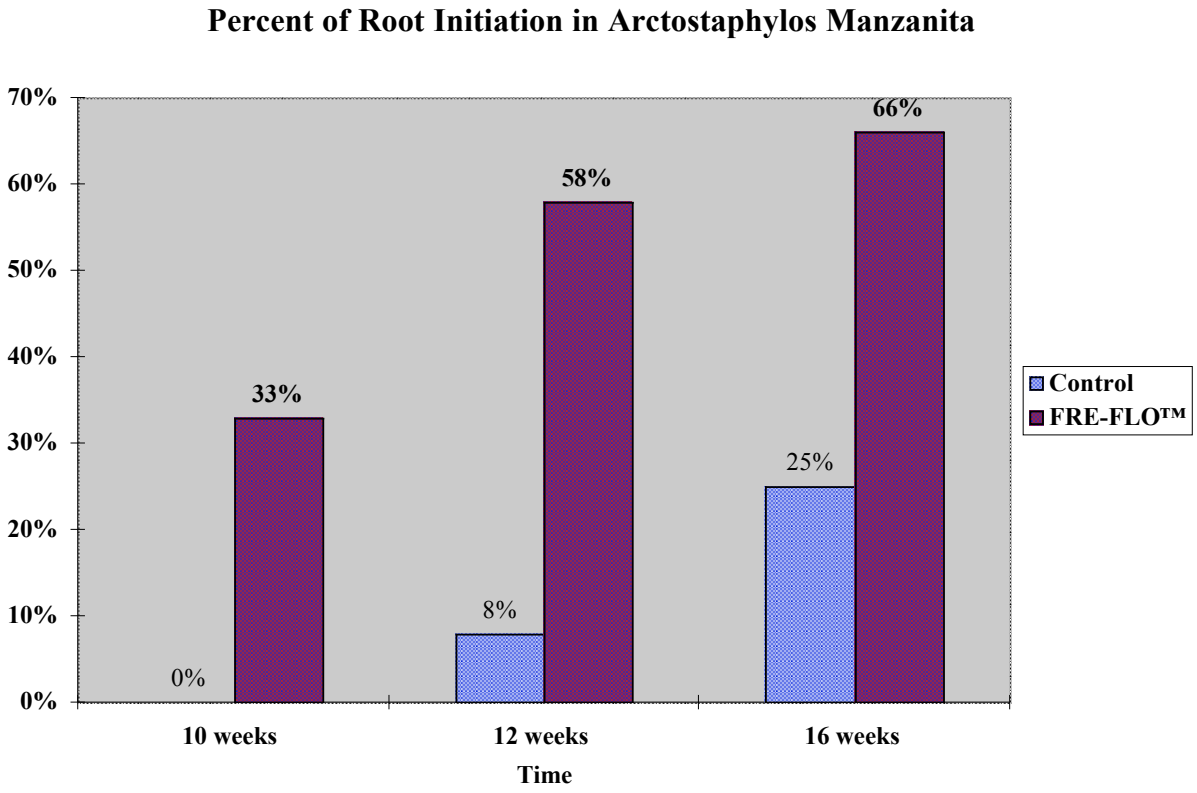
Similar results occurred with Star of Jasmine. After 6 weeks, 42% had root initiation using FRE-FLO™ compared to only 33% in the untreated water.

With Fuchsia plants after 27 days, 30% had root initiation using FRE-FLO™ compared to only 8% in the untreated water. Of the FRE-FLO™ treated plants, 20% had initiated auxiliary roots below the soil and 6% were callused, while none of the untreated plants had even started this.

Conclusion: Plants irrigated with FRE-FLO™ conditioned water develop far faster with much healthier root systems than those irrigated with normal water.



Results of FRE-FLO™ project:
GREENHOUSE - MESA COMMUNITY COLLEGE, MESA, AZ

The Agriculture Department of Mesa Community College observed the following improvements in six months of use of the FRE-FLO™ catalytic converter in their greenhouse operation:

- **Increased growth of plants**.
- **Faster establishment and stronger root system** for transplanting.
- Much **less salt accumulation on the leaves** of the cuttings in the misting bench.

Head of the Agriculture Department James D. Claridge reported, "Our cuttings have responded better and faster with an estimated 2/3 to 3/4 less salt accumulation on the leaves. This has virtually eliminated the need for wiping off the leaves prior to transplanting them out of the bench in one gallon buckets. For this reason we feel that this helps to establish the roots faster and gives the plants a stronger root system to be transplanted."

Results of FRE-FLO™ project at:
RHODODENDRON NURSERY – OCCIDENTAL, CA

A rhododendron nursery in California had an unsightly calcium carbonate residue on their otherwise beautiful plants for 18 years. They had inquired everywhere, implemented many strategies,. purchased a large assortment of chemicals, and installed many devices, all to no avail.

Immediately after installation of a FRE-FLO™ Catalytic Conditioner in February 1994, owner Paul Molinari reported he began to see a marked reduction in the residue accumulation from the overhead sprinkler systems. In warmer months, with the overhead sprinklers on daily for cooling and humidifying, he saw that it was certainly working. In August there was not a sign of calcium residue.

"Your device finally has solved our calcium carbonate residue problem. At last, we have dark green, shiny foliage! I still can't believe my eyes! And it is so simple and is so easy to maintain. It seems like magic, especially after the ordeal of the last 18 years." - Paul Molinari