PURSANOVA™ HYDROPONIC TRIALS USING STRAWBERRY, CORN, SOYBEAN AND WHEAT

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Study Initiation Date
January 7, 2011

Study Completion Date
June 24, 2011

INTRODUCTION

Water, H2O, is essential for life. Hydrogen makes up 90% of the known matter in the universe. Biologically, oxygen is what combusts (oxidizes) hydrogen, releasing energy and it is hydrogen that protects cells from free radical damage. All antioxidants are sources of hydrogen or negative hydrogen ions and hydrogen is the ultimate antioxidant and source of protons for ATP production (1, 2, 3, 6).

Pursanova™ technologies have altered the composition of water using principles of biochemistry and quantum physics to activate its hydrogen component (Fig. 1). The technology includes resonating water over ceramic based, proprietary ores within a stainless steel, hydrogen activating column (Fig. 2). Normal water (drinking, irrigation) must be converted at the cellular level to become functional within living systems or dehydration will occur (2, 5). As living systems grow older, the hydrogen reserves become depleted. As a result, cells become more dehydrated and are more susceptible to free radical damage. Lack of adequate amounts of cellular hydrogen can be a major cause in premature ageing and plant senescence (4, 5, 7). When water passes over the ceramic ores, resonation and activation occurs (Fig. 3). The water becomes more soluble and absorbable. Activated water evaporates 35% less than tap water; surface tension is reduced therefore the mixing ratio of additives can be lowered to maintain efficacy. Studies using Pursanova™ Activated Water have shown increased yields in cucumbers & Romaine lettuce (17-20%), longer shelf life in citrus and bell peppers (Matsuyama Univ., Ehime, Japan), and earlier paddy rice germination & faster growth (Miyazaki Univ., Japan). Numerous, additional field studies are on-going in the USA with cereal crops, vegetable crops used by food processors, and turf.

Objectives

The general objectives of this study were to determine the effects of Pursanova™ Activated Water on strawberry, runner tip plant production and on the growth of corn, soybean and wheat in a hydroponic growing system (hereinafter, the Cascade). A secondary objective was to evaluate fertilizer rates in Pursanova™ Activated Water (AW) on the crops grown.

Test System

A Plant Sciences, Inc. (PSI) greenhouse, hydroponic Cascade system (Fig. 4) was used for the trials. The Control was greenhouse ambient irrigation water. The Pursanova™ AW was generated using a stainless steel column filled with treatment ores, manufactured and provided by Pursanova™ (Fig. 5).

Fertilizers

Peter's Professional 15-10-30 (Scotts-Sierra Horticultural Products Co.) soluble fertilizer was used in all treatments; Potassium sulfate and agricultural calcium were also used as fertilizer supplements as needed. The pH was controlled by Nitric Acid (70% VWR) and Lactic Acid. The pH and EC (electrical conductivity) were measured routinely to adjust for the target ranges for pH (5.5-6.2) and EC (1.6-1.8 mS). PursaAg™, a glucosamine based nutrient supplement, and variable fertilizer rates were used in Treatments 1 and 2 only. Therefore, these two Treatments cannot be directly compared to Treatments 3,4 and the Control.

Pest Control

Maintenance chemicals and biological control predators were used on the strawberry plants throughout the trials on a preventative basis (Appendix 1).

Test Crops

The test crops for the trials were as follows:

- Strawberry (*Fragaria ananassa*): SPLENDOR/BG-959 (Berry Genetics, Inc.) bareroot plants and runner tips
- Corn: Conventional Corn Hybrid; seed – Emerge SX 588 (Schillinger Genetics)
- Soybean: Conventional Soybean Variety; seed – Emerge 235.T (Schillinger Genetics)
- Wheat: Conventional Wheat Variety; seed – Steele (Albert Lea Seed House, MN)

Experimental Design

Pursanova™ Activated Water (AW) was prepared in a 200 gallon tank. Greenhouse water was fed through the Pursanova ore column to fill the tank. When full, a pump continuously circulated the tank water through the column for two hours, activating the water (Fig. 6).

The Plant Sciences, Inc. hydroponic Cascade propagation system was used for all crops in this study (Figs. 7, 8). Five individual test lines were used with 40 pots per line. Each line was irrigated separately with a formulated treatment. The Control line was metered by a Dosatron™ (D14MZ2) at a ratio of 1:200. All Treatments were timed by an electronic controller (Hunter ICC-800). The Cascade system is housed inside a PSI greenhouse with screened automatic vents using ambient sunlight. The irrigation water is provided by the City of Watsonville, CA and is chlorinated. The potting mix is steam sterilized. Plants were irrigated following normal growing practices (Initial: 1 minute/hr., ending at 1.5 min/hr.; daylight hrs.). Growing conditions were maintained to ensure healthy plants. Temperature, humidity and daylight cycles were ambient for Watsonville, CA 95076. Irrigation water pH and EC (electrical conductivity) were monitored and adjusted using Nitric (70%) or Lactic Acid (Purac® Hipure) as needed.

The Treatment dosing formulations were prepared in tank mixes (40 gal) approximately weekly or as needed according to dose rates provided by Pursanova™ (Table 1). Incoming EC and pH of the tank mixes were checked, adjusted and monitored. The target ranges for all treatments were: pH (5.5-6.2) and EC (1.6-1.8 mS). Pots were fertigated 1 minute/hr. during daylight hours only and increased as needed; test material was applied through drip irrigation emitters. Treatments are given in Table 2.

STRAWBERRY TRIAL

Plant Sciences, Inc. strawberry variety, SPLENDOR, was planted as bareroot plants (2 plants/pot) on January 7, 2011. The pots were placed in the hydroponic Cascade system and fertigation Treatments began on January 12, 2011. The Control Treatment received standard greenhouse irrigation water and standard, full strength Peter's fertilizer (Appendix 2). Treatments 1 (greenhouse water) and 2 (Pursanova™ AW) received variable fertilizer treatments; beginning with PursaAg™ only and adding Peter's fertilizer at ⅓, ½ and ultimately ⅔ of Control strength (from 3/23/11 to end of study) with PursaAg™ nutrient supplement. Fertilizer rate in Treatments 1 and 2 was increased due to a chlorotic state of the plants at the low rates. Treatment 3 received 50% fertilizer in Pursanova™ AW. Treatment 4 received full strength fertilizer in Pursanova™ AW. Runners and flowers were initiated by the end of January. Plants were de-blossomed to promote vegetative runner and tip plant development. Plant tip counts were made between runner initiation and March 29 (Fig. 9). Random, newly expanded leaves from each Treatment were collected March 28, 2011 for leaf tissue analyses (Appendix 3). Runner tips were harvested in April, May and June. Final harvests were made June 16-23, 2011, twenty three weeks post planting and the trial was terminated June 24, 2011. The runner tips were planted in trays for rooting and final counts were made per Treatment.

Results

The total number of Strawberry tip plants harvested and tips per mother plant from the five Treatments are shown in Figures 10 and 11. Treatment 4 (full strength fertilizer in Pursanova™ AW), had approximately twice the number of harvested tip plants and tips/mother plant than the Control.

Plant evaluations of Treatment 3 (50% fertilizer in Pursanova™ AW), showed that the leaf petioles, stolons, and tip plants were much more robust with longer internodal distances between tips than any other Treatments. This resulted in very long, rapidly growing runners. The number of harvested runners for Treatment 3 was about 15% greater than the Control when the fertilizer was 50% of Control.

Treatments 1 (greenhouse water) and 2 (Pursanova™ AW) cannot be directly compared to the other Treatments due to variable fertilizer rates, PursaAg™ supplement, and resultant delayed growth. Plant observations of initial slow growth, chlorotic leaves and poor runner initiation, made it clear that ⅓ and ½ the fertilizer rates were insufficient for

optimal plant growth. The resultant tip plant production was 3-4 weeks behind plants in the other Treatments. A ⅔ fertilizer rate was used for Treatments 1 and 2 for the final three months of the study. At the termination of the trials, it was observed that the runner tips developing on Treatment 1 would add an additional 33% to the total and those on Treatment 2 would easily double the number of tips harvested. At the end of the trials, the mother plants in the Control and Treatment #4 which received full strength fertilizer were beginning to appear senescent. These circumstantial observations suggest that the ⅔ fertilizer rate in Pursanova™ AW (Treatment 2) may be more optimal than either the ½ or the full strength rates for maximum harvest of tip plants in the Cascade system.

Strawberry Tissue Analyses

Leaf and petiole samples from each Treatment were assayed for nutrients on March 28, 2011 approximately 10 weeks from planting. Nutrient results for leaf tissue were similar and normal for all treatments except for calcium; all plants were low. During the remainder of the trial, all plants were supplemented with calcium. Petiole nitrate was notably different between Treatments (Table 3). Treatments with full fertilizer (Control and TRT 4/Pursanova™ AW) had significantly higher petiole nitrate than Treatments with 2/3 and ½ fertilizer levels (TRT 1, 2, 3). Since nitrate is soluble and fluctuates rapidly with hydration and fertilization, these differences are expected.

CEREAL CROPS TRIAL

The Cereal crops: Conventional seed of corn, soybean and wheat, were planted into 3 pots/crop/Treatment on March 25, 2011. These pots were placed in the Cascade system on March 28, 2011 and received the same five Treatments as described above for the Strawberry Trial. Fertigation in Treatments 1 and 2 was at ⅔ rate throughout the trials. Seedlings were thinned to 6 plants/pot on April 18, 2011 and grown until harvest on June 2, 2011. Biomass of immature plants was determined on April 18, 2011 when the plants were thinned to 6 plants/pot. Leaf samples were analyzed for basic nutrients on Apr. 19, 2011 (Appendix 4). Roots were not included in the biomass results. Biomass of the final harvest was a composite of the total number of plants (18) from each Treatment.

Results

Biomass and height of immature corn, soybean and wheat were determined at 3.5 weeks after planting (Appendix 5). There appeared to be no notable differences in these data among Treatments.

Final harvest was done on June 2, 2001, nine weeks after planting. Wheat total biomass was similar for all five Treatments (Fig. 12). Total biomass of both corn foliage and ears for Treatments 1, 2, 4 and Control were 30-50% more than that of Treatment 3 (50% fertilizer). Total biomass of soybean foliage and beans was greater than the Control in Treatments 1-4. The biomass of the unhusked beans in Treatment 3 (50% fertilizer in Pursanova™ AW) and Treatment 4 (full strength fertilizer in Pursanova™ AW) were more than 2 times the Control biomass of beans (Figs. 13, 14).

Cereal Tissue Analyses

Nutrient results of leaf tissue analyses are given in Table 3. The results are for immature plants. Nitrogen, primarily nitrate, varied somewhat among the treatments and likely reflects the variation in fertilizer levels among Treatments and hydration levels.

Conclusions and Recommendations

Pursanova™ Activated Water was used in a hydroponic Cascade system for strawberry plant propagation and for growing corn, soybean and wheat plants from seed. It was concluded that the Activated Water had a positive effect on strawberry runner tip propagation and on soybean growth and bean production. The results on corn and wheat were inconclusive when grown within the parameters of a hydroponic system.

Strawberry runner tip propagation, or number of "plug plants" produced per mother plant was nearly twice the Control using Activated Water with full strength fertilizer. Additionally, production in Activated Water with 50% fertilizer resulted in approximately 15% more plug plants than the Control at the end of the 5 month trial.

The results from Treatments 1 and 2 cannot be directly compared in this study due to a growth delay from the initial low and variable fertilizer rates used and also the unknown effect of the PursaAg™ supplement. It is recommended that two field trials be conducted to determine the effects of Pursanova™ Activated Water on: 1. Runner or plug plant production in a commercial strawberry nursery and 2. A fruiting field for fruit production and quality. It is recommended to fertigate with Pursanova™ Activated Water using two-thirds and the commercial standard fertilizer rates.

Growth of the soybean plant as well as production of the harvested crop was clearly improved using Pursanova™ Activated Water. It is notable that the highest biomass, both plant and seed, resulted from 50% fertilizer in Activated Water.

As stated previously, Treatments 1 and 2 cannot be directly compared to the other treatments and the Control. However, it should be noted that the PursaAg™ supplement, which was added to both 1 and 2 throughout the trial, likely had a positive effect on Treatment 1 which was run using tapwater.

It is recommended to conduct field studies on soybean irrigating with Pursonova™ Activated Water at fertilizer rates of 25%, 33%, 50% compared to the commercial standard.

The positive effects of Pursanova™ irrigation water on strawberry runner production and soybean growth and harvest, may be influenced by the altered biophysical properties of surface tension and nutrient availability. This interaction deserves further, controlled studies and may have significant benefits to certain crops in the agricultural industry.

References

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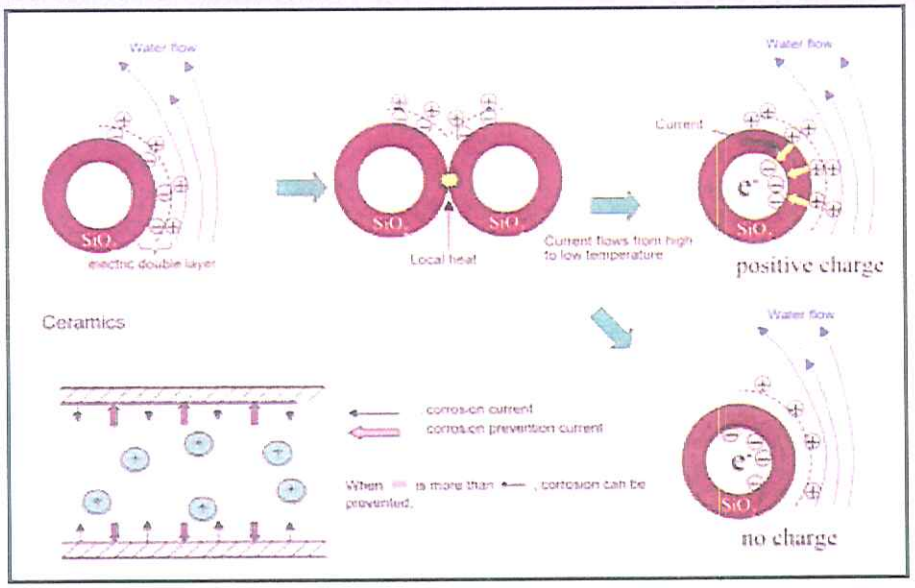
Figure 1

Resonating Ore Technology

Hydrogen Activation & Bonding



- The unique element of water is Hydrogen.
- The negative zeta potential on the surface of the ores improves "the effect of polarization" and "hydrogen bond formation" in water.

The polarity of water causes hydrogen bonds to occur between water molecules. As a result, the Polarity of molecules and hydrogen bonds give the water a solvent.

Pursanova™

Figure 2

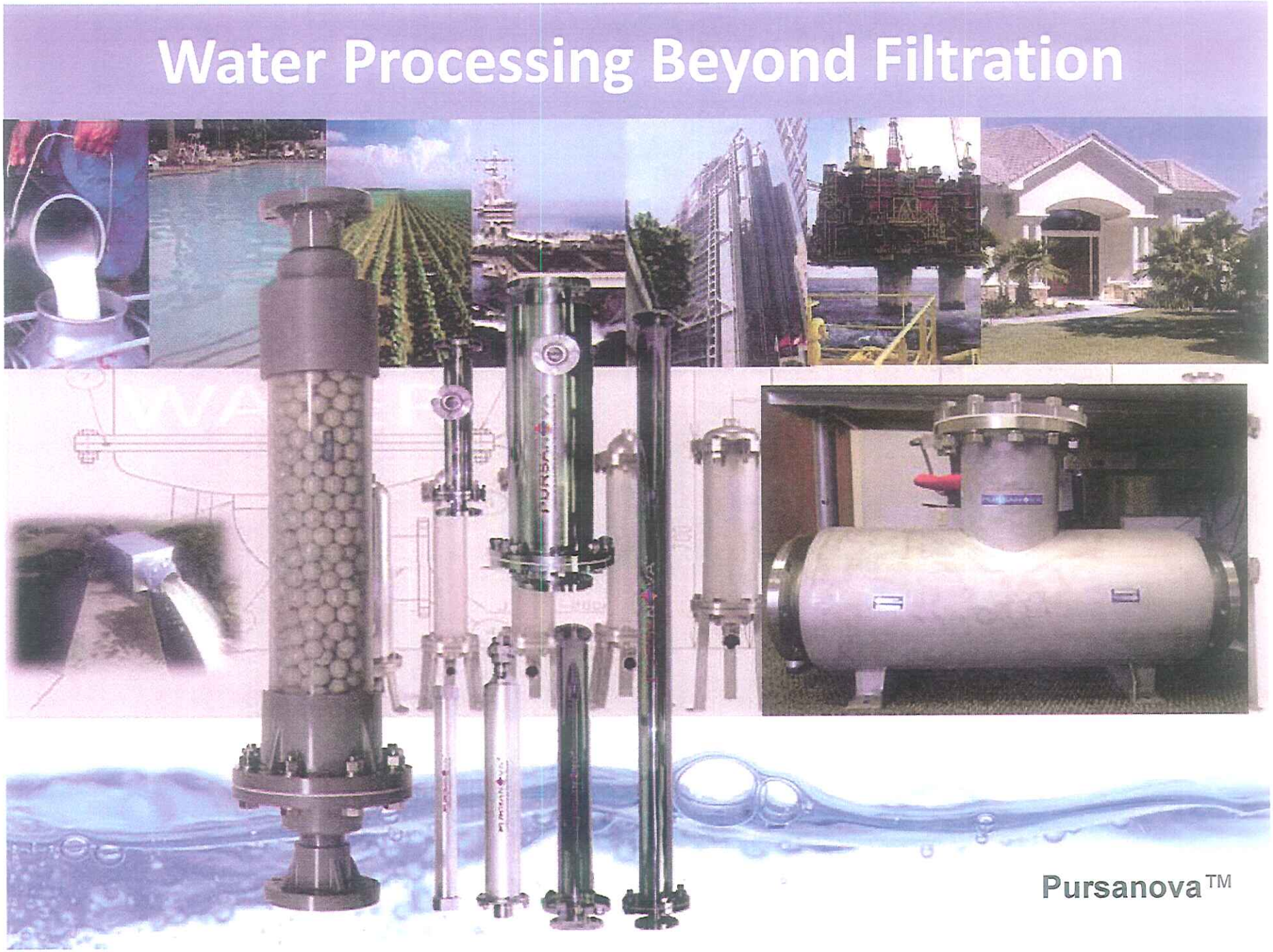


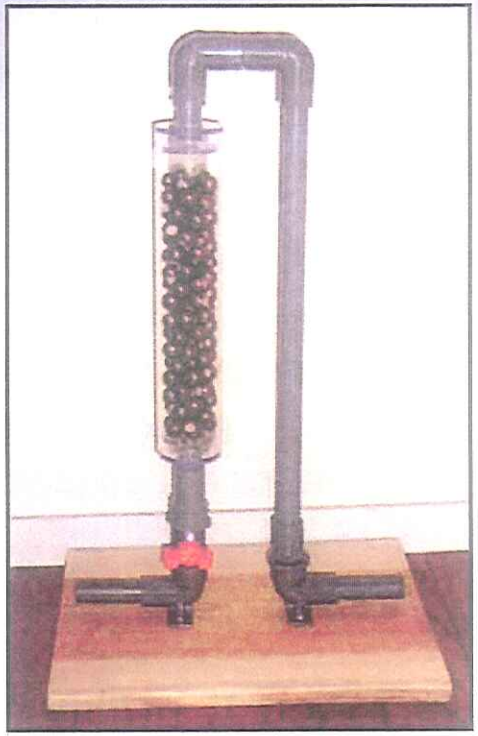
Figure 3

Resonating Ore Technology
Hydrogen Activation & Bonding

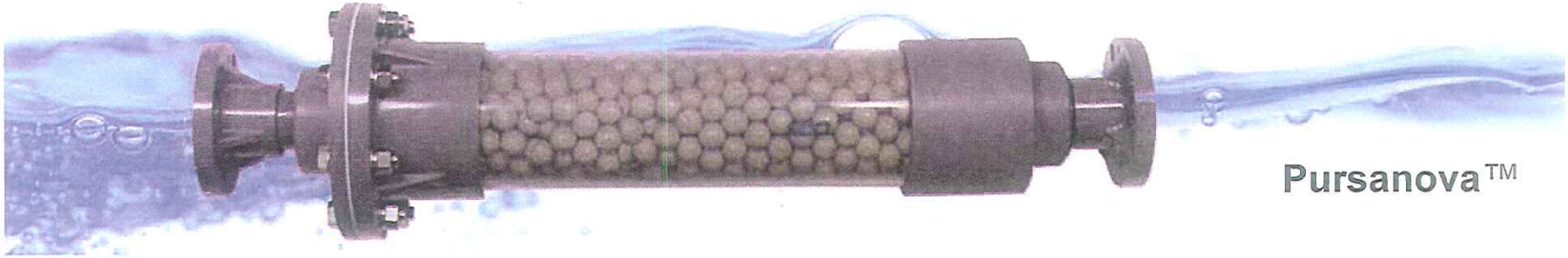
- Proprietary Resonation Method Resulting in the Duplication of Natural Molecular Vibration in Water

In order to produce Activated Water, water circulates through special ceramic spheres in a stainless steel pipeline.

The oscillating movement draws connatural energy from the ores, which produces the activated effect.



Clear pipe illustration



Pursanova™

Figure 4

Pursanova Strawberry Trial

Hydroponic Cascade System

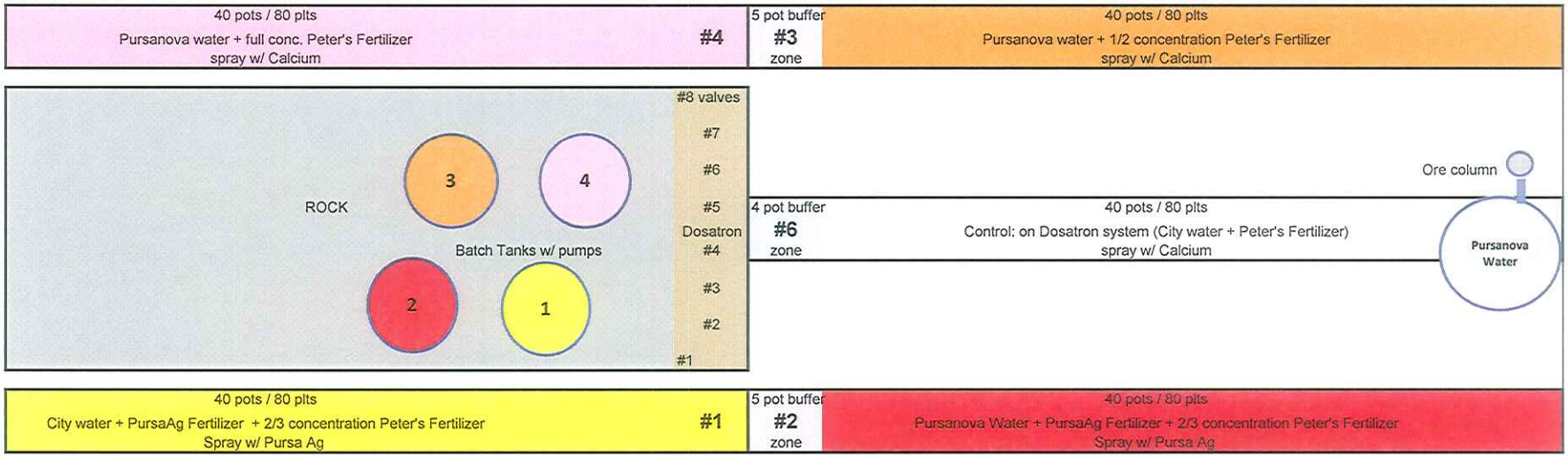


Figure 5

Pursanova Trial: Ore Column

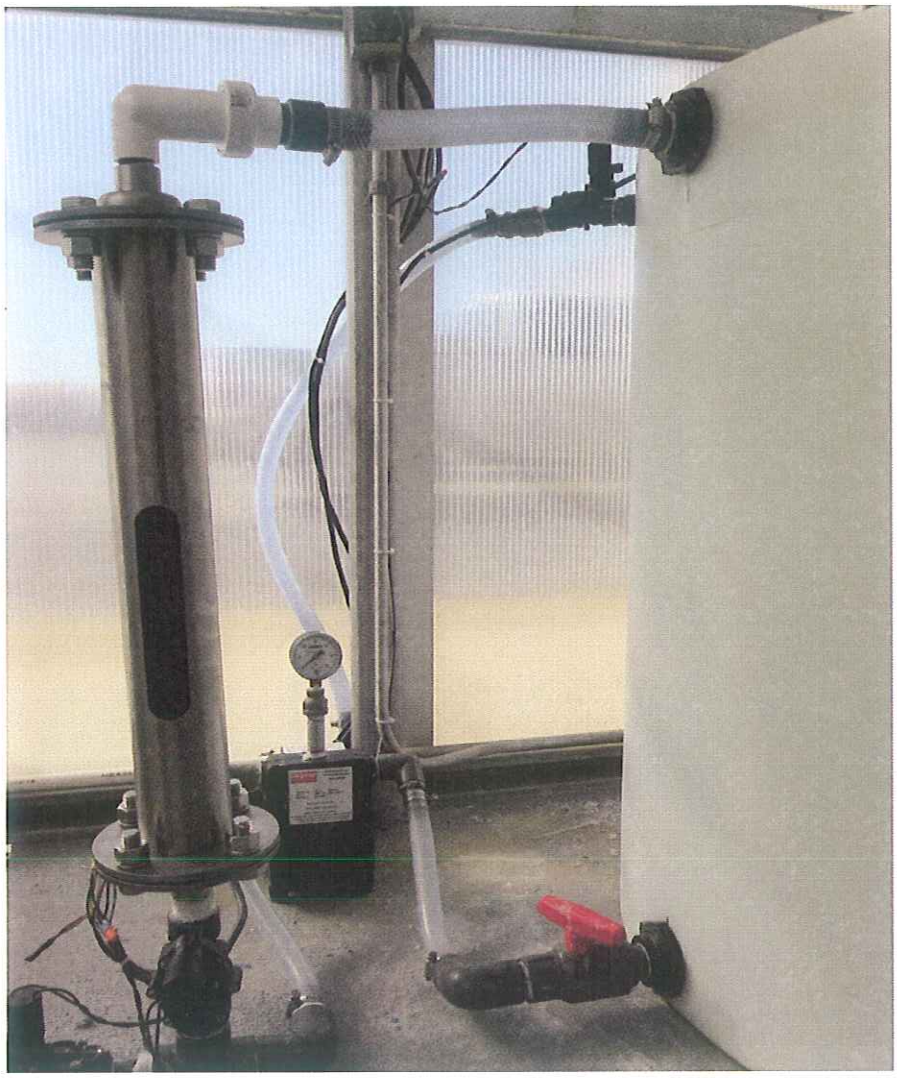


Figure 6

Pursanova Trial: Test System

Figure 7
Pursanova Strawberry Trial - Treatments 1-4

Treatment 1-Tap Water + PursaAg + 2/3 Peters

Treatment 2-Pursanova AW + PursaAg + 2/3 Peters

Treatment 3-Pursanova AW + 1/2 Peters

Treatment 4-Pursanova AW + Full Strength Peters

Photos taken Mar. 29, 2011

Figure 8
Pursanova Cereal Trial

Photo taken May 23, 2011

Figure 9

Pursanova Strawberry Trial: Early Tip Counts

Average Number Tips/Plant

DATE:	24-Jan	7-Feb	14-Feb	22-Feb	28-Feb	8-Mar	14-Mar	29-Mar
TRT 1	0	0.0	0.0	0.2	0.3	0.6	0.9	1.8
TRT 2	0	0.0	0.1	0.4	0.7	1.2	1.6	2.8
TRT 3	0	0.3	0.8	1.2	1.5	2.2	2.6	4.2
TRT 4	0	0.4	1.0	1.9	2.5	3.6	4.7	9.1
Control	0	0.2	1.2	2.3	3.1	4.7	5.0	9.7

Actual Tip Counts

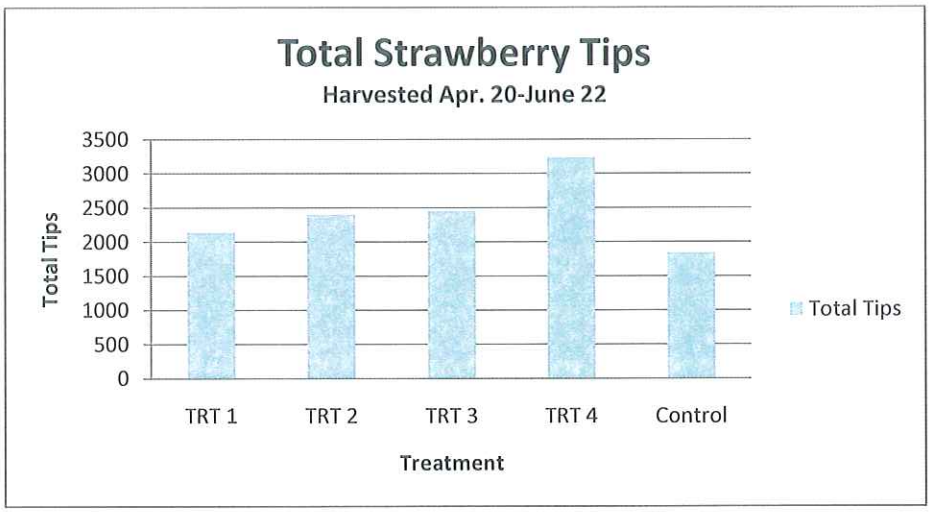
DATE:	24-Jan	7-Feb	14-Feb	22-Feb	28-Feb	8-Mar	14-Mar	29-Mar
TRT 1	0	0	0	15	23	46	75	113/32 pots
TRT 2	0	0	7	29	53	97	129	197/35 pots
TRT 3	0	26	60	94	118	173	205	295/35 pots
TRT 4	0	32	82	151	203	286	372	218/12 pots
Control	0	12	97	183	248	374	400	232/12 pots

1/24-3/14 Tip counts N=80 40 pots / TRT (2 plants each)

29-Mar Tip count N=64 (#1), N=70 (#2, #3), N=24 (#4, Control)
Test plots were reduced in size to 32 pots (TRT 1 & 4) and 35 pots (TRT 2, 3, & Control)

Figure 10

Pursanova Strawberry Trial



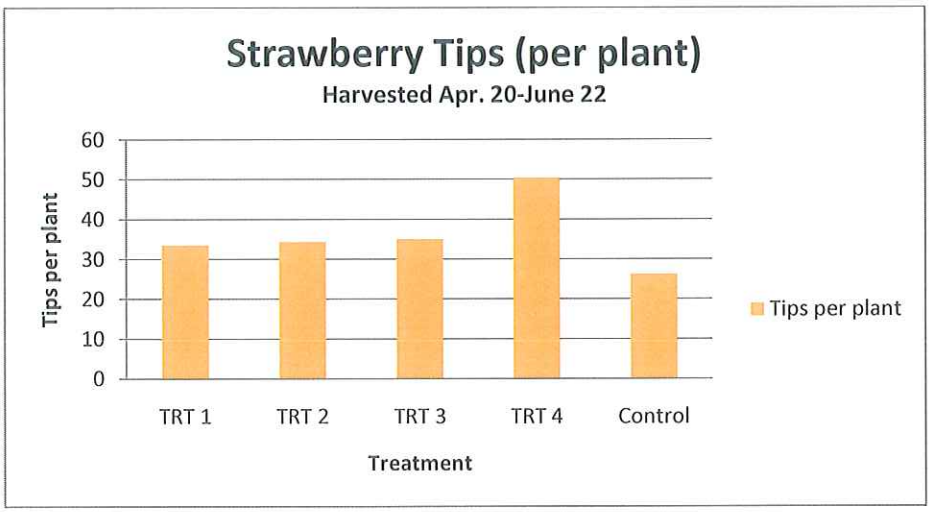
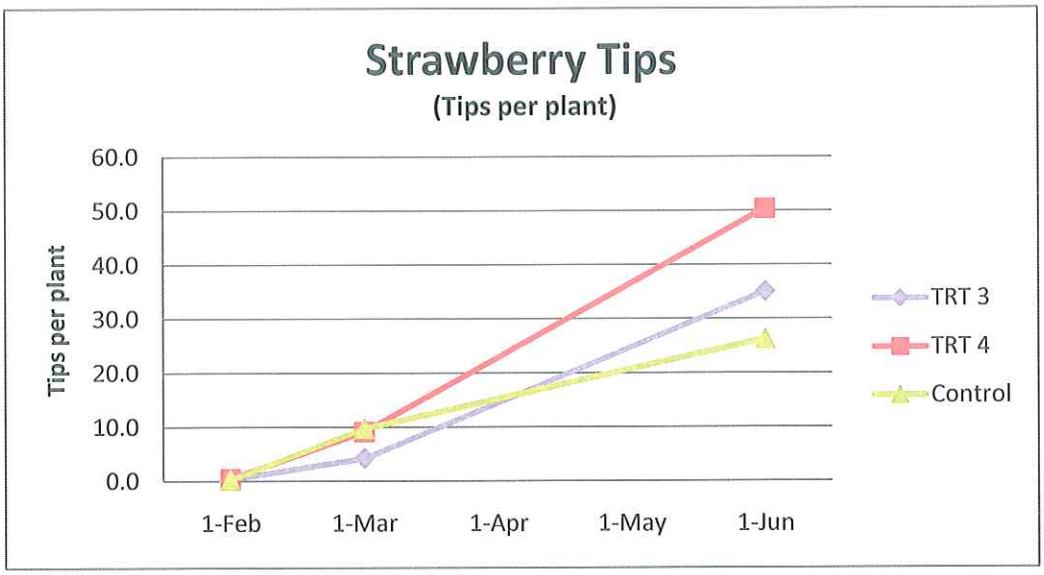


Figure 11

Pursanova Strawberry Trial

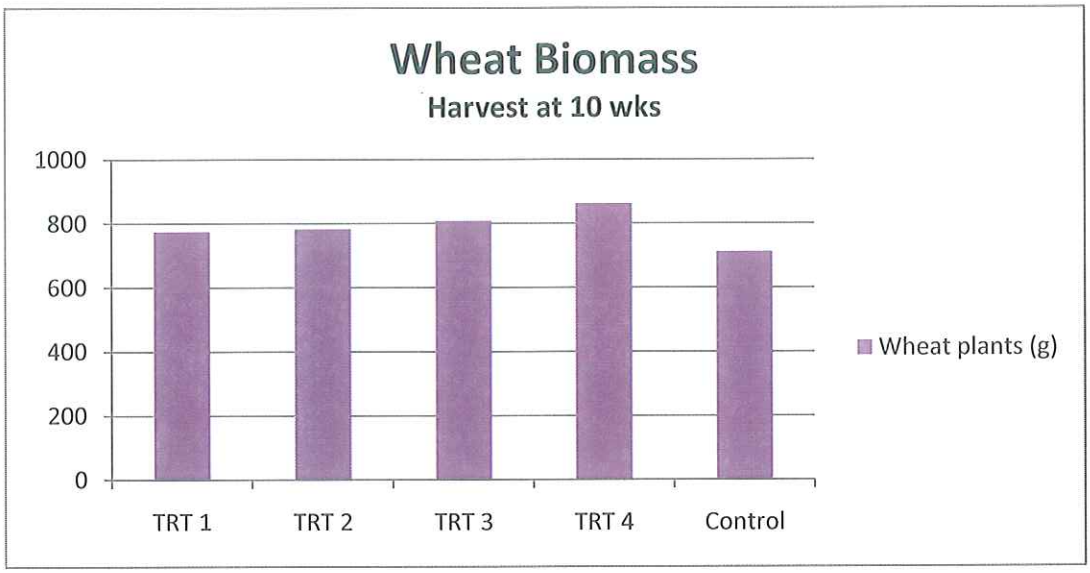


Strawberry Tips (Tips per plant)

	Tip Counts (Immature)		Total Harvested
Date: .	7-Feb	29-Mar	22-Jun
TRT 3	0.3	4.2	35.0
TRT 4	0.4	9.1	50.4
Control	0.2	9.7	26.3

Figure 12

Pursanova Cereal Trial Harvest (Mature)

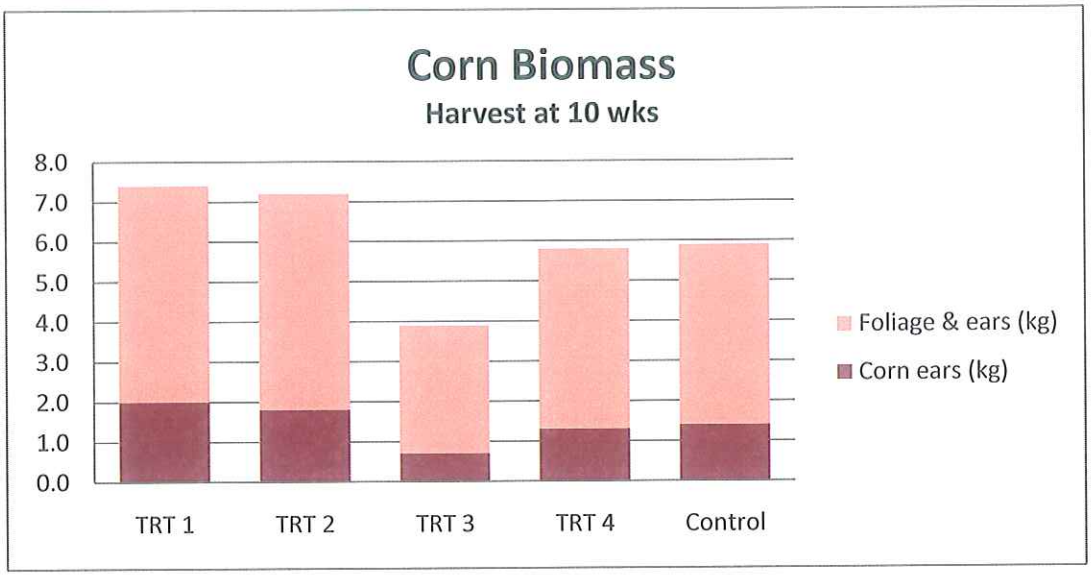


Plant mass does not include roots.

DATE: 6/2/11	Wheat plants (g)
TRT 1	775
TRT 2	783
TRT 3	808
TRT 4	863
Control	712

Figure 13

Pursanova Cereal Trial Harvest (Mature)

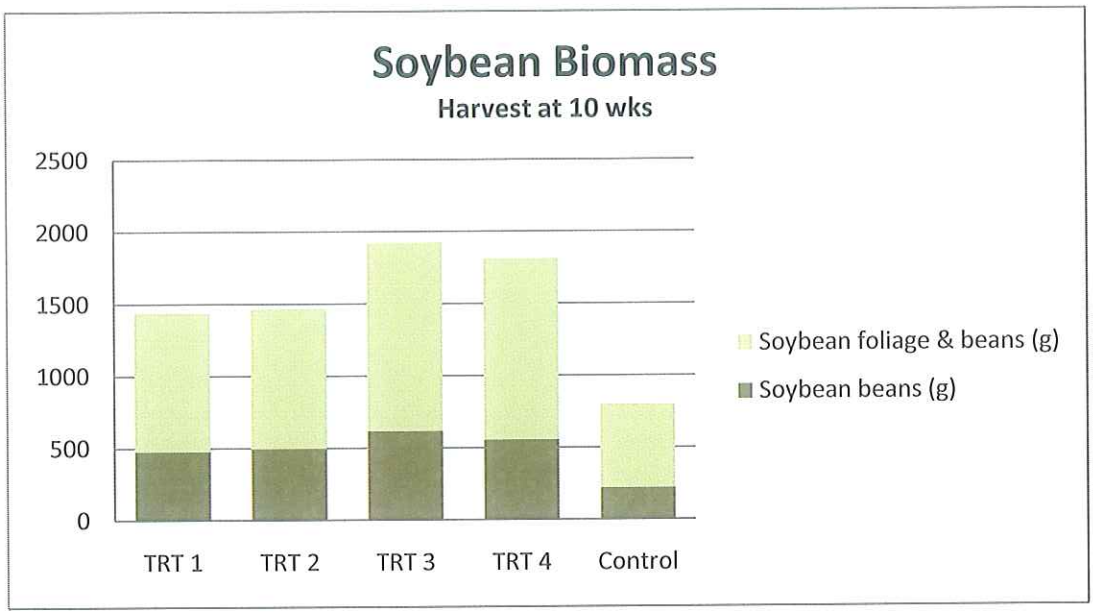


Plant mass does not include roots.

DATE: 6/2/11	Corn ears (kg)	Foliage & ears (kg)
TRT 1	2.0	5.4
TRT 2	1.8	5.4
TRT 3	0.7	3.2
TRT 4	1.3	4.5
Control	1.4	4.5

Figure 14

Pursanova Cereal Trial Harvest (Mature)



Plant mass does not include roots.

DATE: 6/2/11	Soybean beans (g)	Foliage & beans (g)
TRT 1	476	961
TRT 2	496	971
TRT 3	618	1306
TRT 4	555	1256
Control	219	578

Table 1

Pursanova Trials

Table for Pursa-AG dilution rate (Provided by Pursanova)

Diluted solution	Pursanova AW	Pursa-AG
1000 X	100 L	6 g
For fertilizer batch tanks*	40 gal	9 g or 75 ml
For foliar fertilizer spray	5 gal	1.1 g
600 X - For foliar spray (aphid control)	1 gal	5 ml

*Initial supply was powdered PursaAG; switched to liquid on Feb. 24th

Table 2

Pursanova Trials: Water & Fertilizer Treatments

(40 gallon tank mix/Treatment)

Control: Dosatron System (line #6) color code white:

City Water + Peter's Stock Mix at 1:200 injection ratio (equivalent to full concentration Peters in TRT 4)

15 gal. city water

25 lbs Peter's Professional 15-10-30 (NPK)

2 kg. Potassium sulfate (for additional P)

1700 ml Nitric Acid (for pH control)

Batch Tank #1 (line #1) color code yellow:

City Water + PursaAg (+1/3 concentration Peter's Jan. 24-30; ½ conc. Jan. 31-Mar. 24; 2/3 conc. Mar. 25 to end of trial)

40 gal. city water

9 g. Pursa Ag (reduced use in mid-Mar. to every other batch mix)

45 g. (1/3) or 68 g. (1/2) or 91 g. (2/3) Peter's Professional 15-10-30

8 g. (1/3) or 12 g. (1/2) or 16 g. (2/3) Potassium Sulfate

~80 ml. Lactic Acid (for pH control) or 38 ml Nitric Acid (switched to Nitric in mid-Apr.)

Batch Tank #2 (line #2) color code red:

Pursanova water + Pursa Ag (+1/3 concentration Peter's Jan. 24-30; ½ conc. Jan. 31-Mar. 24; 2/3 conc. Mar. 25 to end of trial)

40 gal. Pursanova water

9 g. Pursa Ag (reduced use in mid-Mar. to every other batch mix)

45 g. (1/3) or 68 g. (1/2) or 91 g. (2/3) Peter's Professional 15-10-30

8 g. (1/3) or 12 g. (1/2) or 16 g. (2/3) Potassium Sulfate

~80 ml. Lactic Acid or 38 ml Nitric Acid (switched to Nitric in mid-Apr.)

Batch Tank #3 (line #3) color code orange:

Pursanova Water + ½ concentration Peter's

40 gal. Pursanova water

68 g. Peter's Professional 15-10-30

12 g. Potassium Sulfate

~80 ml. Lactic Acid or 38 ml Nitric Acid (switched to Nitric in mid-Apr.)

Batch Tank #4 (line #4) color code pink:

Pursanova Water + full concentration Peter's (equivalent to control rate)

40 gal. Pursanova water

136 g. Peter's Professional 15-10-30

24 g. Potassium Sulfate

~80 ml. Lactic Acid or 38 ml Nitric Acid (switched to Nitric in mid-Apr.)

Table 3

Pursanova Trial: Leaf Tissue Analysis

(Immature Plants)

	Control	TRT 1	TRT 2	TRT 3	TRT 4
Strawberry (Mar. 28)					
Petiole Nitrate (NO3) mg/kg	2100	340	280	43	1100
Total Nitrogen N%	3.1	2.7	2.4	2.3	2.8
Corn (Apr. 19)					
Petiole Nitrate (NO3) mg/kg	390	190	410	270	810
Total Nitrogen N%	4.2	3.6	3.5	3.7	3.9
Soybean (Apr. 19)					
Petiole Nitrate (NO3) mg/kg	970	790	730	2200	670
Total Nitrogen N%	5.9	4.8	5.6	5.7	6.0
Wheat (Apr. 19)					
Petiole Nitrate (NO3) mg/kg	4200	3000	3200	3800	3400
Total Nitrogen N%	6.6	6.3	6.2	6.0	6.2

Appendix 1

Pursanova Strawberry Trial

MAINTENANCE CHEMICALS & BIOLOGICALS

DATE 2011	COMPOUND / BIOLOGICAL	RATE	TARGET	LINES APPLIED
1/12	Thripex/Spidex		Prevention: spider mite	all
1/18	Thripex			all
1/24	Micronutrients	2 gm/pot		1, 2
1/26 (repeat)	Thripex/Spidex/Apipar/ Aphidend	See biological release schedule	Prevention: spider mite, aphid	all
1/26	Integrity Calcium	1 oz/gal H_2O		3,4,6
2/1	PursaAg	1.1 g/ 5 gal H_2O		1,2
2/1	Integrity Calcium	1 oz/gal H_2O		3,4,6
2/22	PursaAg (600 x)	5 ml/gal H_2O	Aphid	1-4, 6
3/1	Integrity Calcium	1 oz/gal H_2O		3,4,6
3/15	Integrity Calcium	1 oz/gal H_2O		1-4, 6
4/4	Integrity Calcium	1 oz/gal H_2O		1-4, 6
4/19	Rally 40 WSP	1.3 g/ gal H_2O	Powdery mildew	1-4, 6
4/20	Integrity Calcium	1 oz/gal H_2O		1-4, 6
5/3	Rally 40 WSP	1.3g/ gal H_2O	Powdery mildew	1-4, 6

Appendix 2
2011 CASCADE SYSTEM FERTIGATION

Fertilizer (Control):
Peters Professional 15-10-30 mixed in 15 gal. stock bucket; applied by drip irrigation (1/2 gal. per hr. drippers)

Fertilizer Injector and Irrigation Controller:
Dosatron Model D14MZ2
Hunter ICC 800 Irrigation Controller

Stock Mix (Control) at 150 ppm (injection ratio ~1:200):
- 15 gal. water
- 25 lbs Peters Professional 15-10-30
- 2 kg. Potassium sulfate
- 1700 ml Nitric acid 70% to adjust pH

Fertigation target :
Start with 1 min/cycle every hour from 8am – 4pm (9 min.); increase as plants grow.

EC & pH target:
EC (mS) of water in line: 1.6-1.8
pH of water in line: 5.5-6.2 (GH #2 baseline = 7.6)
Adjust by adding Nitric acid or increasing water to keep within target

APPENDIX 3: Strawberry Leaf Tissue Analyses