

## **Grower's Secret Pro Plus Extra Fertilizer Increases Japanese Cucumber Yields and Vitamin A Content**

Summary of a study performed by Crop Care Hawaii LLC

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### **ABSTRACT**

Crop Care Hawaii LLC conducted a study using additional fertilizers on Japanese cucumbers with Grower's Secret Pro in 2005. Field plots were located in Kahuku on the island of Oahu. Three treatments were compared: 1) "Extra Fertilizer"; 2) "Extra Fertilizer" plus foliar application of GSPro; and 3) "Extra Fertilizer" plus drip and foliar applications of GSPro. "Extra Fertilizer" consisted of drip applications of 150 lb/A urea; one at transplant and 4 applications during fruiting. "Extra Fertilizer" also included foliar applications of 10 lb/A of 20-20-20 weekly from transplant to first fruit, and twice monthly from first fruit to end of harvest. GSPro (2 oz/A) was applied at seeding, transplant, and twice monthly to the end of harvest. Treatments were in addition to the farmer/cooperator's standard fertilization and pest management practices. Days to first harvest and total harvest days were not affected by the treatments. Urea plus drip and foliar applications of GSPro increased number of fruits harvested by 59% over standard practices and 22% over the additional fertilizer treatment. GSPro foliar and drip plus extra fertilizer increased the number of #1 fruit by 79% over standard practices. Vitamin A content was also increased by 68%. Thus, GSPro foliar and drip application plus extra fertilizer significantly increased yields, increased the number of #1 fruit, and increased the vitamin A content of the fruit.

### **INTRODUCTION**

Crop Care Hawaii LLC, a Honolulu based agricultural consulting company, was contracted by Grower's Secret Inc. (formerly ABR LLC), to evaluate the use of Grower's Secret Pro (GSPro) on Japanese cucumbers under standard grower practices and with additional fertilizer applications. At the time of the tests, GSPro was still called LCF but was 16 times more concentrated than previous formulation. Hence, the two ounces stated in the results below is the same as one ounce of our current formulation of GSPro. Data from the trial with GSPro under standard grower practices and the report from Crop Care of GSPro with additional fertilizer are in Appendix I and Appendix II, respectively.

In Hawaii, fresh market cucumbers are grown year round up to 3,000 feet and from April to October at higher elevations. Most of the production is on the Big Island with smaller farms on other islands. The slicing type dominates cucumber production. Japanese cucumber accounts for a small portion of which most are immediately sold to restaurants. Selection of this crop for the test was due to availability of a cooperating grower.

Since Japanese cucumbers constitute a coveted niche market, fertilization is a tightly guarded secret. However, there is information available for cucumber production in Hawaii. Each crop removes 32-9-44 lb/A of NPK in addition to a 6 and 23 lb/A of Mg and Ca, respectively. Standard fertilization practices apply between 1,500 to 2,000 lb/A of a 15-15-15 or 20-20-20 fertilizer to each crop. Half is banded to the side and below the seed at planting and the rest split and side banded at two-week intervals. Thus in a month, 300-400 pounds each of N, P, and K have been added. Individual variations include Mg (150 to 500 lb/A) and other nutrients based

on crop performance and tissue analysis. Applying all the fertilizer at the beginning of the crop is not the most efficient use of fertilizer and much may be lost through leaching.

## MATERIALS AND METHODS

Japanese cucumber seedlings were transplanted on April 30, 2006 on field plots located in Kahuku on the island of Oahu. The field was set up as a randomized block with buffer rows on each side of each replicate. Spacing was 2.5 feet in-row and 6 feet between rows. The cooperators' standard fertilizer and pesticide applications (confidential) were deployed consistently across all treatments.

Three treatments were compared: 1) "Extra Fertilizer"; 2) "Extra Fertilizer" plus foliar application of GSPro (2 oz/A); and 3) "Extra Fertilizer" plus drip and foliar applications of GSPro (2 oz/A). "Extra Fertilizer" consisted of drip applications of 150 lb/A urea; one at transplant and 4 applications during fruiting. "Extra Fertilizer" also included foliar applications of 10 lb/A of 20-20-20 weekly from transplant to first fruit, and twice monthly from first fruit to end of harvest. GSPro was applied at seeding, transplant, and twice monthly to the end of harvest. Treatments were in addition to the farmer/cooperator's standard fertilization and pest management practices which served as a control.

The following data were collected:

Harvest data - daily counts and totals weights of #1 fruit and off-grades.

Tissue nutrient levels - three tissue samples were collected every 3 weeks starting 4 weeks after transplant and delivered to Brewer Environmental Industries for analysis. Tissue analysis was conducted by Brookside Laboratories, Inc. Levels of nitrogen, potassium, phosphorus, calcium, magnesium, sulfur, boron, iron, manganese, copper, zinc, aluminum and sodium were measured.

Fresh fruit vitamin/mineral content - samples were collected 11 days after first harvest and delivered to Food Quality Labs for analysis. Levels of vitamin A, vitamin C, vitamin D, vitamin E, phosphorus, calcium, iron, magnesium, potassium, sodium, zinc, copper, manganese and selenium were tested.

Fruit shelf life - six harvested fruit per treatment were placed in plastic bags with holes and stored in a refrigerator at 40 degrees Fahrenheit. Fruit were examined daily for changes in fruit quality.

## RESULTS AND DISCUSSION

In the first trial (Appendix I), no significant differences were observed between controls and the GSPro treatments. Since all the fertilizer had been applied at the start of the growing season, it was suspected that soil fertility might be a limiting factor. The second trial attempted to address this possibility by including additional fertilizer via the drip system and as a foliar application.

In the second trial (Appendix II), total days till first harvest and total harvest days were similar for all treatments. However, significant increases were observed in total number of fruit, total fruit weight, and number of #1 fruit in for the extra fertilizer

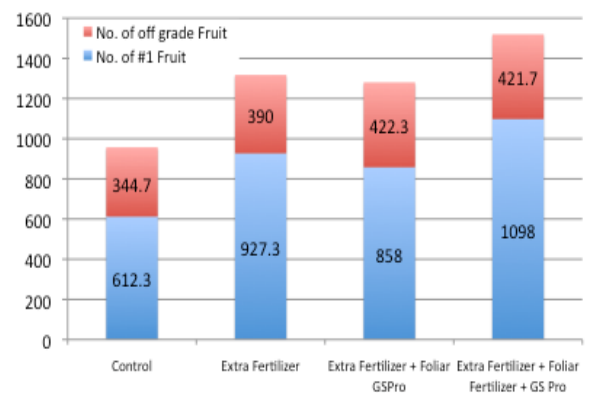


Figure 1. Total number and number of #1 Japanese cucumber fruit are significantly increased by the use of extra fertilizer and Grower's Secret Pro.

treatments, and GSPro plus fertilizer treatments (Figures 1 and 2). Extra fertilizer applied via the drip system increased the number (51%) and total weight (54%). A similar increase in off-grade fruit was also observed. This suggests that the grower's existing fertilization practice was not producing optimal yields. A potential reason is that a significant amount of fertilizer may be lost through leaching because of the practice of deploying fertilizer early in the crop's growing cycle. Addition of GSPro with extra drip and extra foliar fertilizer resulted in a significant increase in fruit number (79%) and total harvest weight (80%). Since extra fertilizer delivered through the drip with and without GSPro were essentially the same, the extra yield increase can be attributed to the additional fertilizer applied to the foliage. This is not unexpected as leaves of most plant are efficient absorbers of nutrients. These results would suggest that efficiently timed fertilizer applications with GSPro would positively impact yields and the current practice of applying all the fertilizer in the first month should be re-evaluated.

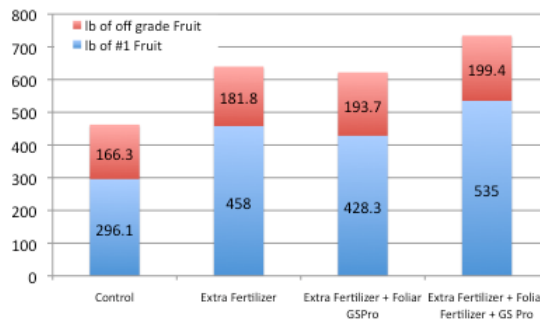


Figure 2. Total weight and weight of #1 Japanese cucumber fruit are significantly increased by the use of extra fertilizer and Grower's Secret Pro.

In addition to increased yields, extra fertilizer via the drip system increased plant nitrogen content by 20% and copper by 26% over controls. Addition of GSPro and extra fertilizer via the drip system increased plant tissue nitrogen content over controls by 26% and copper by 29%. Nitrogen content increased over controls by 30% and copper by 18% with the GSPro treatments with extra drip and foliar fertilizer. No other significant changes were observed with other plant macro- and micronutrients. These data suggest that GSPro may play a role in increasing promoting plant growth as nitrogen gets incorporated into plant tissues. The lower increase in copper with the GSPro plus drip and foliar fertilizer applications may be due to the incorporation of the micronutrient into enzymes that are important with plant growth and seed production.

The mineral/vitamin levels of the fresh fruit were generally unchanged. GSPro plus extra drip and foliar fertilizer increased vitamin A content in fruits increased by 68% over that of the controls. It would be interesting to see if GSPro has similar effect on the nutritional value of other crops.

Another significant benefit with using GSPro was the increase in shelf life of harvested cucumber fruit. The first difference was at 11 days after harvest. Fruits from controls and extra fertilizer via the drip system started to develop tiny-pitted areas while the GSPro treated fruits did not. At 15 days after harvest, the control and extra drip fertilizer treated fruits became moldy and slimy but the GSPro treated fruits did not until 18 days post-harvest. While there were no significant yield differences between extra drip fertilizer and extra drip fertilizer plus GSPro, the addition of GSPro increased shelf life and fruit appearance.

## ECONOMIC ANALYSIS

Total crop production cost for cucumber was \$7,400 for Hawaii in 1999 and averages half that cost in the continental US. A higher return is obtained from Japanese cucumber, a crispier trellised cucumber variety. The amount of Japanese cucumber produced in Hawaii is not clear as production goes directly into local restaurants for food preparation.

Since economic data for Japanese cucumbers is lacking, the analysis below utilized data for slicing cucumbers. In Hawaii, slicing cucumbers average 10 tons/A with a production cost near \$8,000 per acre. The yield is significantly lower than the 16 to 25 tons per acre for marketable yields in Florida. The break-even point for cucumber production in Hawaii is \$0.40 per pound. It is likely that local plant fertilization programs are not properly optimized for cucumber production. Addition of additional urea increased yields by 37% supporting the need for better fertilizer management. Assuming a \$0.40/lb return on investment, a 37% increased applied on the 10 ton/A would return an additional \$2,960 per acre with the input of \$147 of urea. The addition of the extra fertilizer also increased the number of #1 fruit. While the result needs additional refining and testing, it does suggest that standard fertilization practices in Hawaii need to be optimized. Addition of GSPro with the extra urea did not improve yield. However, it did help improve fruit quality and extend shelf life by 3 days.

The best results were obtained with additional urea, 20-20-20, and GSPro applications (Treatment 3) resulting in a total fruit weight increase of 80%. The cost of additional urea and 20-20-20 was \$413 per acre. In Hawaii, an 80% increase is 16,000 pounds of cucumbers. At the break-even price for Hawaii of \$0.40/lb, the \$413/A fertilizer cost and eight applications of GSPro (at \$20/A) would total \$573 and return \$6,400 per acre. Whether similar gains can be obtained in other production areas like California and Florida where productivity per acre is higher and production costs are lower, should be tested.

In addition to the gains in productivity and increase in #1 fruit, Treatment 3 also produced fruit that had higher Vitamin A content. Both treatments using GSPro also resulted in fruits with shelf life extended by 3 days. This is likely due to higher quality skin that is more resistant to drying. This in itself will cut down waste and possibly improve the exportability of Japanese cucumber.

## **CONCLUSIONS**

The third party research showed that plant nutrition is important for successful use of GSPro in crop production. Properly managed, GSPro use will contribute significantly to increasing yields of high quality Japanese cucumber. Whether that hold true for other vegetables is likely but additional testing is needed.

The profit margin is small since national market prices for cucumbers range from \$0.16 to \$0.26 per pound. Proper use of GSPro in an aggressive fertilization program can help widen the margin by significantly increasing production of a high quality and nutritious product with a longer shelf life.

Appendix I  
Trial 1 Raw Data

**LCF Cucumber Trial 1 - 2005  
(Harvest Data)**

Trt 1 = Control

Trt 2 = 1qt. LCF

Trt 3 = 2 qt. LCF

W= number of #1  
fruit

X = wt. of #1 fruit

Y= number of off-grade fruit

Z= wt. of off-grade  
fruit

Day	Blk	Trt	W	X	Y	Z
1	1	1	9	4.05	2	0.95
	1	2	6	3.05	1	0.4
	1	3	7	3.5	1	0.45
	2	1	8	4.15	3	1.6
	2	2	14	6.95	2	1.05
	2	3	5	2.15	0	0
	3	1	33	16.25	8	3.75
	3	2	17	7.65	8	3.65
	3	3	38	18.65	11	4.95
2	1	1	50	19.9	10	4.6
	1	2	35	14.9	6	2.45
	1	3	28	12.3	4	1.6
	2	1	32	12.1	13	5.2
	2	2	51	21.4	19	8.1
	2	3	59	23.38	13	4.9
	3	1	27	10.2	6	2.65
	3	2	42	16.45	11	4.45
	3	3	63	25.75	20	8.1
3	1	1	45	15.2	4	1.4
	1	2	22	18.2	1	0.45
	1	3	43	16.8	7	3
	2	1	41	14.8	7	2.6
	2	2	44	15.6	8	2.8
	2	3	31	11.4	4	1.8
	3	1	49	17.4	2	0.6
	3	2	41	16.6	7	3.4
	3	3	39	14.4	9	3
4	1	1	45	18.75	6	2.3
	1	2	52	23.1	7	2.8
	1	3	49	21.3	5	2
	2	1	59	24.6	9	3.65
	2	2	54	23.45	6	2.2
	2	3	109	45.85	14	5.8
	3	1	107	44.95	11	5.05
	3	2	82	35.9	9	2
	3	3	81	34.4	14	6.5
5	1	1	138	58.7	22	9.35
	1	2	138	63.05	10	4.15

	1	3	135	61.35	22	10.35
	2	1	134	58.7	12	5.05
	2	2	91	38.5	10	3.8
	2	3	68	29.35	10	5.2
	3	1	108	48.1	7	3.2
	3	2	98	45.4	26	11.46
	3	3	82	36.75	21	8.75
6	1	1	115	51.1	18	8.4
	1	2	151	67.21	26	12.2
	1	3	143	63.6	18	8.4
	2	1	110	49.6	7	3.6
	2	2	139	60.65	18	7
	2	3	105	46.83	20	9.8
	3	1	164	79.65	16	8.05
	3	2	171	75.15	24	12.8
	3	3	141	60.7	26	12.6
7	1	1	125	58.3	19	8.6
	1	2	136	10.03	14	6.2
	1	3	146	65.9	12	5.8
	2	1	114	51.1	6	2.4
	2	2	134	59.55	22	10.6
	2	3	135	61.45	21	10
	3	1	155	68.1	14	6.6
	3	2	140	60.1	20	8.8
	3	3	142	60.8	13	6.2
8	1	1	103	48.3	22	12
	1	2	109	53.75	11	5.6
	1	3	128	59.7	18	8.4
	2	1	126	58.2	9	4
	2	2	103	49.4	17	7.8
	2	3	127	63.4	25	12
	3	1	93	42.05	8	3.8
	3	2	117	55.5	14	6.8
	3	3	75	35.15	12	5.8
9	1	1	105	48.9	29	13.6
	1	2	126	48.12	23	11.2
	1	3	120	57.8	16	8.2
	2	1	125	56.75	19	10.2
	2	2	80	38.45	16	8.8
	2	3	84	42.3	10	6
	3	1	87	39.8	8	6.2
	3	2	124	59.85	16	8.2
	3	3	84	44.15	10	5
10	1	1	99	44.2	14	6.6
	1	2	123	53.65	12	5
	1	3	112	49.85	11	4.8
	2	1	123	56.25	15	6.8
	2	2	99	84.7	19	8.6
	2	3	87	39.85	18	8
	3	1	91	40.69	6	2.8

	3	2	97	42.35	14	6.4
	3	3	100	57.6	11	5.6
11	1	1	91	39.8	15	7.8
	1	2	127	57.45	14	6.3
	1	3	135	56.25	12	5.8
	2	1	91	41.9	6	3.1
	2	2	90	40.1	6	2.8
	2	3	105	49.3	19	8.7
	3	1	115	52.45	12	6.05
	3	2	97	40.9	15	6.8
	3	3	74	32.75	26	12.2
12	1	1	114	48.3	21	9.5
	1	2	139	61.35	11	5
	1	3	127	55.55	10	4.85
	2	1	122	54.39	13	6.75
	2	2	117	53.15	15	7.1
	2	3	122	53.25	12	4.9
	3	1	170	76.4	15	6.65
	3	2	125	57.2	17	9.05
	3	3	145	64.46	21	10.15
13	1	1	123	56.35	26	13
	1	2	144	66.3	13	6.05
	1	3	139	65.85	21	10.25
	2	1	119	40.45	4	2.2
	2	2	119	58.95	15	7.9
	2	3	154	68.25	19	10.6
	3	1	149	74.35	19	11.3
	3	2	166	80.15	27	14.9
	3	3	141	70	33	17.6
14	1	1	91	39.8	15	7.8
	1	2	127	57.45	14	6.3
	1	3	135	56.25	12	5.8
	2	1	91	41.9	6	3.1
	2	2	90	40.1	6	2.8
	2	3	105	49.3	19	8.7
	3	1	115	52.45	12	6.05
	3	2	99	40.9	15	6.8
	3	3	74	32.75	26	12.2
15	1	1	80	41	21	11
	1	2	75	36.4	15	8.1
	1	3	51	25	15	9
	2	1	90	40.4	23	12
	2	2	65	32	10	5
	2	3	57	27.4	11	6.3
	3	1	53	26	17	10
	3	2	68	30.01	16	9.1
	3	3	62	29.2	11	6.3
16	1	1	57	31	22	12.4
	1	2	60	29	14	6.8
	1	3	55	28	13	6.55

	2	1	60	31	14	8.75
	2	2	49	24.4	13	7
	2	3	55	28.2	10	6
	3	1	45	22	20	13
	3	2	47	24	7	4.25
	3	3	48	24.25	8	5.2
17	1	1	36	18.05	9	4.45
	1	2	61	30.25	17	9.35
	1	3	48	24.35	9	5.1
	2	1	48	22.5	6	3.75
	2	2	61	30.25	11	7
	2	3	48	24.4	13	7.7
	3	1	49	24.5	7	4.55
	3	2	57	28.75	12	5.5
	3	3	43	19.8	16	9
18	1	1	42	20.95	12	6.1
	1	2	61	29.05	10	5.8
	1	3	42	19.85	17	8.2
	2	1	61	26.85	7	4.1
	2	2	61	28.15	10	4.2
	2	3	43	21.4	16	8.1
	3	1	62	29.35	3	1.25
	3	2	40	17.95	12	5.45
	3	3	45	19.75	6	2.5
19	1	1	37	15.2	12	7
	1	2	49	24.15	7	3.25
	1	3	39	18	7	3.6
	2	1	41	18.05	7	4.4
	2	2	31	14.3	14	7.35
	2	3	32	14.25	11	6.05
	3	1	41	18.65	4	2.05
	3	2	33	15.05	4	2.4
	3	3	43	20.25	5	3.75
20	1	1	56	26.55	14	6.7
	1	2	87	44.25	15	9.15
	1	3	69	35.45	21	11.6
	2	1	78	37.85	8	4.1
	2	2	112	54.05	24	12.55
	2	3	57	29.65	21	11.75
	3	1	64	30.95	11	6.3
	3	2	59	28.55	17	9.35
	3	3	73	34.75	14	8.3
21	1	1	49	25.09	5	2.53
	1	2	42	22.1	5	3.12
	1	3	75	36.43	5	2.12
	2	1	93	46.46	15	8.25
	2	2	79	35.75	15	7.45
	2	3	69	33.89	10	5.76
	3	1	110	53.25	14	7.73
	3	2	77	36.9	8	4.66



	3	3	112	54.23	15	8.59
22	1	1	50	24.5	13	6.15
	1	2	67	36.5	21	13.9
	1	3	69	31.5	10	4.35
	2	1	78	39.15	14	8.06
	2	2	63	29.15	16	7.15
	2	3	53	23.7	8	3.7
	3	1	59	27.3	10	5.45
	3	2	73	31.45	12	6.5
	3	3	64	29.65	8	6.8
23	1	1	69	32.7	15	7.9
	1	2	63	29.9	10	4.45
	1	3	47	21.65	12	5.8
	2	1	80	38	19	10.9
	2	2	78	36.2	14	6.95
	2	3	53	25.65	20	9.6
	3	1	62	31	14	9.1
	3	2	75	32.05	10	4.6
	3	3	67	29.7	14	6.5
24	1	1	54	24.7	13	7.3
	1	2	58	26.7	16	8.2
	1	3	63	30.75	18	10.85
	2	1	58	27	18	9.3
	2	2	65	29	22	11.95
	2	3	58	28.65	9	4.6
	3	1	50	23	17	3.9
	3	2	53	26	20	11.55
	3	3	66	30.95	23	13.9
25	1	1	58	26.9	22	11.15
	1	2	71	33.45	14	6.45
	1	3	56	26.75	16	6.9
	2	1	66	33.5	18	9.95
	2	2	58	27.3	25	12.35
	2	3	41	19.15	28	12.4
	3	1	82	37.8	6	3.75
	3	2	62	29.25	21	10.75
	3	3	53	23.15	27	14.7
26	1	1	60	28.45	23	11.65
	1	2	87	39.25	13	5.65
	1	3	75	35.65	11	4.8
	2	1	86	38.55	24	12
	2	2	47	19.8	24	9.7
	2	3	65	29.5	30	10.9
	3	1	89	43	15	8.95
	3	2	72	35.35	18	9.6
	3	3	58	26.1	23	11.65
27	1	1	50	21.35	14	11.65
	1	2	66	29.45	24	12.63
	1	3	44	20	24	14.3
	2	1	72	30.8	17	9.3

	2	2	42	17.73	36	17.1
	2	3	56	25.3	16	7.9
	3	1	76	33.8	23	11.25
	3	2	64	28.9	25	14.15
	3	3	31	14.6	6	2.25
28	1	1	46	21	36	15.4
	1	2	52	22.3	28	13.45
	1	3	54	23.8	27	12.4
	2	1	40	17.6	28	13.5
	2	2	38	16.4	35	18.85
	2	3	49	21.2	24	11.2
	3	1	40	18.6	26	12.4
	3	2	67	26.6	38	18.6
	3	3	43	19.2	22	12.4
29	1	1	50	23.4	24	13.9
	1	2	70	30.6	29	12.8
	1	3	70	34.2	29	13.3
	2	1	69	34.27	31	25.6
	2	2	42	20.2	32	15.4
	2	3	60	30.2	29	15.6
	3	1	70	32.8	36	18.2
	3	2	64	28.2	34	17.3
	3	3	40	19.4	20	9.1
30	1	1	60	28.45	23	11.65
	1	2	87	38.25	13	5.65
	1	3	75	35.65	11	4.8
	2	1	86	38.55	24	12
	2	2	47	19.8	24	9.7
	2	3	65	35.65	11	4.8
	3	1	89	43	15	8.95
	3	2	82	35.35	18	9.6
	3	3	58	26.1	23	12
31	1	1	48	21.75	18	7.85
	1	2	43	18.8	13	7.65
	1	3	45	20.25	12	5.4
	2	1	47	20.75	13	6.1
	2	2	42	18.2	16	7.45
	2	3	37	16.35	16	6.35
	3	1	33	14.85	15	7.1
	3	2	39	19	8	4
	3	3	44	18.3	12	5.6
32	1	1	36	15.95	21	10.1
	1	2	46	19.4	17	8.25
	1	3	45	19.85	18	8.5
	2	1	41	18.55	19	9.2
	2	2	29	13.05	15	7.55
	2	3	35	15.55	15	6.7
	3	1	30	11.5	21	11.75
	3	2	24	11.1	18	9.05
	3	3	35	14.1	24	12.3

33	1	1	36	15.85	12	5.95
	1	2	33	13.25	14	5.95
	1	3	31	13.55	20	9.85
	2	1	34	13.2	17	7.35
	2	2	27	10.25	13	6.4
	2	3	30	11.9	17	7.65
	3	1	29	12.7	10	6.3
	3	2	22	7.75	14	5.95
	3	3	35	16.95	8	5.8
34	1	1	37	16.7	11	6.75
	1	2	50	2.55	10	4.65
	1	3	47	21.2	9	4.55
	2	1	38	16.55	14	6.25
	2	2	41	18.15	11	5.35
	2	3	44	19	9	4.55
	3	1	37	13.5	20	10.5
	3	2	43	19.45	12	7.3
	3	3	47	21.05	11	4.8
35	1	1	40	19.06	18	8.2
	1	2	41	17.3	16	7.8
	1	3	44	19.45	11	6.65
	2	1	41	18.6	16	8.5
	2	2	38	17.6	15	6.35
	2	3	46	20.5	18	9.2
	3	1	35	16.2	15	7.2
	3	2	33	16.4	22	10.35
	3	3	32	14.9	21	10.35
36	1	1	46	19.1	12	4.4
	1	2	31	14.05	23	10.5
	1	3	44	18.75	14	6.35
	2	1	44	19.65	14	7.2
	2	2	36	14.55	15	6.35
	2	3	47	18.95	18	7.3
	3	1	20	10.65	25	9.6
	3	2	42	18.6	13	6.25
	3	3	35	15.9	15	7.45
37	1	1	42	17.8	17	7.85
	1	2	36	15.15	17	9.05
	1	3	44	19.35	11	6.1
	2	1	45	20.1	17	8.4
	2	2	38	16.2	16	6.5
	2	3	49	22.95	5	3.8
	3	1	27	11.75	20	9.7
	3	2	42	19.7	12	5.8
	3	3	27	12.2	24	10.8
38	1	1	38	16.9	19	7.95
	1	2	26	15	20	8.5
	1	3	41	17.2	20	8.3
	2	1	31	13.3	24	10.25
	2	2	38	16.3	11	4.7

	2	3	46	20.35	15	7.2
	3	1	22	8.65	28	12.35
	3	2	43	19.55	14	6.75
	3	3	34	15.35	9	4.35
39	1	1	17	7.35	18	7.8
	1	2	21	8.7	20	8.3
	1	3	26	10.75	19	8.8
	2	1	26	10.6	23	9.2
	2	2	21	8.5	14	6
	2	3	20	8.15	18	7.25
	3	1	13	5.9	17	7
	3	2	20	7.95	23	9.7
	3	3	23	9.35	15	7.25
40	1	1	20	8.3	14	6.8
	1	2	18	7.8	17	7.25
	1	3	24	10.45	14	6.6
	2	1	14	6.3	12	5.9
	2	2	16	6.9	12	5.7
	2	3	16	6.65	15	7.1
	3	1	16	8.01	10	4.3
	3	2	19	8.2	18	7.35
	3	3	17	7.05	16	7.9
41	1	1	11	4.9	12	5.83
	1	2	12	5.9	20	8.15
	1	3	13	6.1	16	6.4
	2	1	9	4.1	10	5.1
	2	2	14	6.1	11	4.8
	2	3	17	7.2	12	5.9
	3	1	12	5.9	14	6.2
	3	2	16	6.7	14	6.5
	3	3	12	5.6	14	7.05
42	1	1	8	4.87	11	4.42
	1	2	12	5.6	18	7.2
	1	3	15	6.8	12	5.1
	2	1	10	5.4	13	7.65
	2	2	10	6.3	12	5.45
	2	3	12	5.45	11	4.8
	3	1	12	7.3	11	4.46
	3	2	8	5.1	14	6.1
	3	3	7	3.3	9	4.55

APPENDIX II  
(Original Report)  
Effect of LCF on Cucumber Production – Trial #2  
Crop Care Hawaii LLC 2005  
Lynne Constantinides

**Background**

A 26,000 sq. ft (0.6 acre) planting was used to test the effects of Liquid Compost Factor (LCF) on Japanese cucumber production. The field was located in Kahuku, Hawaii on the island of Oahu. Crop Care Hawaii, LLC was responsible for field design and supervision of treatment applications, data collection, and data analysis. This trial measured the effect of LCF syrup and additional fertilizer applications on days to first harvest, total number of harvest days, number of fruit, weight of fruit, plant tissue nutrients, vitamin/mineral content of fruit, and shelf life.

Trial 1 assessed the effect of adding LCF to the participating farmer's standard fertilizer/pest management practice on cucumber production. An additional goal of trial 2 was to assess the effect of LCF plus additional fertilizer applications on cucumber production.

**Materials & Methods**

Cucumber seedlings were transplanted to field plots on 30 April 2006. The field was set up as a randomized block with buffer rows on each side of each replicate. Plant to plant spacing was 2.5 feet within a row and 6 feet between rows.

The field test consisted of a control and three treatments (treatment 1 = extra fertilizer, treatment 2 = 2 oz. LCF foliar/A + extra fertilizer and treatment 3 = 2 oz. LCF drip/A + 2 oz. LCF foliar/A + extra fertilizer). Each treatment and control consisted of three replicates. The control was the standard fertilizer/pest control practice of the cooperating farmer. All standard fertilizer and pesticide applications were made consistently across all treatments during this field trial.

To delineate the effects of additional fertilizer from that of LCF on cucumber production, an "extra fertilizer" treatment was required. By comparing the "extra fertilizer" treatment to the LCF plus extra fertilizer treatments, the true effect of LCF on cucumber production could be determined. The "extra fertilizer" treatments consisted of the same fertilizers applied by the same methods at the same rates and dates. "Extra fertilizer" treatments consisted of urea applied a few days after transplant through the drip at a rate of 150#/A. Four additional applications of urea were applied during fruiting through drip irrigation at the 150#/A rate. Peters 20-20-20 was applied foliarly at a rate of 10#/A every week from transplant to first fruit and twice a week from first fruit to end of harvest. The first

application of LCF was at seeding. The second application of LCF was at transplant. LCF applications were made every 2 weeks thereafter to the end of harvest.

The cooperating farmer determined when harvest would commence and end for each treatment. Harvest data included daily counts of #1 fruit and off-grades and total weight of #1 fruit and off-grades per replicate.

To determine the effects of LCF on nutrient uptake, three tissue samples were collected every 3 weeks starting 4 weeks after transplant and delivered to Brewer Environmental Industries for analysis. Tissue analysis was conducted by Brookside Laboratories, Inc. Levels of nitrogen, potassium, phosphorus, calcium, magnesium, sulfur, boron, iron, manganese, copper, zinc, aluminum and sodium were measured.

To determine effects of LCF on vitamin/mineral content on the fresh fruit, samples were collected 11 days after first harvest and delivered to the Food Quality Lab for analysis. Levels of vitamin A, vitamin C, vitamin D, vitamin E, phosphorus, calcium, iron, magnesium, potassium, sodium, zinc, copper, manganese and selenium were analyzed.

To determine effect of LCF on shelf life, six harvested fruit per treatment were placed in plastic bags with holes and stored in a refrigerator at 40 degrees Fahrenheit. Fruit were examined daily for changes in fruit quality.

## **Results**

Total days from transplant to first harvest were 33 for all treatments and control. Total harvest days were 42 for all treatments and control. Therefore, LCF did not affect the days to first harvest or number of harvest days.

All yield and tissue analysis data was analyzed using Analysis of Variance (ANOVA).

Yield data showed significantly greater total number of fruit, total fruit weight and number of #1 fruit in the treatments as compared to the control (table 1). Total number of fruit increased above the control by 37%, 34% and 59% in treatment 1, 2 and 3, respectively. Total fruit weight increased above the control by 38%, 35% and 59% in treatment 1, 2 and 3, respectively. **Number of #1 fruit increased above the control by 51%, 40% and 79% in treatment 1, 2 and 3, respectively. Total weight of #1 fruit increased in treatment 3 by 80% and 16% and 25% above the control for treatment 1 and treatment 2, respectively.**

Tissue analysis data showed significant increases in nitrogen and copper tissue levels in the treated plots (table 2). Nitrogen increased above the control by 20%, 26% and 30% in treatment 1, 2 and 3, respectively. Copper increased above the control by 26%, 29% and 18% in treatment 1, 2 and 3, respectively.

The mineral/vitamin levels of the fresh fruit were generally unchanged except for the levels of vitamin A. Vitamin A increased by 68% in treatment 3 ("lab #4" on Food Quality Lab report) above the control and "extra fertilizer" treatment.

Concerning shelf life testing, refrigerated fruit from the control and treated plots were in good condition at 6 days after harvest. At nine days after harvest (images 1, 2, 3 & 4) all fruit were starting to collapse at the blossom end. This was due to low levels of calcium in the field and subsequently in the fruit tissue. Eleven days after harvest the control and treatment #1 fruits started to develop tiny pitted areas (images 5 and 6). Fifteen days after harvest, the control and treatment #1 fruits (images 9 and 10) were developing mold and slimy. However, treatment #2 and #3 (images 11 and 12) fruit were still holding up well. Treatment #2 and #3 fruit did not become slimy until 18 days after harvest.

### **Summary**

Applications of extra fertilizer and/or LCF did not significantly effect the days to first harvest or total number of harvest days in Japanese cucumber.

**Extra fertilizer applications were responsible for significantly increasing total number fruit by 37%, total fruit weight by 38% and number of #1 fruit by 51%. The LCF plus extra fertilizer treatment significantly increased the total weight of #1 fruit above the extra fertilizer treatment alone by 17%. This comparison indicates that applications of LCF plus extra fertilizer has a benefit of producing higher yields of #1 fruit beyond that of applying extra fertilizer alone.**

Extra fertilizer applications were responsible for significantly increasing levels of nitrogen by 20% and copper by 26% in the leaf tissue.

Levels of vitamin A in the fruit treated with LCF and extra fertilizer increased 69% above the control and "extra fertilizer" treatment. More testing may be needed to clearly assess the effect of LCF on mineral and vitamin content of fruit.

The shelf life of cucumber fruit treated with LCF was extended by at least three days.

## Appendix III

### Trial 2 Data Report

<b>Liquid Compost Factor Yield Analysis in Cucumber</b>						
(n.s. = not significant)						
<b>Table 1.</b> Effect of LCF on Cucumber Yield						
Treatment	# of #1 fruit	Wt. #1 Fruit (lb)	# of off grade fruit	Wt. off grad fruit (lb)	Total # Fruit	Total Fruit Wt. (lb)
Control	612.3 <b>C</b>	296.1 <b>B</b>	344.7	166.3	957 <b>B</b>	462.4 <b>B</b>
Extra Fert.	927.3 <b>AB</b>	458.0 <b>B</b>	390.0	181.8	1317.3 <b>A</b>	639.8 <b>A</b>
Extra Fert.+LCF foliar	858.0 <b>B</b>	428.3 <b>B</b>	422.3	193.7	1280.3 <b>A</b>	622 <b>A</b>
Extra Fert.+LCF foliar+LCF drip	1098.3 <b>A</b>	535.0 <b>A</b>	421.7	199.4	1520.0 <b>A</b>	734.4 <b>A</b>
<i>F</i> =	<b>8.20</b>	<b>7.29</b>	1.06	0.80	<b>6.91</b>	<b>6.21</b>
<i>P</i> =	<b>0.0080</b>	<b>0.0112</b>	0.4193	0.5271	<b>0.0130</b>	<b>0.0175</b>
This cucumber test was conducted by Crop Care Hawaii.						
There was a Calcium problem that was corrected during the harvest period.						
There was no significant difference in the total wt of #1 fruit between the Control, Extra fertilizer and Extra fertilizer + LCf foliar.						
There was a significant difference in #1 total weight between this group and extra fertilizer + LCF Foliar +LCF Drip. This treatment has 80.7% more #1 weight than Control Treatment.						