High Tunnel Production of Greenhouse Cucumbers

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Introduction

High tunnels are passively heated, manually vented greenhouses. There are many commercial and farmer-created design variations. Common characteristics include roll-up sides, a covering of single layer polyethelene and soil based crop culture. High tunnels are growing in popularity with horticultural growers in the Northeast U.S. due to growing degree-day accumulation and weather exclusion. Tomatoes are the most popular high tunnel crop and in previous research have provided the greatest economic return. Alternative crops to tomatoes are being explored for rotation and product line expansion.

Parthenocarpic (or English) cucumbers are a successful greenhouse crop in European and North American greenhouses. They were selected for evaluation over two field seasons as a high tunnel crop due to their retail value, vertical space utilization and relatively quick yield.

Materials and Methods

A variety trial was established in Penn Yan, NY in a cooperating grower's 20 by 120-foot high tunnel to evaluate yield and disease resistance of 10 English cucumber varieties. On May 8, 2006 plants of 10 varieties at first flower stage were transplanted into a Lima silt loam soil (pH 6.6) at an in-row spacing of 16-inches with 42-inches between rows. The treatments were arranged in a randomized complete block design with four replications, 10 plants per replication. Black plastic mulch and drip tape were laid prior to transplanting. The crop was fertilized with 25 dry oz of 9-15-30 in 300 gallons of water on June 26; and July 4, 20, 27 through a 1:100 injector system via irrigation drip tape. 40 dry oz of 20-20-20 was applied July 18 in the same delivery system. A fungicide application at label rate of chlorothalonil (Bravo), tank mixed with bifenthrin insecticide (Capture EC) was made with a hand pressurized 2.5 gallon back-pack sprayer on June 21. A bifenthrin-only application was made on June 29. Bifenazate miticide (Acramite WS) was applied at label rate on July 4 with a backpack mist blower. 4000 *Phytoseiulus persimilis* predatory mites were released on June 9. A mixture containing 6000 predatory mites of the species *P. persimilis, Neoseiulus californicus* and *Mesoseiulus longipes* was introduced on July 9. Varieties were pruned to a single leader and vertically trellised weekly. Cucumber fruit harvest and yield data collection began on June 3 and ended August 9, with 2 to 3 harvests per week.

Number of fruit per block and total weight per block was recorded at each harvest. Percent foliage infested with *Podosphaera xanthii* powdery mildew was determined on July 19. Fruit length of 4 fruit per block was recorded on July 11. Varieties Ivanhoe and Corona were removed from the trial July 17 due to disease pressure. The trial was terminated on August 8. Data were analyzed using statistical software Analysis of Variance (ANOVA) procedure, and treatment means were separated using Fisher's Least Significant Difference ($p \leq 0.05$).

In 2007 a variety trial was established in the same cooperating grower's 20 by 120-foot high tunnel. Cucumber seedlings of varieties Ilias, Jawell, Manar, Ocean, and Robin, at 2-4 leaf stage were transplanted on 14 May 2007. Planting was arranged in four blocks of 10 plants each, with an in-row spacing of 12 inches. Rows were double staggered with a single drip tape and black plastic, 36 inches between plastic beds. Plants were watered in with 8 ounces of 20-20-20 fertilizer diluted in three

gallons of water to soil saturation. Additional 20-20-20 fertilizer was applied on May 19 at 8 ounces in 300 gallons water, June 9 at 16 ounces in 300 gallons water, June 17 at 14 ounces per 300 gal, June 29 at 32 ounces in 300 gallons water, July 4 at 96 ounces in 15 gallons water (hand applied), July 10 at 4 ounces in 300 gallons water; a fertilizer formulation of 9-15-30 was applied on July 17 at a rate of 32 ounces in 300 gallons water and July 18 at a rate of 24 ounces in 300 gallons water. 24 ounces of Calcium Nitrate was fertigated on July 12 and 24 ounces of Epson salt on July 13.

Biological control was used throughout the 2007 growing season, with no chemical controls applied. 500 *Aphidius colemani* and 250 *Aphidius ervi* were released on June 17 and 29 for aphid control; 500 *Orius insidiosus* on July 4 and 10,000 *Amblyseius cucumeris* on July 20 and 27 for thrips control; and 2000 *Amblyseius californicus* for spider mite control on July 20 and 27. Number of fruit per block and total weight per block was recorded at each harvest. The trial was terminated on August 10. Data were analyzed using statistical software Analysis of Variance (ANOVA) procedure, and treatment means were separated using Fisher's Least Significant Difference.

Results

In 2006 Ilias yielded significantly more fruit than all other varieties (Table 1.). Ilias also yielded the highest mean weight per block, at 108.2 pounds (10 plant blocks) but, varieties Manar, Alladin and Discover did not statistically differ. Corona and Ivanhoe were grouped as the lowest yields, as measured by both mean fruit per block and mean weight per block in pounds. Powdery mildew infection ratings were measured on a 0-9 scale, with 0 representing 0% foliage infected and 9 representing plant death due to complete foliar infection. Discover had the lowest powdery mildew rating at 0.3, which was statistically similar to Manar, Niagara, Curtiz, Murgis. Nearly complete foliar infection was recorded for Corona and Ivanhoe, both with a mean of 8.3. Ivanhoe and Murgis had the longest mean fruit length of 15.5 inches. Alladin, Discover and Camaro were also in the same statistical group. Ilias and Manar were ranked in the lowest group for length.

Table 1. Variety yield in pounds and fruit number; mildew severity and length in 2006.

Variety	**Mean Fruit per Block (10 plants in a block)**	**Mean Weight per Block (10 plants in a block)**	**Mean Powdery Mildew Rating per Block**	**Mean Fruit Length in Inches**
Ilias	307 a*	108.2 a	3.8 b	8.4 e
Manar	226.5 b	84.6 ab	0.5 e	7.6 e
Alladin	146.5 c	88.8 ab	2 cd	15 ab
Discover	128.8 cd	84.4 ab	0.3 e	14.7 ab
Curtiz	123.3 cd	76.8 b	1 de	14.5 bc
Murgis	118.8 cd	78.4 b	1 de	15.5 a
Camaro	111.3 cd	73.6 b	3.3 bc	14.7 ab
Niagara	110.3 cd	67.9 b	0.8 de	13.5 d
Corona	77.3 de	38.6 c	8.3 a	13.7 cd
Ivanhoe	51.5 e	31.1 c	8.3 a	15.5 a
LSD	*51.9*	*25.5*	*1.3*	*0.9*

*Means with different letters (grouping) differ significantly according to Fisher's Protected LSD (P<0.05)

In 2007 Ilias continued to lead with highest yield as measured by mean pounds per plant and mean fruit per plant although this was not significantly different from other varieties (Table 2). Powdery Mildew did not impact production in 2007.

Table 2. Yield per variety in 2007 as measured by mean pounds and fruit per plant.

Variety	**Mean pounds per plant**	**Mean fruit per plant**
Ilias	11.1 ns*	27.7 ns
Manar	10.9	25.9
Ocean	10.9	23.7
Jawell	8.9	22.4
Robin	9.6	20.9

*No significant differences between groups according to Fishers's Protected LSD ($P<0.05$)

Discussion

In 2006 great yield differences were observable between varieties. If the high tunnel were planted solely to highest yielding variety, Ilias, the equivalent would be nearly 4000 pounds, approximately 80 bushels from 2400 square feet. However pest and disease pressure from Two Spotted Spider Mite (*Tetranychus urticae*), Powdery Mildew, Bacterial Wilt (*Erwinia tracheiphila*) and Aphids (*Aphis* and *Myzus* spp.) was too great to continue the trial beyond the month of August. Manar showed excellent powdery mildew resistance and its yield in weight was also ranked in the highest statistical grouping. The varieties 'Ilias' and 'Manar' are 'beit-alpha' types, harvested at a much smaller size than the other 'English' varieties.

In 2007 the trial was dedicated solely to beit-alpha varieties. Although all varieties performed similarly statistically, Ilias and Manar were grower favorites for earliness and fruit quality. By increasing density from the 2006 rate of 1 plant/5.2 sq ft to 1 plant/2 sq ft, yield and economics were improved. Extrapolating data from our highest yielding variety, Ilias, indicates a potential of 13320 pounds, or 266.4 bushels from 2400 sq ft.

Further research is needed in several areas:

- Pest Management. Precise guidelines are needed for both biological and chemical control.
- Variety Evaluation. Production in the colder 'shoulder' seasons when prices are higher would increase profitability, but many varieties are highly cold sensitive.
- Crop rotation. English cucumbers can be double-cropped themselves or with other short season crops, such as snap beans, greens or other cucurbits. Feasibility and profitability of these systems must be evaluated.

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