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Evaluation of Twelve Greenhouse Mini Cucumber (Beit Alpha) Cultivars and Two Growing Systems During the 2002-2003 Winter Season in Florida

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Introduction

Mini cucumbers (Beit alpha types) have increased in popularity in the United States. Greenhouse production commercially in Florida and Georgia during the 2002-2003 season was approximately 3 acres. These initial trials appear to show potential for increases in greenhouse acreage in Florida. Traditionally, cucumber yields are much lower in the winter season compared to spring, fall, or even summer. This trial was conducted to evaluate production specifically for the winter season to determine the best varieties for winter production in Florida greenhouses.

Materials and Methods

This cucumber trial was conducted at the University of Florida North Florida Research and Education Center – Suwannee Valley near Live Oak, FL from 13 Dec 2002 to 7 Apr 2003. The greenhouse structure was a stand-alone 20 x 55 ft greenhouse with 8 ft sidewalls covered with two layers of polyethylene with the area between the two layers inflated with air. The greenhouse was heated with propane forced-air heaters and cooled with a fan and evaporative pad system. Temperature controls were set for a minimum of 64°F and a maximum of 85°F.

The trial was designed as a split-plot design with three replications. The main plots were varieties and the split plots were media (rockwool or perlite). The media treatments were: 3 x 8 x 36 inch sleeved Grodan Classic rockwool slabs (Agrodynamics, Coppell, TX), or lay-flat bags 36 inches long and 10.5 inches in diameter filled with perlite (horticultural grade perlite, Airlite Crop, Vero Beach, FL). Cucumber seeds of twelve cultivars (Table 1) were planted into 128 cell (1½ x 1½ inch cells) styrofoam trays filled with Metro Mix 200 growing medium for the plants to be used in the lay-flat perlite bags. Transplants to be used in the rockwool slabs were started by seeding directly into a 3 x 3 x 2.5 inch rockwool cube with a 1-inch hole in the center of the cube. All seeds were slightly covered with perlite. The seeds were planted on 13 Dec 2002. Transplants were grown using a weekly fertilization of a complete hydroponic nutrient solution set at 80 ppm of N and 120 ppm K. Transplants were planted to the

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experimental plots on 10 Jan 2003 when the plants were 4-5 inches in height. Each rockwool slab or perlite bag was planted with three cucumber plants to form one experimental unit. This resulted in a plant density of 3.2 square ft per plant.

Nutrient solution delivery was via a micro-irrigation system with one emitter per plant. Irrigation was scheduled using a starter tray system (AgroDynamics) and was set to maintain a leachate rate of 15-20% on each irrigation event (Florida Greenhouse Vegetable Production Guide http://edis.ifas.ufl.edu/TOPIC_Greenhouse_Production). Leachate was collected but not recirculated. Nutrient solution, once transplants were planted, was set at 100 ppm N (Table 2) and delivered for three weeks. At three weeks after transplanting, nutrient solution was increased to 180 ppm N and maintained until crop termination.

Plants were trained up a single string by wrapping the string around the stem once a week. Once the plant reached the overhead trellis cable (7-ft high), the stem was trained along the cable for one foot and allowed to drape down and grow to the floor. Any side shoots were pruned out as they appeared. All small fruit were removed from the lower one-foot of the stem as they appeared.

Marketable size fruits were harvested daily beginning 11 Feb 2003 until 7 Apr 2003. Fruits were graded into three grades: No 1 fruit = one-inch diameter or smaller and reasonable good shape, No 2 = greater than one-inch diameter and somewhat curved, or Cull = poorly shaped or with obvious defects. Fruits of each grade were weighed and the weights recorded. These grades were identified by a local commercial grower since no USDA grades exist for these mini cucumbers.

Postharvest evaluations were conducted on fruits harvested and stored on 23 Feb, and at harvest only on 25 Mar 2003. Ten fruit from each cultivar were collected and measurements were taken on length, diameter, external color, firmness, and skin smoothness. Measurements were taken on 27 February and fruits were stored in plastic clamshells at 10°C (50°F) for eight days and reevaluated for the same parameters on 7 March. Fruit weights were taken before and after storage to determine weight loss. External color was determined with a Minolta Chroma Meter CR-200. The measurement was taken at the equator of the fruit. Measurements are presented as Lightness, Chroma Value, and Hue Angle. Firmness was determined with an Instron Series IX Automated Testing System 7. A 10-mm cross-sectioned slice was made at the equator of the fruit, the slice was laid on its side and a 3-mm probe was used to determine the bioyield point of the flesh. The bioyield point is the force required to deform the tissue until it ruptures. Data were analyzed by analysis of variance and means separation was by Duncan's Multiple Range Test. Ratings for fruit skin smoothness were taken on 26 Feb 2003. Fruit sets of 5 fruit per variety were given an

observational rating based on a scale of 1-5; 1=smooth (lack of ridges), and 5=rough appearance due to ridges.

Ratings were also made on a later planting of the same 12 varieties used in this trial (planted on 10 Jan 2003). During the season for the crop planted 10 Jan 2003, no powdery mildew was observed. A later planting of the same varieties was used to make observations on powdery mildew.

On 8 Jan 2003 (two days before planting to trial), night temperatures dropped to 50°F due to a heater malfunction. Chilling injury was observed on the transplants and observational injury ratings were recorded on 10 Jan 2003.

The crop was monitored for insects, mites, and diseases during the season using standard IPM scouting techniques. Diseases were managed by environmental controls primarily, including horizontal air-flow fans and floor-level air and heat distribution via eight-inch diameter polyethylene tubes. No pesticide spray applications were required during the crop trial.

Results and Discussion

Chilling Injury – Damage to transplants due to sudden cool temperatures indicate cucumber varieties varied in sensitivity to chilling injury (Table 3). The varieties 'Kian', 'Tornac', and 'Tenor' showed the most chilling injury. The most severe chilling injury symptoms included stunting, and severe yellowing. A mild symptom was a light green color of the leaves. Intermediate chilling injury was slight yellowing. Intermediate chilling injury was observed in 'General' and 'Manar'. All other varieties showed only slight chilling injury symptoms.

Cucumber Yield – Total marketable yield ranged from 1393 to 2637 grams per plant (Table 4). 'Tenor' had the lowest total marketable yield of all varieties at 1393 grams per plant. 'Alamir', 'LDC845', 'General', and 'Manar' all had total marketable yield of 2300 grams or more per plant but were not significantly different from most varieties.

Total No. 1 fruit yield ranged from 853 to 2073 grams per plant with 'Tenor' having the lowest No. 1 yield. Top total No. 1 yields were found in 'Alamir', 'LD CB845', 'General', 'Manar', and 'Tornac'. These same varieties along with 'Sarig' were also included in those producing the most No. 1 fruits per plant, each producing 25-30 fruit per plant.

High early No. 1 yields were found in 'LD CB845', 'Manar', '4419', 'Alamir', and 'General'. Low early yield was found in 'Tenor' and 'Condesa'.

Several varieties produced similar No. 2 fruits with yields of 500-770 grams per plant. No significant differences were found among the number of No. 2 fruit or cull weights per plant.

It should be noted some 'Tenor' plants had unusual growth and were not uniform in appearance. The non-uniformity appeared to be genetically related.

Growing Media – the two growing media, rockwool and perlite, produced similar yield and quality for several yield parameters (Table 5) including: total No. 1 fruits yield and number of fruits, total No. 2 fruit yield and number of fruits, total cull fruit yield and number of fruits, and total marketable fruit yield and number of fruits. Early No. 1 fruit yield and number was higher with perlite than rockwool.

Fruiting pattern of mini cucumber.

Fruit Size Characters – No significant difference in fruit width was found among the twelve cucumber varieties with all means between 26.4 to 27.7 mm in diameter (Table 6). Fruit length ranged from 136 to 178 mm per fruit. 'Tenor' had the longest fruits at 178 mm, followed by '4419' at 167 mm, and 'Ilas' at 157 mm. Lowest fruit length was found in 'Delta Star' at 136 mm, but was similar in length to 'Condesa', 'Sarig', 'Kian', 'General', 'Alamir', and 'Manar', all between 136 and 144 mm.

Firmness (resistance to biological force) – Measurements of bioyield force are shown in Table 7. Initially, the firmest variety (highest bioyield force) on 27 Feb was 'Condesa'. After one week of storage firmest varieties were 'Condesa', 'Delta Star', 'Kian', and LD CB845'. The 25 March sampling showed the firmest varieties to be 'Delta Star', 'Condesa', 'Kian', and 'LD CB845'. Overall, the following varieties were firmest: 'Condesa', 'Delta Star', 'Kian', and 'LD CB845'.

Fruit Weight Loss – The variety with the most weight loss was '4419' followed closely by 'Almir', 'Delta Star', and 'General'. Cucumber variety 'Sarig' had the lease weight loss followed by 'Condesa' (Fig 1). There were no major visual differences between varieties after storage. However, all of the varieties did appear to lose sheen (gloss) near the stem end, while the rest of the fruit remained shiny.

Fruit Color Parameters – Peel color parameters were measured for Lightness, Chroma, and Hue (Table 8). There were negligible differences in color, with Hue Angles ranging from 123 to 126^{o}, in the yellow-green sector, where 90^{o}= yellow and 180^{o} = green. Lightness (0 = black and 100 = white) and Chroma Value (color intensity) also remained fairly constant between harvests and following simulated commercial storage.

Sensor Evaluation for Taste – The sensory evaluation for taste is summarized in Table 9. No significant difference was found among the twelve varieties. All varieties had ratings of 3.3 to 4.7, signifying good to excellent taste.

Fruit Skin Smoothness – Samples of five representative fruit per variety were evaluated for ratings of fruit smoothness (Table 10). The variety with the smoothest appearance was 'Sarig', followed by 'General', 'Manar', and 'Kian'. The varieties with the most ridges (roughest appearance) were 'Condesa', 'Alamir', 'Tenor', and 'Ilas'.

Powdery mildew symptoms on greehouse cucumber.

Powdery Mildew – Observational ratings for powdery mildew were made on a separate and later planted crop (Table 11). Varietes with the most tolerance to powdery mildew were 'Tornac', 'Condesa', Delta Star', '4419', and 'Tenor'. The variety with the least tolerance to powdery mildew was 'Sarig', followed by 'Alamir', LD CB845' and 'Ilas'.

Overall Conclusions

Several varieties performed very well in this trial. The choice of media made little difference except in terms of early yield. This was likely due to higher level of chilling damage in the transplant stage to rockwool-grown plants. The data presented here can be used to evaluate several characteristics of mini cucumber varieties. The data should especially be valuable when evaluating yield, fruit length, color, transplant chilling sensitivity, skin smoothness, and powdery mildew tolerance. The winter yield of cucumbers in Florida greenhouses is known to be reduced significantly from other spring or fall crops. This trial evaluates the specific performance of these mini cucumber varieties during the winter season.

'Sarig' is a standard variety with little or no powdery mildew tolerance. All other varieties are listed as powdery mildew tolerant. This trial data indicates several powdery mildew tolerant varieties performed similar in terms of yield to that of 'Sarig' under these growing conditions and could be considered for commercial production.

Table 1. Mini cucumber cultivars and seed sources.

Cultivar	Seed Source	
Ilas	Daehnfeldt	PO Box 947 | Albany, OR 97321 | Ph 561-928-5868, Fax 541-928-5581
LD CB845	Daehnfeldt	
Tenor	Daehnfeldt	
General	DeRuiter	PO Box 20228 | Columbus, OH 43220 | Ph 614-459-1498, Fax 614-442-1716
Manar	DeRuiter	
Tornac	DeRuiter	
4419	Hazera	1369 East Ave. | Chico, CA 95926-7335 | Ph 888-894-7346, Fax 888-894-7346
Sarig	Hazera	
Alamir	Nunhems	PO Box 18 | Lewisville, ID 83431 | Ph 208-754-8666, Fax 208-754-8669
Kian	Nunhems	
Condesa	Rijk Zwaan	PO Box 40 | 2678 ZG DeLier | The Netherlands
Deltastar	Rijk Zwaan	

Table 2. Nutrient solution concentrations (ppm) used at various stages of cucumber growth.

Nutrient	Stage of growth		
	Seeding to transplant	Transplant to 3 weeks	3 weeks to termination
N	80	100	180
P	50	50	50
K	120	150	200
Ca	150	150	150
Mg	40	40	50
S	50	50	60
Fe	2.8	2.8	2.8
Cu	0.2	0.2	0.2
Mn	0.8	0.8	0.8
Zn	0.3	0.3	0.3
B	0.7	0.7	0.7
Mo	0.05	0.05	0.05

Table 3. Observational rating on transplant chilling injury on 10 Jan 2003.

Variety	**Chilling Injury Rating (1-5)[z]**
Ilas	2
LD CB845	2
Tenor	4
General	3
Manar	3
Tornac	4
4419	2
Sarig	2
Alamir	2
Kian	4
Condesa	2
Deltastar	2

[z] Chilling injury rating (1-5)

1 = No damage
2 = Slight chlorotic color change
3 = clear chlorotic color change
4 = severe chlorotic color change
5 = severe burn

Note: Ratings were taken on 10 Jan, two days after transplants were exposed to 50ºF temperature for 6-8 hours (8 Jan) due to heater malfunction.

Table 4. Seasonal mini cucumber fruit yield and fruit number per plant for No. 1, No. 2, and cull fruit per plant for the total season and early season.

Variety	No. 1 Fruit		No. 2 Fruit		Cull		Total Marketable		Early No. 1 Yield[z]	
	Wt (gm)	Fruit No.	Wt (gm)	Fruit No.	Wt (gm)	Fruit No.	Wt (gm)	Fruit No.	Wt (gm)	Fruit No.
Alamir	2073 a[y]	30.0 a	564 abc	6.3	100	1.5 abc	2637 a	35.7 ab	304 abc	4.7 bc
LD CB845	1998 ab	26.6 ab	610 abc	6.3	147	2.2 abc	2608 ab	33.0 abc	400 a	6.0 a
General	1981 abc	28.7 ab	649 abc	10.0	70	1.0 bc	2631 a	38.7 a	298 abc	4.3 bc
Manar	1954 abc	27.7 ab	380 c	3.6	138	2.2 abc	2334 ab	31.3 abcd	390 ab	5.7 ab
Tornac	1786 abcd	24.7 bcd	440 bc	8.0	153	2.8 a	2227 ab	32.7 abc	282 c	4.0 cd
4419	1660 bade	19.3 e	491 abc	4.0	94	1.0 bc	2151 ab	23.3 d	213 abc	3.7 cd
Sarig	1629 bcde	25.7 abc	439 bc	5.6	163	2.6 a	2067 b	30.3 bed	253 c	3.7 cd
Ilas	1607 cde	20.3 de	624 abc	6.0	145	2.0 abc	2231 ab	26.3 cd	236 cd	3.3 cd
Kian	1567 de	21.7 cde	673 ab	7.0	144	1.9 abc	2240 ab	28.7 bcd	293 bc	4.3 bc
Condesa	1378 e	19.7 e	761 abc	7.0	58	1.0 c	2140 ab	26.7 cd	160 de	2.3 d
Delta Star	1383 e	19.7 e	745 abc	7.3	105	1.2 bc	2128 ab	27.3 cd	252 c	4.0 cd
Tenor	853 f	8.7 f	540 abc	4.3	162	2.0 abc	1393 c	13.0 e	63 e	0.7 e
Significance[y]	**	**	*	NS	NS	**	**	**	**	**

[z] Early harvests include first ten harvests (11 Feb to 21 Feb 2003).

[y] Within a column, means followed by different letters are significantly different according to DMRT at 5% (*) or 1% (**) level. NS=differences are not significant.

Note: Grades used were:

No. 1 = one-inch diameter or smaller and reasonable good shape.
No. 2 = greater than one-inch diameter and somewhat curved.
Cull = poorly shaped and/or with obvious defects.

Table 5. Effect of growing media on mini cucumber seasonal yield per plant and quality.

	Rockwool	Perlite	Significance[z]
Total No. 1 wt (gm)	1659	1647	NS
Total No. 1 Fruit No.	23	22	NS
Total No. 2 wt (gm)	596	556	NS
Total No. 2 Fruit No.	6	11	NS
Total Cull wt (gm)	100	142	NS
Total Cull Fruit No.	6	2	NS
Total Mkt wt (gm)	2256	2203	NS
Total Mkt Fruit No.	29	34	NS
Early No. 1 wt(gm)	215	324	**
Early No. 1 Fruit No.	3	4	**

[z] Means across a column were either not significant (NS) or significant at the 1% level.

Table 6. Differences in length and width of twelve mini cucumber varieties during the winter season of 2002-2003.

Variety	Length (mm)	Width (mm)
Tenor	178 a [z]	26.8
4419	167 b	26.9
Ilas	157 c	26.9
LD CB845	149 d	26.4
Tornac	147 de	27.0
Manar	144 def	27.5
Alamir	140 def	27.1
General	140 def	27.7
Kian	139 def	27.0
Sarig	139 ef	26.8
Condesa	137 f	26.8
Delta Star	136 f	26.6
		NS

[z] Means within a column followed by different letters are significantly different as separated by Duncan's Multiple Range Test ($p \leq 0.05$). NS = means are not significantly different.

Table 7. Firmness of mini cucumber varieties for two harvests.

Variety	Biological Force 27 Feb (N)	Biological Force 7 Mar (N)	Biological Force 25 Mar (N)
4419	10.5 ab[z]	10.4 bc	9.0 c
Alamir	10.5 bc	10.1 bc	9.3 bc
Condesa	12.2 a	11.6 ab	10.3 ab
Delta Star	11.1 b	12.0 a	10.7 a
General	10.1 bc	10.5 bc	9.0 c
Ilas	9.9 bc	10.3 bc	9.5 bc
Kian	10.3 bc	10.7 abc	10.3 ab
LD CB845	10.2 bc	10.7 abc	10.3 ab
Manar	10.3 bc	9.7 cd	9.1 c
Sarig	9.7 c	8.6 d	9.3 bc
Tenor	9.4 c	10.5 bc	9.0 c
Tornac	10.2 bc	9.4 cd	8.4 c

[z] Means within a column followed by different letters are significantly different as separated by Duncan's Multiple Range Test ($p \leq 0.05$). NS = means are not significantly different.

Table 8. Effect of mini cucumber varieties on color parameters.

Variety	Fresh Initial 27 Feb Harvest			After Storage 7-Mar			Fresh Initial 25 Mar Harvest		
	Lightness	Chroma	Hue	Lightness	Chroma	Hue	Lightness	Chroma	Hue
4419	44 a[z]	28 a	124 ef	42	27 abc	126 ab	40 b	28 abcd	124 abc
Alamir	43 abc	28 a	124 cdef	42	27 abc	125 ab	41 b	26 bcd	126 a
Condesa	44 a	27 ab	123 f	43	29 ab	124 ab	39 b	25 cd	124 ab
Delta Star	43 abc	27 abc	124 cdef	42	26 bc	125 ab	46 a	30 a	122 c
General	42 abcd	28 a	125 abcd	43	29 ab	125 ab	43 ab	26 abcd	125 a
Ilas	40 cd	24 d	126 abcd	42	27 abc	125 ab	39 b	24 cd	125 a
Kian	43 ab	27 a	124 def	44	30 a	123 b	42 ab	28 abc	124 ab
LD CB845	42 abcd	25 bcd	126 abcd	43	27 abc	125 ab	42 ab	26 cd	125 a
Manar	39 d	24 cd	126 abcd	42	28 abc	125 ab	42 ab	24 d	125 a
Sarig	42 abcd	26 abcd	125 bcde	43	29 ab	125 ab	39 b	26 cd	126 a
Tenor	41 bcd	24 cd	126 ab	41	25 c	126 a	42 ab	27 abcd	124 abc
Tornac	41 bcd	26 abcd	125 abcd	44	28 ab	125 ab	41 b	30 ab	123 abc
				NS					

[z] Means within a column followed by different letters are significantly different as separated by Duncan's Multiple Range Test ($p \leq 0.05$). NS = means are not significantly different.

Table 9. Sensory evaluation for taste of mini cucumber varieties.

Variety	Taste Rating (1-5)
Alamir	4.7
Kian	4.3
LD CB845	4.3
Tenor	4.0
Ilas	4.0
Delta Star	4.0
Sarig	4.0
Tornac	4.0
4419	3.7
General	3.7
Manar	3.3
Condesa	3.3
	NS[z]

[z] NS indicates means in column are not significantly different (p=0.05).
Ratings were made on a 1-5 scale: 1-best taste, 5=poorest taste.

Table 10. Observational ratings for fruit skin smoothness

Variety	Smoothness Rating (1-5)[z]
Sarig	2
Manar	3
General	3
Kian	3
Delta Star	4
4419	4
Tornac	4
LD CB845	4
Ilas	5
Tenor	5
Alamir	5
Condesa	5

[z] Fruit samples were rated for smoothness of the skin on a scale of 1-5, with 1=no ridges giving a smooth appearance, 2=very slight ridges, 5=significant ridges on fruit giving it a "rough" appearance.

Table 11. Observational ratings for powdery mildew susceptibility on several cucumber varieties.

Variety	Powdery Mildew Rating[z]	
	30 May	10 Jun
Tornac	4	2
Condesa	3	5
Delta Star	10	5
4419	6	10
Tenor	20	13
Kian	28	20
Manar	30	25
General	35	40
Ilas	60	45
LD CV845	60	45
Alamir	78	50
Sarig	90	100

[z] Ratings were made based on the percentage of the combined surface of the top 10 leaves with visible powdery mildew.

Fig 1.

Weight loss in beit-alpha cucumbers after 8 days of storage at 10°C (50°F)