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Gherkin elite line selection

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ABSTRACT - *Gherkin lines were obtained by mass selection cycles in alteration with inbreeding cycles in a F_2 population evaluated by Koch and Costa (1991). The purpose of the present study was to identify and select elite lines with plant uniformity and desirable fruit characteristics. Seedlings of 71 lines were obtained in a greenhouse and transplanted to a bed covered with black polypropylene felt. The plants were grown prostate along the ground, without pruning, in a randomized complete block design, with three replicates and five plants per plot. Three criteria were trendsetters for line selection: lack of dormancy, plant and fruit uniformity, and yield components performance. Based on these parameters, the $F_6M_5S_1$ gherkin lines 1, 2, 3, 4, 5, 6, 8, 15, 20, 55, 60, and 63 were selected. These elite gherkin lines were called Paulista Gherkin, due to their contrasting characteristics in relation to the common type.*

Key words: gherkin, *Cucumis anguria* var *anguria* L., selection.

INTRODUCTION

Common Brazilian gherkins are not bitter in taste and highly variable in prickliness and size (Paiva 1994). According to Pimentel (1985), there are two gherkin cultivar types: one with prickly and the other with spineless fruits. Queiroz (1993), studying the northeastern Brazilian gherkin germplasm, identified three types: a spineless one, another with scattering thick spines, and the last densely covered with thin spines. However, according to Yokoyama (1987), the genetic basis of Brazilian gherkin germplasm is too narrow. He recommended interspecific hybridization with compatible indigenous *Cucumis* species in order to increase the genetic variability.

Wild *Cucumis* species have small bitter fruits, and variability in color and prickliness. Cucurbitacine, a terpenoid compound, confers bitterness to the fruit and vegetative parts, and is the reason why wild gherkin is discarded for food use. In the African savannas, *Cucumis'* fruit bitterness is an effective deterrent against herbivores and responsible for its survival. However, the wild *Cucumis* species is also a broad genetic resource, which is important for the improvement of domesticated *Cucumis* crop species. Interspecific hybridization has been employed in *Cucumis* breeding to incorporate disease resistance and other characteristics into commercial species (Paterniani 1988).

Koch and Costa (1991) worked with parental populations from a native gherkin accession of the *Cucumis* germplasm collection from Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo (ESALQ/USP), Piracicaba, SP, and realized an interspecific cross *with Cucumis anguria* var *longaculeatus* x *Cucumis anguria* var *anguria*. Fruit taste, weight, and prickliness inheritance were assessed for further recombination and selection of agronomic characteristics. The authors determined that leaf type inheritance was due to an incomplete dominance gene action, fruit taste was monogenic, while the bitter was dominant over the non-bitter taste. Fruit prickliness was controlled by two dominant genes that cause a more intense fruit prickliness. Double recessive genes produced thornless fruits. Fruit weight was defined by additive gene action, which allows effective genetic improvement for this important fruit characteristic in gherkin. Paiva (1984) also estimated gherkin yield genetic parameters based on 64 progenies. The author identified a high heritability for fruit weight, so simple mass selection would be efficient to improve fruit size and quality.

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Allogamous gherkin breeding, on the other hand, would offer the advantages of: monoecious expression, larger flowers for crossing, ginoecism induction by Ethrel to high fruit retention ability without fruit abortion, high seed number per fruit; and a short cycle to physiological seed maturity.

Yokoyama and Silva Júnior (1988) stated that gherkin breeding should be aimed at the following objectives: a) adaptability to crop management system; b) disease and best resistance to increase fruit quality and higher yield; and c) no seed dormancy. They also suggested pedigree selection method from segregating populations originated from interspecific crosses by mass selection and inbreeding scheme to achieve genetic uniformity. It should be emphasized that allogamous gherkin do not suffer vigor depression under inbreeding.

This paper aimed to report the final step of gherkin breeding to identify and select elite lines originated from an interspecific cross of *C. anguria* var *anguria* and *C. anguria* var *longaculeatus*.

MATERIAL AND METHODS

The experiment was carried out May through September 1998, on experimental area in Piracicaba, State of São Paulo, Brazil (lat 22° 42' S, long 47° 39' W, and altitude 543 m asl).

Gherkin lines were developed from a gherkin breeding program launched in 1984, in ESALQ/USP. Initially, *Cucumis anguria* var *anguria* were crossed with *Cucumis anguria* var *longaculeatus* cultivars. After the F_2 population had been used to assess fruit and leaf type inheritance by Koch and Costa (1991), Costa[1] advanced six cycles by mass selection blended with inbreeding cycles and developed more than a hundred lines in the F_7S_2 generation, as shown in Figure 1. These lines differ from the common type by their thornless fruit, higher mature fruit weight (over 90 g) and non-lobular shaped leaves, similar to those of cucumber (Figure 1).

From among 71 lines, 12 lines of the $F_7M_6S_2$ generation were eliminated at the germination stage due to their seed dormancy. Seed germination was carried out using phenolic foam. All lines with seed germination below 60% were discarded due to their seed dormancy. Thirty days after sowing, the seedlings of the remaining 56 lines were transplanted to stiro-foam trays with 128 cells filled with commercial substrate. Seedlings were transplanted to only 72 cells of each stiro-foam tray to produce larger transplants. After 21 days, they were transplanted to the field.

Plants were spaced 0.50 m in a single row of a 1.20 m wide bed and the beds covered with black polypropylene felt. A trickle irrigation system was used with Krystalon fertilizer for fertilization.

Plants were grown prostrate along the ground in the usual cucurbit cropping system. Pest and disease control was similar to that used for cucumber crop.

[1] Costa CP. Personal communication, 1998.

Cucumis anguria var *anguria* x *Cucumis anguria* var *longaculeatus*
↓
F_1
↓
M_1 F_2 Selection for non-bitter taste and thornless fruits.
↓
M_2 F_3 Selection for non-lobular shaped leaves.
↓
M_3 F_4 Selection for larger sized mature fruits.
↓
M_4 F_5 Individual plant selfing and selection for larger fruit size (over 90 g), non-bitter, and thornless.
↓
M_5 S_1 F_6 S_1 progeny evaluation and selection for larger fruit size (over 90 g). Second selfing generation.
↓
M_6 S_2 F_7 S_2 progeny evaluation and elite line selection.

M_1 - M_5: mass selection cycle; S_1 - S_2: selfing generation.

Figure 1. Origin and pedigree of gherkin elite lines.

Three selective criteria were adopted for line evaluation. The first one was based on seed dormancy. Lines with poor germination due to seed dormancy were discarded. The second one was related to plant and fruit uniformity in prickliness and bitterness. A scoring system was employed for line uniformity, where: 1 = high and 5 = low uniformity. Fruits were thinned out to get more concentrated fruiting in the two earliest harvests. The third one was based on yield components. The yield was expressed in the total number and total fruit weight per plot. Fruit length, diameter, and flesh thickness was measured with a caliper rule, using 10 fruit samples per plot for both harvest stages. Flesh thickness was measured from the external fruit surface up to the placenta, considering an average value from two cross-section measurements per fruit. Fruit weight was estimated based on total fruit weight by the total number for both harvests. The length (L) to width (W) ratio was obtained. The L/W ratio expresses the fruit shape where values near 1 indicate round shaped fruits, while values above 1 indicate elongated fruits. Five fruits per plot were sampled and their juice extracted to determine the total soluble solids (TSS), expressed as Brix (^{o}Brix) degrees, by a refractometer. The following selective criteria were used to identify the best and most uniform elite lines: a) average fruit weight over 50 g; b) plant of medium prolificacy (lines with highest fruit number but with fruit weight over 50 g were considered medium prolific); c) elongated fruit shape (L/W ratio above 1.0); d) flesh thicker than 4 mm and e) soluble solids contents over 3 ^{o}Brix.

A randomized block design, with three replicates and five plants per plot was used. The analysis of variance was carried out and Tukey´s multiple range test at 5% probability was applied to compare the means.

RESULTS AND DISCUSSION

Gherkin seeds may express negative photoblastism, which induces dormancy in some varieties. Dormancy has been mentioned as a trait of high heritability (Cardoso 1995). Out of 71 lines, 12 were discarded as their germination was below 60%.

Twenty-seven lines were discarded owing to poor uniformity (scales 3, 4, and 5). Accordingly, 29 $F_7M_6S_2$ lines (1, 2, 3, 4, 5, 6, 8, 11, 15, 17, 20, 26, 27, 29, 35, 37, 42, 54, 55, 56, 58, 60, 61, 62, 63, 64, 69, 71, and 76) were selected for their high uniformity.

Elite lines were chosen mainly based on fruit weight yield criteria with values over 50 g (Tables 1 and 2). On average, Brazilian common gherkins weigh 35 g (Pimentel 1985, Resende 1998, Filgueira 2000).

Lines with a higher number of fruits per plant usually presented lower average fruit weight. Most of the remaining lines showed intermediate values for these fruit yield components (Table 1). Lines with intermediate fruit number but with fruit weight over 50 g were elected.

The L/W ratio is an important characteristic for fruit brining, either of entire fruits or segments. Cylindrical-shaped cucumber fruits, with a L/W ratio around 3.0, are considered ideal for brining (Ribeiro and Melo 1989). The L/W ratio of gherkin depends on the varietal fruit type and correct maturity stage at harvest time. Modolo and Costa (2000) employed a scoring system based on the physiological seed maturation degree to define the ideal harvest stage for fruit processing. However, no relationship was found between seed maturation and L/W ratio. Gherkin fruits are more round than elongated when compared to cucumber fruits for pickles. Therefore, further studies are needed to determine the ideal harvest stage and the best L/W ratio for pickles processing. In this experiment, lines with elongated fruits and L/W ratio values above 1 were selected, namely lines 1, 2, 3, 4, 5, 6, 8, 11, 15, 17, 29, 35, 42, 55, 58, 60, 63, 64, and 76.

Compared to line 76, line 20 presented a thicker flesh, statistically (Table 2). Thick flesh is a desirable characteristic for fresh cut consumption. The remaining lines showed intermediate performance. No differences among lines were observed in the amount of soluble solids.

Considering all three selection criteria, the following $F_6M_5S_1$ gherkin lines were singled out as elite lines: 1, 2, 3, 4, 5, 6, 8, 15, 20, 55, 60, and 63. This group of genetically improved gherkin lines was designated Paulista Gherkin, due to its contrasting fruit and plant characteristics, distinct from the Common Brazilian Gherkin. Further studies are required to adjust a better and more adequate production system for this crop.

Table 1. Fruit length (L), width (W), L/W ratio, mean fruit weight (FW) and total number of fruit per plant (TFN) of $F_6M_5S_1$ gherkin fruit lines, at the first harvest stage

Lines	L	W	L/W	FW	TNF
	cm			g	
L1	6.73 ab	4.43 ab	1.52 abcd	63.38 ab	1.93 b
L2	6.76 ab	4.72 a	1.43 bcde	70.26 a	4.33 ab
L3	6.70 ab	4.52 ab	1.48 abcd	64.19 ab	3.40 ab
L4	6.18 abcd	4.34 ab	1.42 bcde	58.39 ab	3.66 ab
L5	6.53 abc	4.21 ab	1.55 abcd	54.70 ab	2.86 b
L6	6.45 abc	4.47 ab	1.44 abcde	61.77 ab	4.00 ab
L8	6.58 abc	4.02 b	1.64 ab	51.48 ab	3.48 ab
L11	6.53 abc	4.27 ab	1.53 abcd	56.50 ab	4.70 ab
L15	7.10 a	4.51 ab	1.58 abc	68.85 a	4.60 ab
L17	6.66 ab	4.33 ab	1.54 abcd	63.74 ab	3.37 ab
L20	6.24 abc	4.57 ab	1.36 cdef	62.96 ab	4.70 ab
L26	5.04 e	4.02 b	1.25 ef	39.06 b	7.64 a
L27	5.12 de	4.36 ab	1.17 f	43.29 b	5.00 ab
L29	6.05 abcde	4.06 ab	1.48 abcde	50.68 ab	1.00 b
L35	6.78 ab	4.48 ab	1.51 abcd	63.19 ab	3.37 ab
L37	6.16 abcde	4.43 ab	1.39 cdef	54.30 ab	1.53 b
L42	6.17 abcd	3.98 b	1.54 abcd	46.14 ab	2.53 b
L54	5.47 cde	4.10 ab	1.33 def	43.11 b	5.26 ab
L55	6.57 abc	3.93 b	1.67 a	49.41 ab	4.50 ab
L56	5.81 bcde	4.26 ab	1.36 cdef	48.58 ab	2.46 b
L58	5.98 abcde	4.15 ab	1.44 bcde	48.16 ab	2.86 b
L60	6.46 abc	4.10 ab	1.58 abc	52.32 ab	2.93 b
L61	6.23 abcd	4.53 ab	1.37 cdef	58.40 ab	3.26 b
L62	5.68 bcde	4.25 ab	1.33 def	49.10 ab	4.53 ab
L63	6.55 abc	4.29 ab	1.53 abcd	57.00 ab	3.60 ab
L64	6.30 abc	4.38 ab	1.44 bcde	56.82 ab	4.33 ab
L69	5.89 bcde	4.19 ab	1.40 cde	46.20 ab	2.20 b
L71	5.52 cde	4.15 ab	1.33 def	47.59 ab	1.43 b
L76	5.85 bcde	4.04 ab	1.45 abcde	45.83 ab	2.86 b
VC	5.63	5.06	4.87	14.54	38.89

Means in a column followed by the same letter are not significantly different according to Tukey's multiple range test at 5% probability.

Table 2. Fruit length (L), width (W), L/W ratio, mean fruit weight (FW) and total number of fruits (TNF) per plant, fruit flesh thickness (FT), and soluble solids level (SSL) of $F_6M_5S_1$ gherkin lines, at the second harvest

Lines	L	W	L/W	FW	TNF	FT	SSL
	cm			g		mm	°Brix
L1	7.24 a	4.76 a	1.52 a	77.21 a	4.93 a	6.20 ab	3.75 a
L2	6.94 ab	4.73 a	1.46 a	73.42 ab	4.33 a	5.44 ab	3.66 a
L3	6.97 ab	4.75 a	1.46 a	73.38 ab	2.26 a	5.77 ab	3.66 a
L4	6.46 ab	4.38 a	1.47 a	57.83 abc	3.66 a	5.77 ab	3.75 a
L5	6.61 ab	3.98 a	1.66 a	46.31 abc	4.60 a	5.71 ab	3.41 a
L6	6.69 ab	4.56 a	1.46 a	67.38 abc	2.33 a	5.99 ab	3.50 a
L8	7.12 ab	4.40 a	1.62 a	64.44 abc	2.51 a	5.87 ab	3.50 a
L11	6.72 ab	4.51 a	1.49 a	62.37 abc	2.46 a	4.87 ab	3.58 a
L15	7.38 a	4.67 a	1.58 a	73.22 ab	2.86 a	5.51 ab	3.58 a
L17	7.21 a	4.66 a	1.54 a	72.99 ab	5.22 a	5.99 ab	3.50 a
L20	6.49 ab	4.69 a	1.38 a	66.00 abc	4.38 a	6.43 a	3.91 a
L26	5.84 ab	4.14 a	1.40 a	47.22 abc	3.02 a	4.49 ab	3.16 a
L27	5.34 ab	4.22 a	1.26 a	43.38 abc	6.60 a	4.58 ab	3.25 a
L29	4.74 ab	2.70 a	1.17 a	36.12 bc	2.13 a	5.89 ab	3.33 a
L35	7.09 ab	4.58 a	1.54 a	68.07 abc	4.64 a	4.86 ab	3.33 a
L37	6.40 ab	4.60 a	1.39 a	61.90 abc	4.20 a	4.94 ab	3.50 a
L42	6.21 ab	3.93 a	1.58 a	45.88 abc	1.26 a	4.93 ab	3.16 a
L54	5.76 ab	4.18 a	1.37 a	46.58 abc	3.66 a	4.80 ab	3.58 a
L55	7.12 ab	4.31 a	1.65 a	62.28 abc	3.13 a	5.38 ab	3.33 a
L56	6.02 ab	4.24 a	1.41 a	53.68 abc	1.91 a	5.02 ab	3.83 a
L58	6.54 ab	4.41 a	1.48 a	61.16 abc	1.46 a	5.76 ab	3.58 a
L60	6.81 ab	4.57 a	1.49 a	67.36 abc	2.86 a	5.37 ab	3.16 a
L61	6.49 ab	4.50 a	1.44 a	64.28 abc	2.93 a	5.74 ab	3.33 a
L62	5.93 ab	4.44 a	1.33 a	57.72 abc	2.53 a	4.76 ab	3.00 a
L63	6.81 ab	4.52 a	1.50 a	65.47 abc	3.40 a	4.90 ab	3.16 a
L64	6.58 ab	4.25 a	1.55 a	55.53 abc	3.73 a	4.73 ab	3.16 a
L69	6.77 ab	4.76 a	1.42 a	69.97 abc	4.06 a	5.24 ab	3.41 a
L71	3.87 b	2.78 a	0.93 a	32.96 c	1.46 a	4.78 ab	3.08 a
L76	6.29 a	4.39 a	1.43 a	59.03 abc	2.73 a	4.26 b	3.08 a
VC	16.15	15.25	19.98	19.95	50.96	11.82	11.24

Means in a column followed by the same letter are not significantly different according to Tukey's multiple range test at 5% probability.

Seleção de linhagens elite de maxixe

RESUMO - *Linhagens de maxixe foram obtidas através de ciclos de seleção massal intercalados com ciclos de endogamia de uma população F_2 avaliada por Koch and Costa (1991). O objetivo do trabalho foi identificar e selecionar linhagens elite com uniformidade de planta e características favoráveis de fruto. Mudas de 71 linhagens foram obtidas em ambiente protegido e posteriormente transplantadas para canteiros cobertos com filme de polipropileno. As plantas foram conduzidas prostradas e sem poda. O delineamento experimental foi blocos ao acaso, com 3 repetições e parcela de cinco plantas. Foram adotados três critérios de seleção: ausência de dormência, uniformidade de planta e fruto e avaliação dos componentes de produção. Com base nos critérios adotados foram eleitas as linhagens de maxixe ($F_6M_5S_1$): 1, 2, 3, 4, 5, 6, 8, 15, 20, 55, 60 e 63. Este grupo de linhagens melhoradas, em razão de suas características contrastantes do tipo comum, foi denominado Maxixe Paulista.*

Palavras-chave: maxixe, *Cucumis anguria* var *anguria* L., seleção.

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