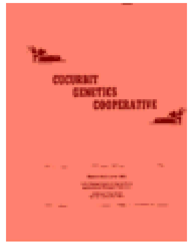
Cucurbit Genetics Cooperative



Report No. 8

July 1985

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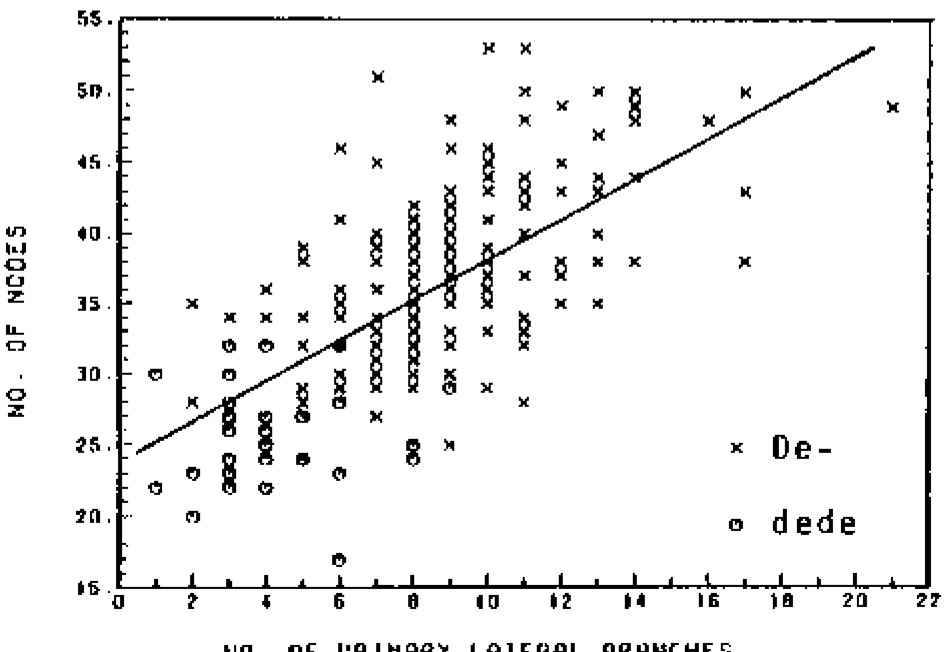

NO. OF NODES
NO. OF PRIMARY LATERAL BRANCHES
De-
dede

Cucurbit Genetics Cooperative Report 8:ii-iv (Introduction) 1985

Introduction

Resolution and Notes

Resolution and notes of organization meeting, October 28, 1976, Denver Hilton, Denver, Colorado, U.S.A.

The following resolution was adopted by research workers interested in organizing a Cucurbit Genetics Cooperative: the Cucurbit Genetics Cooperative is organized to develop and advance the genetics of economically important cucurbits.

Membership to this Cooperative is voluntary and open to workers who have an interest in Cucurbit Genetics (an invitation to participate is extended to all Horticulturists, Entomologists, Plant Pathologists, Geneticists, and others with an interest in Cucurbits).

Reports of the Cooperative will be issued on an annual basis. The reports will include articles submitted by members for the use of the members of the Cucurbit Genetics Cooperative. None of the information in the annual report may be used in publications without the consent of the respective authors for a period of five years. After five years the information may be used in publications without the consent of the authors.

Dues

Further, dues for the Cucurbit Genetics Cooperative (CGC) will be $2.50 per year and will be used to defray cost of preparation and mailing of the annual report. Members from outside the U.S.A. are encouraged to pay dues in at least two-year increments because of bank charges incurred for clearing checks. Only postal money orders or checks drawn on U.S. banks are acceptable. The annual report will include four sections: Research Notes, Stocks and Germ Plasm desired or for Exchange, Membership Directory, and Financial Statement. Other sections will be added in future reports as desired, i.e. gene lists, linkage groups, etc.

In accordance with the above resolution, we requested that an invitation to join the CGC be published in the following:

- Agronomy News
- Euphytica
- HortScience
- Journal of Economic Entomology
- Journal of Heredity
- Phytopath News

We are most pleased to acknowledge the assistance of the editors of these publications.

Dues structure and biennial membership, effective 1985:

Subscriber	Dues (biennial membership)	Back issue fee
U.S.	$ 6.00	$ 3.50
Libraries	10.00	6.00
Foreign	10.00	6.00

Report of Eighth Annual Meeting

The eighth annual meeting of the Cucurbit Genetics Cooperative was held in conjunction with the American Society for Horticultural Science on August 6, 1984 in Vancouver, British Columbia, Canada. There were 31 members in attendance.

The meeting was called to order by R. L. Lower, Chairman. He reported on the publication of CGC No. 7 and the financial status of CGC. The cost of publishing and mailing GGC No. 7 was $542.64 which left a balance of $1859.65. As with the first six reports, 200 copies of CGC No. 7 were printed. The membership at that time was 179, of which 143 were current and 36 were in arrears.

The Chairman expressed concern over the paucity of watermelon reports in CGC No. 7, although their number in the previous six reports ranged from 1 to 5. He also noted that the length of reports was increasing, and that many of the reports required extensive revision of content and format. Authors were reminded to use the previous report as a style guide.

Based upon the Chairman's recommendation, the Vine Crops Crop Advisory Committee (CAC) was established in December 1983. This committee functions as part of the Germplasm Resources Information Network (GRIN). The committee is responsible for drafting descriptor lists for the cucurbits, setting priorities for germplasm collection and evaluation, and reviewing proposals for cucurbit germplasm exploration and collection, and evaluation. J. D. McCreight is the Chairman of this committee which is composed of scientists from the USDA, universities and the seed industry.

R. L. Lower announced his resignation and turned the meeting over to J. D. McCreight who had accepted the appointment to the position of Chairman as of July 1. He expressed appreciation to R. L. Lower for his efforts in establishing CGC and publishing seven high quality reports.

There were several announcements of upcoming meetings. There was some discussion about updating the gene lists in the next CGC Report or as a feature in HortScience. It was proposed that CGC maintain an inventory of genetic stocks and that scientists deposit a sample of stocks in the National Seed Storage Laboratory. This responsibility could be assumed by the CGC Coordinating Committee or by the Vine Crops CAC.

Ninth Annual Meeting

The Ninth Annual Meeting of CGC will be held at Virginia Polytechnic Institute, Blacksburg, Virginia in conjunction with the American Society for Horticultural Science in July-August 1985.

Comments from the Coordinating Committee

The call for papers for the 1986 report will go out in October, 1985 and they should be submitted to the respective Coordinating Committee member by December 31, 1986. The report will be published by July, 1986.

The Coordinating Committee gratefully acknowledges R. L. Lower for his devoted efforts in bringing Cucurbit Genetics Cooperative to a reality, for establishing a tradition of high quality reports and for establishing the Vine Crops Crops Advisory Committee.

We are eager to hear from the membership regarding the future direction of CGC.

It is a pleasure to acknowledge the assistance of five people who did much for CGC this past year: Dayna Lamar for typing correspondence and portions of this report, and assisting in the day-to-day business of CGC. Janet Foreman and Jay Schwed for assistance in updating the membership list and records. And, R. L. Lower and Madelyn Alt in the printing and binding of CGC No. 8 at the University of Wisconsin.

- **Coordinating Committee**
- G. W. Elmstrom (muskmelon)
- W. R. Henderson (watermelon)
- J. A. Juvik (*Cucurbita* spp.)
- R. W. Robinson (other genera)
- T. C. Wehner (cucumber)
- J. D. McCreight, Chairman

Other Meetings

- The Pickling Cucumber Improvement Committee (PCIC); Dallas, Texas on October 30 - November 1, 1985; contact Greg Tolla.
- The National Muskmelon Research Group (NMRG); Charleston, South Carolina, November 11, 1985; contact C. E. Thomas.
- Vine Crops Crop Advisory Committee (VCCAC); Charleston, South Carolina, November 12, 1985; contact J. D. McCreight or C. E. Thomas.

Cucurbit Genetics Cooperative Report 8:2-3 (Article 1) 1985

Segregation of the Determinate (*de*) Allele in Crosses Between *Cucumis sativus* L. and *C. sativus* var. *hardwickii* (R.) Alef.

D.E. Delaney and R.L. Lower

University of Wisconsin, Madison, WI 53706

In 1982, we initiated a breeding program for increasing the number of lateral branches on determinate plant types. The objective was to alter the plant architecture of current determinate lines by incorporating the multiple lateral branching character from *Cucumis sativus* var. *hardwickii*. The new plant type would capitalize on both the shorter length of determinate genotypes and the larger photosynthetic area and sequential fruit-setting ability of var. *hardwickii*. Previous unpublished data had suggested that the frequency of determinate individuals in determinate *C. sativus* x var. *hardwickii* crosses was lower than expected based on single gene recessive inheritance. Thus, another objective of the study was to further investigate this phenomenon.

A *C. sativus* var. hardwickii line (LJ 90430) was crossed onto four determinate *C. sativus* lines ('Spacemaster', NCSU M21, NCSU M27, and USDA 1909) to create four populations. Seed of the four populations was planted in 1983 at the Hancock Experimental Farm, Hancock, WI, on 1.5m centers. Individual plants in the F_2 and BC_1 generations to the determinate parents (BC_1 P_1) were classified visually into two classes, determinate (*dede*) and indeterminate (*De*-), based on vine and internode length, termination of apical growth, and leaf color (determinate genotypes generally have a darker green color). Termination of growth was determined by tagging the apex of the main stem at 10 day intervals. If the stem had not lengthened in 10 days, it was considered determinate.

Two additional populations were evaluated in 1984. In both populations the determinate *C. sativus* parent was NCSU M11de, which was crossed to two different indeterminate lines, LJ 90430, and a near-isogenic line, NCSU M11. Plants in the F_2 and BC_1P_1 generations were classified by plant type, as before, except the main stems were not tagged.

In all four populations in the 1983 study, the frequency of determinate plant types in the F_2 was lower than the expected 3:1 ratio (Table 1). The chi square values for goodness of fit were all significant at least at the .10 level. In contrast, segregation ratios in the BC_1P_1 were not significantly different from the expected 1:1 ratio, except in the 'Spacemaster' x LJ 90430 population. Some of the discrepancy in the F_2 ratios could be due to misclassification. However, since fruit set was not controlled, it is likely that misclassification could have occurred in either direction (i.e. classifying a determinate individual as indeterminate or an indeterminate plant as determinate). The presence of early fruit set is known to reduce node number and deter growth in *C. sativus* (1,3). While other investigators have expressed difficulty in classifying determinate and indeterminate segregates (1,2), none have reported segregation ratios deviating from that expected with single gene inheritance. These investigators were not utilizing var. *hardwickii* germplasm, however.

Table 1. Chi square (X^2) tests for plant type segregations in the F_2 and BC_1P_1 generations of crosses between five determinate *C. sativus* lines and *C. sativus* var. *hardwickii* (LJ 90430), and a *C. sativus* x *C. sativus* cross (NCSU M11de x NCSU M11).

		Generation							
		F_2				BC_1P_1			
Population	**Genotype**	**Expected**	**Observed**	X^2	**P**	**Expected**	**Observed**	X^2	**P**

				1983					
Spacemaster x LJ 90430	De-	178.5	200	10.36	.001	57	69	4.28	.02-.05
	dede	59.5	38			57	45		
NCSU M21 x x LJ 90430	De-	178.5	191	3.50	.05-.10	57.5	51	1.47	.30-.40
	dede	59.5	47			57.5	64		
NCSU M27 x x LJ 90430	De-	180	197	6.10	.01-.02	58.5	51	1.92	.10-.20
	dede	60	43			58.5	66		
USDA 1909 x x LJ 90430	De-	177	188	2.73	.10	54.5	63	2.65	.10-.20
	dede	59	48			54.5	46		
				1984					
NCSU M11de x LJ 90430	De-	155	181	17.08	<.001	40	45	1.25	.25-.50
	dede	52	26			40	35		
NCSU M11de x NCSU M11	De-	156	148	1.64	.20	42	37	1.19	.25-.50
	dede	52	60			42	47		

The comparison of two additional populations in 1984, revealed that the F_2 segregations failed to fit a 3:1 ratio only when var. *hardwickii* was used as the indeterminate parent. The NCSU M11de x NCSU M11 population gave an acceptable fit to a 3:1 ratio, but the NCSU M11de x LJ 90430 population again had fewer determinate plant types than expected. However, as in 1983, both populations segregated 1:1, indeterminate:determinate, in the BC_1P_1.

In crosses between *C. sativus* and var. *hardwickii* most of the determinate segregates in the F_2 and BC_1P_1 resembled the respective determinate parent for lateral number. The determinate plant types that seem to be missing are those with high numbers of lateral branches. It seems likely that the plant growth regulators may be involved. More investigations are continuing.

Literature Cited

1. Denna, D. W. 1971. Expression of determinate habit in cucumbers (*Cucumis sativus* L.). J. Amer. Soc. Hort. Sci. 96:277-279.
2. Kauffman, C. S. 1973. An investigation of the inheritance of determinate habit and short internode dwarf cucumbers, *Cucumis sativus* L. M.S. Thesis. North Carolina State University, Raleigh, N.C.
3. McCollum, J. P. 1934. Vegetative and reproductive responses associated with fruit development in cucumber. Cornell Agr. Exp. Sta. Memoir 163.

Cucurbit Genetics Cooperative Report 8:4-6 (Article 2) 1985

Near-Isogenic Lines of Several Cucumber Varieties

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In over 40 years of cucumber breeding at Cornell, a number of near-isogenic lines have been bred by the backcross method. A few have been released as varieties and the rest as germplasm, but not all of the latter have had formal release notices because of their minor importance. A complete listing to date is given in Tables 1 and 2, and seed in small amounts is available from the author. These are being deposited in the National Seed Storage Laboratory as sufficient seed is produced.

The background genotypes are all well-known as commercial varieties except for the Cornell 551 series. 55-551 is a white spine pickle based largely on Stays Green but not derived from a true backcross program. Its chief value is in having a level of cucumbermosaic (CMV) resistance comparable to Tablegreen, considerably higher than any other pickle we have tested.

Most of the genes incorporated by backcrossing are well known except for mildew resistance and dwarfness. Mildew resistance in all our material other than Poinsett is from Spartan Salad and appears to be conditioned by two recessive genes which have not been identified with those given gene symbols. Dwarfness is derived from Hardin's PG57 and is initially selected as a single recessive gene which shortens the hypocotyl of seedlings. Within this group there has been selection for a wide range of mature plant types, from extreme dwarfness in Spacemaster and 78-515, a dwarf version of SR551, to only slight vine size reduction in the Marketmore and SMR18 dwarfs. All have been selected for greater earliness than the recurrent parents. Consequently the dwarf lines are not truly near-isogenic but are listed as a convenient way of letting people know of their existence and availability.

Except for the dwarfs, most lines have been backcrossed 5 times to the recurrent parent but in some cases several more backcrosses were made. The most extreme dwarfs have only 3 backcrosses to Tablegreen and SR551, respectively, but the Marketmore dwarf has a total of 7 with the last 5 to Marketmore 76. The SMR18 dwarfs have had 3 and 5 backcrosses, respectively, to some version of SMR18.

Table 1. Characteristics of Cornell Cucumber Variety and Germplasm Releases of Slicing Type.

	1985 Status[1]	Unif. color u	Non-bitter bi	Gynoec. F	Dwarf	Resistance to: CMV	Scab Ccu	PM+DM[2]	Bact. wilt Bw	TLS[3] Cca
Near-Isogenic Lines with Tablegreen Background Genotype										
Tablegreen	V	x	-	-	-	High	-	Low-Med.	-	
Tablegreen 65	V	x	-	-	-	High	x	Low-Med.	-	-
Tablegreen 68	G	x	-	x	-	High	x	Low-Med.	-	
Tablegreen 72	V	x	x	-	-	High	x	Low-Med.	-	
Tablegreen 72F	G	x	x	x	-	High	x	Low-Med.	-	
Spacemaster	V	x	-	-	x	High	x	Low-Med.	-	
Spacemaster 80		x	x	-	x	High	x	Low-Med.	-	
Tablegreen 65 Bw	G	x	-	-	-	High	x	Low-Med.	x	
Tablegreen 72 Bw	G	x	x	-	-	High	x	Low-Med.	x	
Tablegreen 86	T	x	-	-	-	High	x	Med.-High	-	
Near-Isogenic Lines with Marketmore Background Genotype										
56-388	G	-	-	-	-	High	-	- -	-	(x)
Marketmore	V	-	-	-	-	High	x	- -	-	x
Marketmore 70	V	x	-	-	-	High	x	- -	-	(x)
Marketmore 70F	G	x	-	x	-	High	x	- -	-	(x)
Marketmore 72	G	x	x	-	-	High	x	- -	-	(x)
Marketmore 72F	G	x	x	x	-	High	x	- -	-	(x)
Marketmore 76	V	x	-	-	-	High	x	Med.-High	-	-
Marketmore 76F	G	x	-	x	-	High	x	Med.-High	-	(-)
Marketmore 80	V	x	x	-	-	High	x	Med.-High	-	(-)
Marketmore 80F	G	x	x	x	-	High	x	Med.-High	-	(-)
Marketmore 80 Bw	G	x	x	-	-	High	x	Med.-High	x	(-)
81-545	T	x	-	-	x	High	x	Med.-High	-	(-)
Near-Isogenic Lines with Poinsett Background Genotype										
Poinsett uu	G	x	-	-	-	-	-	Med.-High	-	(-)
Poinsett SR	G	-	-	-	-	-	x	Med.-High	-	(-)
Poinsett 76	V	x	-	-	-	-	x	Med.-High	-	-
Poinsett 83	G	x	-	-	-	High	x	Med.-High	-	-
Poinsett 83 bi	G	x	x	-	-	High	x	Med.-High	-	(-)
Poinsett 83F	G	x	-	x	-	High	x	Med.-High	-	(-)

[1]V = Variety, G = Germplasm, T = Trial.

[2]Powdery mildew resistance (PMR) and downy mildew resistance (DMR) are closely associated and in most cases, the level of one is indicative of the level of the other. Apparent PMR varies with conditions; it is lower when temperatures and light intensity are low, when plants are becoming senescent, and when there is abundant inoculum from susceptible plants nearby.

[3]Resistance to target leafspot caused by *Corynespora cassiicola*. x = resistant, - = susceptible in greenhouse tests at Ithaca. Same symbols in ( ) = presumed reaction based on isogenicity but not actually tested.

Table 2. Characteristics of Cornell Cucumber Variety and Germplasm Releases of Pickling Type.

	1985 Status[1]	Unif. color u	Non-bitter bi	Gynoec. F	Dwarf	Resistance to CMV	Scab Ccu	PM+DM[2]	Bact. wilt Bw	TLS[3] Cca
Near-Isogenic Lines with Cornell 551 Background Genotype										
55-551	G	-	-	-	-	High	-	-		(x)
SR551	G	-	-	-	-	High	x	-	-	x
SR551F	G	-	-	x	-	High	x	-	-	(x)
SR551 u	G	x	-	-	-	High	x	-	-	(x)
SR551 uF	G	x	-	x	-	High	x	-	-	(x)
PMR 551	G	x	-	-	-	High	x	Med.-High	-	-
PMR 551F	G	x	-	x	-	High	x	Med.-High	-	(-)
SR551 Bw	G	x	-	-	-	High	x	-	x	(x)
PMR551 Bw	G	x	-	-	-	High	x	Med.-High	x	(-)

78-515	G,T	-	-	-	x	High	x	-	-	(x)
Near-Isogenic Lines with Wisconsin SMR18 Background										
SMR18 WS	G	-	-	-	-	Med.	x	-	-	x
SMR18 WSF	G	-	-	x	-	Med.	x	-	-	(x)
SMR18 u BS	G	x	-	-	-	Med.	x	-	-	(x)
SMR18 u BSF	G	x	-	x	-	Med.	x	-	-	(x)
SMR18 u WS	G	x	-	-	-	Med.	x	-	-	(x)
SMR18 u WSF	G	x	-	x	-	Med.	x	-	-	(x)
PSMR18 WS	G	-	-	-	-	Med.	x	Med.-High	-	-
PSMR18 WSF	G	-	-	x	-	Med.	x	Med.-High	-	(-)
Dwarf SMR18 u	T	x	-	-	x	Med.	x	-	-	(x)
Dwarf PSMR18 WS	T	-	-	-	x	Med.	x	Med.-High	-	(-)

[1]V = Variety, G = Germplasm, T = Trial.

[2]Powdery mildew resistance (PMR) and downy mildew resistance (DMR) are closely associated and in most cases, the level of one is indicative of the level of the other. Apparent PMR varies with conditions; it is lower when temperatures and light intensity are low, when plants are becoming senescent, and when there is abundant inoculum from susceptible plants nearby.

[3]Resistance to target leafspot caused by *Corynespora cassiicola*. x = resistant, - = susceptible in greenhouse tests at Ithaca. Same symbols in ( ) = presumed reaction based on isogenicity but not actually tested.

Cucurbit Genetics Cooperative Report 8:7-8 (Article 3) 1985

Short Petiole, A Useful Seedling Marker for Genetic Studies in Cucumber

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During a visit of the first author to the Ukrainian Research Institute of Vegetable Gardening in Charkov, USSR, Dr. M.C. Efimov demonstrated the use of the 'short petiole' recessive character for marking maternal lines in hybrid pickling cucumber seed production. Because of its expected value in linkage studies, seed was requested, and Dr. Efimov generously supplied us with some seeds of the mutant line '1753' through the N.I. Vavilov All Union Institute of Plant Industry in Leningrad.

Because this mutant has not yet been described, we present here some data on its morphology, genetic basis and first results of linkage studies. The petioles of the first true leaves of the mutant are very short (1 to 2 cm) (Table 1) and the leaf blade smoothly narrows to the petiole. The later leaves usually also have petioles shorter than normal. The effect of the mutant can be distinguished clearly in the seedling stage by judging the first true leaves. There also appears to be an effect of the mutant on stem elongation, since especially under winter light conditions the internodes below the first and usually the second true leaf don't develop, resulting in an opposite arrangement of the first leaves. Differences occurred in vigor and fertility of the mutant plants, so we selected a typical fertile individual for crosses with other marker lines.

Results of our crosses to date with the mutant corroborate Efimov's information, that the character is governed by a single, completely-recessive gene. This is illustrated by the segregation of the F_2 progeny of a cross between our short petiole line and a glabrous (*gl*) line. The monohybrid ratio for the short petiole character in this cross was 267 : 83 ($x^2 = 0.31$, $0.5 < p < 0.7$). In a different cross with a compact (*cp*) line we obtained 258 : 92 ($x^2 = 0.31$, $0.5 < p < 0.7$). On the basis of this evidence we officially propose the designation *short petiole* for Efimov's mutant, symbol sp. The dihybrid ratio obtained in the above-mentioned F_2 of the cross sp x *gl* was 194 : 73 : 69 : 14 ($X^2 = 3.90$, $0.2 < p < 0.3$). This perfect fit to the expected ratio demonstrates that *sp* and *gl* are independent from each other. We obtained dihybrid ratios in F_2s of the cross *sp* x *cp* and also of cross *sp* x *lh* (long hypocotyl), which clearly did not fit the expected ratio of 9 : 3 : 3 : 1, but we are not ready to conclude linkage because we surmise that the expression of these genes may interact with that of *sp.* This will be the subject of further study. Crosses of *sp* with other marker lines are in progress.

Table 1. Petiole length (cm) of the first four true leaves of mutant and normal plants segregating for the *short petiole* (*sp*) gene tested in summer, 1983.

	Leaf node			
Genotype	**1**	**2**	**3**	**4**
sp sp	1.9	1.8	6.7	3.2
Sp sp	15.0	14.2	16.2	16.1
Sp Sp	15.2	15.9	17.6	17.8
sp sp as percent of *Sp-*		21		

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Optimum Heat Unit Summation Technique for Harvest Prediction of Fresh-Market and Pickling Cucumbers in North Carolina

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Heat unit summation techniques have found widespread applicability for predicting stages of development for many horticultural and agronomic crops (3). Boswell (2) first documented the concept of heat summations relative to vegetable crop production in 1929. We were interested in finding a method of predicting harvest maturity of cucumbers, especially one that could be applied to once-over harvest. A number of methods have been used to calculate heat unit summations. The objective of this study was to determine which of those methods predicted harvest with the least variation over years and seasons.

Methods. The data for this comparative study of methods to determine heat unit requirements were taken from 5 years (1980 through 1984) and 2 seasons (spring and summer) of plantings for 2 crops and 2 or 3 crop maturities (early, midseason and late fresh-market cucumbers, and early and mid-season pickling cucumbers). The experiment was run at the Horticultural Crops Research Station near Clinton, N. C. Daily high and low temperatures were recorded from planting through first harvest of each crop and maturity group for a multiple-harvest system. Standard cultural practices were used for all crops.

Number of days from planting through first harvest was used as the standard of comparison for the heat unit summations. The CV (coefficient of variation) over 5 years and 2 seasons for each crop and maturity group was used as the measure of how consistent each method was in predicting time of first harvest. Arnold (1) demonstrated that the CV is the appropriate statistic for identifying the measure with the best prediction ability. Heat unit summations were calculated using 14 different methods, and several different base and ceiling temperatures as follows.

1. The standard Growing Degree Day (GDD) computation was made as follows.
GDD = Â (Mean-Base) (1)
where Base=0, 10, 13, 15.5, or 18°C, and Mean-(daily maximum + daily minimum)/2, and data were summed over all days from planting to first harvest. There was no ceiling temperature.

2. Use daily maximum (Max) instead of Mean as follows.
GDD = Â (Max-Base) (2)
where Base is the same as in 1 above.

3. Use Ceiling to determine Max as follows. GDD = Â (Mean - Base), where Max is Max or Ceiling of 27, 29, 32 or 35 (whichever is lower).

4. Use Ceiling instead of Max as follows. GDD = Â (Max - Base), where Max is Max or Ceiling of 27, 29, 32 or 35 (whichever is lower).

5. If maximum is greater than the given ceiling reset maximum by subtracting the difference between the maximum and ceiling from the ceiling, then use Eqn. 1 for range of ceilings and bases as in Number 3.

6. If maximum is greater than the given ceiling reset maximum by subtracting the difference between the maximum and ceiling, then use Eqn. 2 for range of ceilings and bases as in Number 3.

7. If maximum is greater than the given ceiling, subtract the difference between the maximum and ceiling from the daily mean used in Eqn. 1 using the range of ceilings and bases from Number 3.

8. Sum Growing Degree Hours (GDH) by using Eqn. 1 for each hourly mean. Use range of ceilings and bases from Number 3.

9. Same as Number 8, but reset maximum as in Number 3.

10. Same as Number 8, but reset maximum as in Number 5.

11. Sum GDH accumulated during day time only.

12. Same as Number 11, but reset maximum as in Number 3.

13. Same as Number 11, but reset maximum as in Number 5.

14. Weight daily GDD accumulation by daylength as follows.
GDD = Â (Mean-Base) x Daylength)

Results. Comparison of the CV's indicated that the methods with the most stable ability for harvest prediction were 6 and 14. Both of those methods were better than using days from planting to harvest as the index. Since method 6 required less effort to calculate than method 14, we decided to investigate it further. The lowest CV's occurred with bases of 15.5 and 18°C and a ceiling of 32°C, so we tried bases of 14.5, 15, 16 and 16.5 and ceilings of 31, 31.5 and 33°C. Those temperatures did not improve the CV over environments for the 5 crops and maturities tested. Thus, the method of choice would be Number 6 with a base of 15.5 and a ceiling of 32°C

Table 1. Coefficients of variation (CV) for 14 methods of calculating heat unit summations with varying base and ceiling temperatures (°C) vs. days from planting to harvest.

Method	Base	Ceiling	CV	Method	Base	Ceiling	CV	Method	Base	Ceiling	CV
1	0	none	6	4	0	32	7	6	0	32	8
	10	none	11		10	32	4		10	32	4
	13	none	15		13	32	5		13	32	4
	15.5	none	22		15.5	32	6		15.5	32	3
	18	none	32		18	32	8		18	32	3
2	0	none	6	4	0	35	6	7	0	35	6
	10	none	7		10	35	6		10	9	5
	13	none	8		13	35	7		13	35	6
	15.5	none	10		15.5	35	9		15.5	35	7
	18	none	14		18	35	12		18	35	10
3	0	27	7	5	0	27	8	7	0	27	8
	10	27	7		10	27	6		10	27	6
	13	27	10		13	27	7		13	27	7
	15.5	27	16		15.5	27	11		15.5	27	11
	18	27	27		18	27	22		18	27	22
3	0	29	6	5	0	29	7	7	0	29	7
	10	29	8		10	29	5		10	29	5
	13	29	11		13	29	7		13	29	7
	15.5	29	16		15.5	29	11		15.5	29	11
	18	29	25		18	29	18		18	29	18
3	0	32	6	5	0	32	6	7	0	32	6
	10	32	9		10	32	7		10	32	7
	13	32	13		13	32	11		13	32	11
	15.5	32	19		15.5	32	16		15.5	32	16

	18	32	28		18	32	24		18	32	24
3	0	35	6	5	0	35	6	7	0	35	6
	10	35	11		10	35	10		10	35	10
	13	35	15		13	35	14		13	35	14
	15.5	35	21		15.5	35	20		15.5	35	20
	18	35	31		18	35	29		18	35	29
4	0	27	9	6	0	27	13	8	15.5	none	20
	10	27	7		10	27	20	9	15.5	32	19
	13	27	7		13	27	23	10	15.5	32	17
	15.5	27	6		15.5	27	29	11	15.5	none	14
	18	27	5		18	27	39	12	15.5	32	12
4	0	29	8	6	0	29	10	13	15.5	32	10
	10	29	5		10	29	11	14	15.5	32	3
	13	29	5		13	29	11				
	15.5	29	4		15.5	29	12		Days (planting		
	18	29	5		18	29	14			to harvest)	10

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Sources of Resistance to Viruses in Two Accessions of *Cucumis sativus*

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Recently we have determined that two accessions of *Cucumis sativus* 'Surinam' and 'TMG-1' are valuable sources of resistance to the most common viruses affecting this species in the United States.

'Surinam', a cultivar from the South American country of the same name, possesses a single recessive gene (*wmv-l-l*), which confers resistance to watermelon mosaic virus 1 (WMV-1) (2). Following inoculation with this virus, plants respond with a mild systemic mottle, usually confined to one or two leaves. Subsequent growth is free of symptoms, and plants remain as vigorous as the healthy controls. 'Surinam' appears also to be resistant to some isolates of watermelon mosaic virus 2 (WMV-2) but susceptible to others. It also is susceptible to cucumber mosaic virus (CMV) and zucchini yellow mosaic virus (ZYMV) (2). This cultivar is of intermediate maturity, producing cylindrical-stippled fruits averaging about 20 cm in length.

'TMG-1' derived from a single plant selection of an old Chinese cultivar from Taiwan (1). This line is resistant to CMV, WMV-1, WMV-2 and ZYMV. Of particular value is its resistance to ZYMV, since all the American cultivars are very susceptible to this virus. Infected plants exhibit severe foliar mosaic and necrosis, stunting and fruit distortion. Of the two strains known to be present in the Untied States, ZYMV-CT and ZYMV-FL, 'TMG-1' reacts with some systemic veinal chlorosis to the former and with localized infection to the latter. Preliminary data on the inheritance of resistance indicate that resistance is conferred by a recessive factor. F_1 plants deriving from crosses between 'TMG-1' with several commercial cultivars show a high level of hybrid vigor. 'TMG-1' possesses excellent horticultural characteristics. Plants are vigorous and of early maturity, fruits are dark-skinned and smooth, about 30 cm long.

Frequently, viruses affecting cucumber, as well as other cocurbits, are concurrently found in the same field, hence the necesssity to develop a new generation of multi-viral resistant cultivars. 'TMG-1' provides cucumber breeders with sources of resistance to four viruses.

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A Giemsa C-banding Procedure for *Cucumis* Chromosomes

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The gene lists of different *Cucumis* species have been already compiled (3). However, the genes have not been assigned to any of the chromosomes, which are not distinguishable by normal staining procedures. Modern staining techniques like Giemsa C-banding has facilitated the identification of individual chromosomes in many plant and animal species (5). In this report, a standardised procedure for C-banding of chromosomes of *Cucumis* species by Giemsa staining is described. Essentially, the method suggested by Schwarzacher et al. (4) for orchids has been modified to suite the *Cucumis* chromosomes. The procedure involves the following steps:

- Germinate the seeds in a germinator at 28 to 30°C and collect the roots when they attain a 5 to 10 mm length. Meristematic roots can also be collected
from the plants.

- Pre-treat the roots with 0.002 M hydroxyquinoline for 2.5 to 3 hr. at room temperature (20°C).

- Fix the roots in 1:3 acetic alcohol for 48 hr.

- Keep the roots in distilled water for 20 min. on the day of squashing.

- Transfer to 1 N HC1 for 5 min. at room temperature. - Macerate the roots in an enzyme solution containing 1% cellulase and 0.5% pectinase in 0.01 M
citrate buffer (pH 4.0) at 38°C for 25 to 30 min.

- Soften the roots in 45% acetic acid for 25 to 30 min. at room temperature.

- Squash the meristematic tips in a drop of 45% acetic acid. Observe the
chromosomes with a phase objective (Neofluar 40x) during slide preparation.

- Remove the coverslip after freeze drying in liquid nitrogen and air drying the slides for 2 days.

- Incubate the slides in 45% acetic acid at 60°C for 20 min.

- Denature the preparations in 6% Barium hydroxide solution for 6 to 7 min. at room temperature and wash in running tap water thoroughly for 1 hr.

- Incubate the slides in 2 x SSC (pH 6.8) at 60°C for 2 hr.

- Rinse the slides in 0.04 M phosphate buffer (pH 6.8) and stain in 4% Giemsa solution (in 0.04 phosphate buffer pH 6.8) for 10 to 15 min.

- Rinse the slides in phosphate buffer and air dry. Mount the preparation in euparol.

The procedure has yielded well differentiated banded complements in *C. sativus* var. *hardwickii* (Royle) Alef. (Fig. 1), *C. sativus* L. and *C. melo* L., which facilitated the identification of individual chromosomes in these species (1,2).

Acknowledgement

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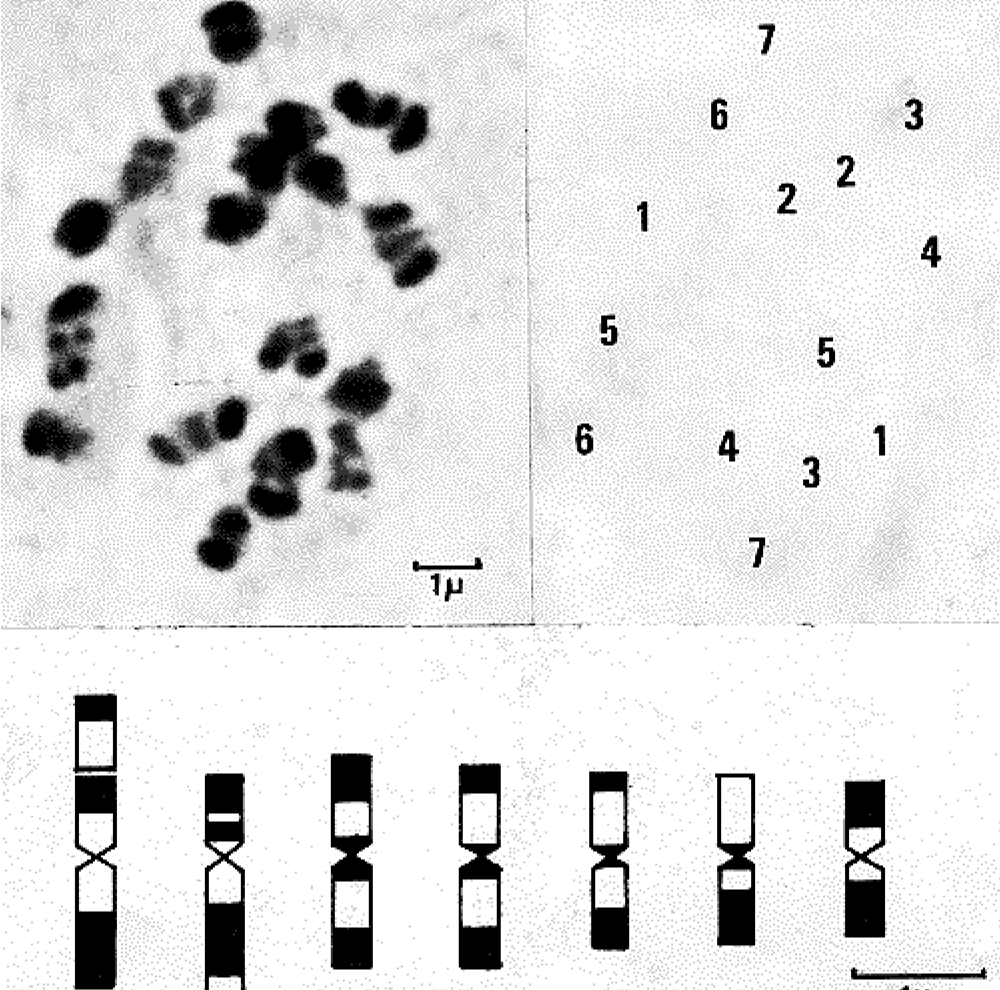

Fig. 1. Giemsa C-banded mitotic chromosomes and idiogram of *C. sativus* var. *hardwickii* (Royle) Alef.

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Cucurbit Genetics Cooperative Report 8:15-18 (Article 7) 1985

Morphological and Anatomical Comparisons between Two *Cucumis sativus*, Botanical Varieties: *hardwickii* and *sativus*.

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Cucumis sativus var. *hardwickii* (R.) Alef. (*C. h.*) can produce 50 to 76 mature fruits per plant, and thus has potential for use by plant breeders as a genetic source for increasing yields in the commercial cucumber, *Cucumis sativus* var. *sativus* L. (*C. s.*) (1,3). Fruit set and seed development in *C. s.* restricts additional fruit set (1,2). This inhibitory or competitive effect, absent in *C. h.*, is a major limitation for yield in *C. s.*

If *C. h.* is to be utilized in a breeding program, additional information is needed regarding the physiology, morphology, and anatomy of different accessions. Since limited morphological and anatomical information is available for *hardwickii* this study was designed to: 1) compare morphological and anatomical aspects of *C. s.* and *C. h.* and, 2) to determine which plant characters, if any, would allow for effective discrimination between and within these two botanical varieties.

The morphology of 5 genotypes of *C. s.* and 5 genotypes of *C. h.* were evaluated in the fall 1981 and spring 1982 in a greenhouse at Madison, Wisconsin. The 5 C. s genotypes selected each represent different morphological types.

Seeds were germinated in 5 cm peat pots containing a soil mixture of 2:2:1:1, sand:soil:peatmoss:perlite (by volume) and standard fertilization (30:30:30) was applied weekly with irrigation water. Seasonal light intensities (PPFD) for September, October, and November were 701, 469, and 325 umol $s^{-1}m^{-2}$. The temperature was approximately 27°C night.

Seedlings of each entry were transplanted to 0.2m pots, arranged in a randomized complete block design with 5 replications and harvested after 60 days. Plant height was recorded twice weekly beginning six days after transplanting. Flowers were removed because developing fruits inhibit additional growth of the plant. Length, leaf area, and dry weight were recorded at 30 and 60 days after transplanting. Leaf area was measured with a leaf area meter (Type AAM-5, Hayashi Denko Company Ltd., Tokyo, Japan). An analysis of variance was performed on morphological data and Duncan's multiple range test was used for mean separation.

At harvest (60 days) 3 *C. s.* genotypes ('Marketmore 76', 'Calypso', and KY37- CG) and 2 *C. h.* genotypes (PI 215589 and LJ 90430) exhibiting a broad range of morphological diversity were sampled for anatomical studies. Standard microtechniques (4) were used to study transverse sections of leaves, petioles, internodes, flowers, and roots. Samples from 3 to 5 replications of each entry were combined. Leaves and petioles were excised at the sixth node, internodes between the fifth and sixth node, flowers from axillary branches at the sixth and tenth nodes, and root tips from main roots were sampled at random.

The 3 morphological plant characters measured, plant height, leaf area, and dry weight, showed substantial differences within and between cultivars of *sativus* and collections of *hardwickii*. In the fall, *C. h.* PI 215589 was significantly taller than all cultivars of *C. s.* and other *C. h.* collections, while PI 183967 and KY37-CG were significantly shorter (Table 1). Two *C. h.* (PI 273648 and PI 183967) and 2 determinate cultivars of *C. s.* (W2747 and KY37-CG) had similar plant heights.

In the spring, 'Raider' was significantly taller than it was in the fall and was similar in height to the 2 tallest collections (PI 273648 and LJ 91176). The determinate *C. s.* cultivars, W2747 and KY37-CG, were significantly shorter than the indeterminate *C. s.* cultivars. In the spring, the range in plant height among the collections of *C. h.* was significantly less than it was in the fall. The height of LJ 91176 and PI 215589 was great in both seasons. In the fall PI-273648 was shorter than most other collections but in the spring it had the greatest plant height.

All genotypes of *C. s.* except KY37-CG had greater leaf area than *C. h.* collections in both seasons. The leaf area of 'Calypso', W2747, KY37-CG, LJ 91176, LJ 90420, PI 215589 was less in the spring than in the fall. The leaf area (cm^2) within the *C. h.* collections did not differ significantly in the fall. In the spring, PI 273648 had a statistically greater leaf area than PI 215589 and LJ 90430 (Table 1).

Dry weight for *hardwickii* collections had a wide range in the fall and had an intermediate range in the spring compared to *C. s.* cultivars. 'Marketmore 76' and PI 183967 had the greatest and least dry weight, respectively, for both seasons (Table 1).

Leaf thickness varied among the genotypes of *C. s.* but remained relatively constant in *C. h.* collections. 'Calypso' and 'Marketmore 76' had the greatest average leaf thickness of approximately 41 um and 43 um, respectively, while KY37-CG had a thickness of 32 um. With the exception of KY37-CG all leaves were on the average (2.3 to 5.6 um) thicker in the fall than in the spring (Table 1).

The mesophyll of all 5 *C. s.* genotypes had 1.5 layers of palisade cells and generally 3 layers of spongy-parenchyma except KY37-CG which occasionally had 4. The mesophyll cells of 'Marketmore 76' and PI 215589 were compact while KY37-CG and 'Calypso' and LJ 90430 had a looser arrangement. The upper epidermal layer was more prominent than the lower one in all genotypes except KY37-CG, where it was flatter.

There was 9 bicollateral vascular bundles within the stems of both *C. s.* and *C. h.* genotypes. Six of the vascular bundles are differentiated at the periphery of the internode around the 3 smaller ones near the center. The vascular bundles of the *C. s.* cultivars, 'Calypso', 'Marketmore 76', and KY37-CG were approximately twice the size of the *C. h.* genotypes LJ 90430 and PI 215589. There were more xylem and phloem elements in the 3 *C. s.* genotypes compared to the 2 genotypes of *C. h.* 'Marketmore 76' and KY37-CG consistently had more xylem elements than other entries.

The petioles of all lines, like the internodes, had 9 vascular bundles (except LJ 90430 which had 7). In both *C. s.* and *C. h.* genotypes, the 2 adaxial vascular bundles were nearly one-fourth as large as the 7 abaxial bundles.

Dry weight was correlated with plant height, leaf area, and number of laterals. For example, the *C. h.* genotype LJ 91176 was tall with an intermediate leaf area and the greatest number of laterals when compared to other genotypes, which may account for its high dry weight. On the other hand, KY37-CG and W2747 had lower dry weights resulting from a determinate growth habit and fewer laterals. The average leaf area per plant of *C. s.* genotypes was approximately twice that of *C. h.* genotypes.

Anatomical observations showed variation in leaf thicknesses between the 2 botanical varieties in both seasons. The stem diameters of the 3 *C. s.* cultivars were approximately twice that of the 2 *C. h.* collections. The phloem and xylem elements in the vascular bundles of stems of *C. s.* genotypes exceeded that of the *C. h.* genotypes. The most significant difference in the petiole of LJ 90430 was the 7 vascular bundles compared to 9 in the other genotypes. The cellular structure in the roots and flowers were similar in both botanical varieties.

Table 1. Plant height, leaf area and dry weight of cucumber genotypes grown for 60 days after transplant in fall and spring.

		Fall 1981			**Spring 1982**		
Genotype	**Botanical variety[z]**	**Plant ht. (cm)**	**Leaf area (cm^2)**	**Dry wt. (g)**	**Plant ht. (cm)**	**Leaf area (cm^2)**	**Dry wt. (g)**
PI 215589	h	245 a[y]	83 de	112 abc	264 ab	78 e	39 cd
LJ 91176	h	199 b	115 de	113 abc	274 a	107 de	38 cd
Marketmore 76	s	198 b	233 ab	116 ab	248 b	216 b	62 a
Calypso	s	183 bc	227 b	113 abc	253 ab	195 cd	53 b
Raider	s	175 bc	197 bc	108 bcd	282 a	220 ab	52 b
LJ 90430	h	159 c	89 de	104 de	212 b	70 e	37 de
PI 273648	h	127 d	118 de	98 e	310 a	200 cd	40 cd
W2747	s	126 d	222 b	107 cd	131 e	239 a	31 ef

PI 183967	h	70 e	66 e	88 f	212 b	112 de	30 f
KY37-CG	s	66 e	16 cd	101 de	131 c	172 cd	36 de

[z] *C. sativus* var. *sativus* (s); *C. sativus* var. *hardwickii* (h).

[y] Duncan's multiple range test, means with the same letter are not significantly different (P=.05).

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Cucurbit Genetics Cooperative Report 8:18-21 (Article 8) 1985

Preliminary Yield Evaluation of Inbred Lines Derived from *Cucumis sativus* var. *hardwickii* (Royle) Kitamura

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Recently, usage of *Cucumis sativus* var. *hardwickii* (Royle) Kitamura germplasm (hereafter referred to as *hardwickii*), has increased in cucumber improvement programs because of its potential for increasing fruit yields in the cultivated cucumber, *Cucumis sativus* var. *sativus* L. (hereafter referred to as *sativus)* (3). Although *hardwickii* has the ability to set a large number of seeded fruits sequentially on each plant, its fruit are ellipsoid, bitter, and have a large seed cell (3). These negative characteristics, along with its susceptibility to most economically important North American cucumber diseases (5) provide a challenge for plant breeders interested in capitalizing on its yield potential.

Morphological differences among *hardwickii* accessions (7), suggest differences in their potential for transmitting useful traits (4). *Hardwickii* lines PI 183967 and PI 215529 differ in combining abilities for fruit number, length and diameter; lateral branch number; flowering date; sex expression and plant dry weight (4,9). Lower et al. (6) reported on type of gene action and heterosis for yield and vegetative characteristics in a cross between a *sativus* line (Gy 14) and an inbred *hardwickii* line selected from PI 183967 (LJ 90430). Variation in fruit weight per plant, lateral branch number, main stem length and fruit length and diameter can be accounted for by an additivedominance genetic model (2,6).

Flowering characteristics of *hardwickii* directly affect time of fruit development. *Hardwickii* accessions differ in photoperiodic response (4,9). Although early flowering is promoted under short days (approximately 9 to 14 hours) in *hardwickii* PI 183967 (LJ 90430) and LJ 91176, plants of PI 215589 will eventually flower under long days (16 hours)(l). This short day flowering response in PI 215589 appears to be controlled by a single recessive gene and is most likely allelic (1) to the delayed flowering mutant (df) reported by Shiffriss and George (8).

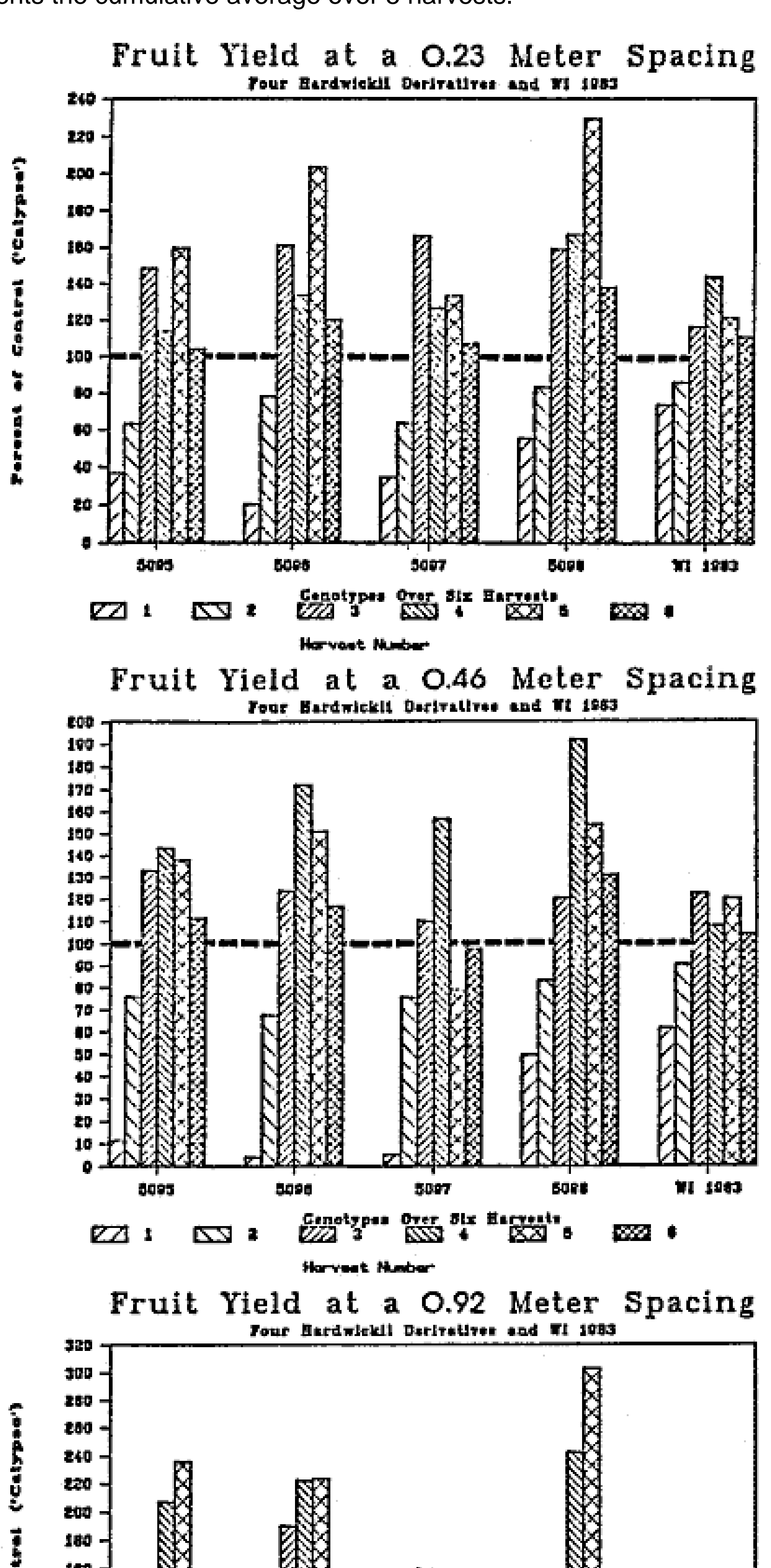
One objective of the USDA cucumber breeding program is to incorporate high fruit setting ability and multiple branching from *hardwickii* into *sativus* germplasm. *Hardwickii* germplasm from PI 183967 and PI 215589, along with several *sativus* processing cucumber inbreds with relatively diverse genetic backgrounds (segregating plants with high fruiting capacity), were intercrossed to form several populations. One such population originating from *hardwickii* x *sativus* matings is non-bitter, gynoecious, multiple- branching, and resistant to 6 diseases. The best of 4 F4 and F_5 lines random- mated and subjected to 2 cycles of recurrent selection for fruit number under a 0.9 m between-plant spacing provided the experimental population (WI 5242). Four lines (5095, 5096, 5097 and 5098) were established by self-pollinating selected plants from the cycle 2 population. Previous studies (7) indicated that *sativus* x *hardwickii* F_1 backcrossed to *sativus*, when tested under a close spacing (12 cm between plants and 1.5 m between rows), did not produce yields that differed significantly from those of the recurrent parent. This study was initiated to compare fruit yields bf the 4 inbred lines with the *sativus* inbred WI 1983 and the hybrid 'Calypso' at 3 plant spacings.

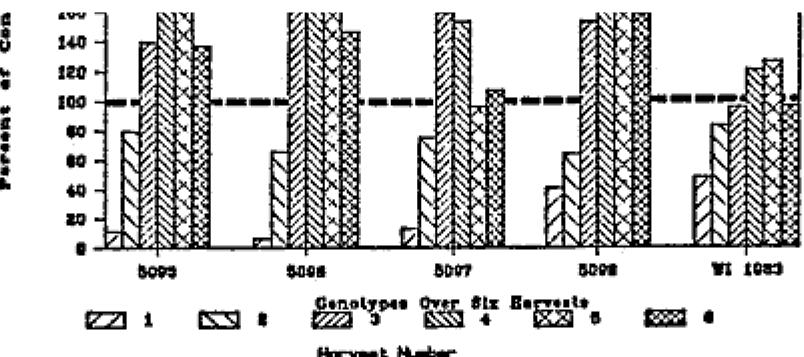
WI 1983 and commercial processing hybrid 'Calypso' were evaluated at 3 betweenplant spacings (0.23, 0.46 and 0.92 m) in randomized complete blocks with 6 replications. Supplemental irrigation and standard cultural practices were used, and plots were harvested 5 times starting when 'Calypso' plots had 10% oversize fruit. Rows were 1.5 m apart.

Fruit yields of *hardwickii*-derived lines were lower (20 to 90%) than 'Calypso' but nearly equal to WI 1983 in harvests 1 and 2 at all spacings. In harvests 3 through 5, fruit yields of the 4 lines were higher (10 to 200%) than both 'Calypso' and WI 1983 (Figure 1). Cumulative yields of WI 5095 and WI 5097 over 5 harvests under the 0.46 and 0.23 m spacings were similar to 'Calypso' and WI 1983. In contrast, cumulative yields of WI 5096 and WI 5098 were higher than 'Calypso' and WI 1983 at the 0.23 (20 and 35%), 0.46 (15 and 30%) and 0.92 (45 and 55%) meter spacings. In this study, fruit yields of 4 *hardwickii*

derivates were competitive with 'Calypso' in late harvests at close spacing. However, since fruit length/diameter (L/D) ratios were short (2.3 to 2.6) and interior quality was not acceptable, F_1 hybrids between these *hardwickii* derivates and standard processing cucumber inbreds need to be evaluated in order to determine whether yielding ability can be maintained along with improvements in L/D ratio and fruit quality.

Figure l. Comparative fruit yielts between four *C. hardwickii* derived inbreds and a parental *C. sativus* inbred and the processing cucumber hybrid 'Calypso' under 3 spacings. Fruit yields of harvests 1-5 are given as percent of 'Calypso' and harvest 6 designation represents the cumulative average over 5 harvests.





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Electrophoretic Variation Among Wild Species in the Genus *Cucumis*.

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Previously (9), we have documented the relative activity of 47 metabolic enzymes, and general protein in cucumber (*Cucumis sativus* L.). In conjunction with this study we determined that enzyme polymorphisms existed in glucosephosphate isomerase (GPI), glutathione reductase (GR), isocitrate dehydrogenase (IDH), peptidase with phenyl-alanyl-proline (PEP-PAP) and phosphoglucomutase (PGM). We used additional enzymes (16) in order to obtain an initial estimate of the potential genetic difference between several species in the *anguria* and *sativus* groups (8) as classified by Esquinas-Alcazar (4).

Preliminary data from this study indicated that, although species within the groups evaluated share some common banding patterns, enough difference existed between them to suggest that their genetic distance is certainly as great as Esquinas-Alcazar stated. The objective of this study was to survey the electrophoretic variability within and between cross-compatible and cross-incompatible wild *Cucumis* species in order to: 1) document the relative mobility of electromorphs observed in 7 enzyme systems and; 2) provide information which might lead to a better understanding of the biosystematics of this genus.

Cotyledonary extracts of 8 wild *Cucumis* species and 1 *Cucumis sativus* L. inbred processing cucumber line (Gy 14A) were examined by horizontal starch (12%) gel electrophoresis. The plant introductions examined included accessions of 4 annual (*C. africanus* Lindley F., *C. anguria* L., *C. dipsaceus* Spach and *C. myriocarpus* Naud.), and 2 perennial (*C. ficifolius* A. Rich and *C. zeyheri* Sond.) cross-compatible wild diploid (2n=24) species. The autotetraploid, *C. heptadactylus* Naud. (2n=48), was also examined since it is considered a member of this cross-compatible group based on hybridization studies by Deakin et al. (3).

Isozyme banding patterns of shikimic dehydrogenase (SKDH), triose phosphate isomerase (TPI), GPI, IDH, PGD, PEP-PAP, and PGM were recorded and comparisons were made among zymograms (Table 1). In order to standardize the relative mobilities of the observed electromorphs, extracts of Gy 14 were loaded on each gel, and histochemical staining for specific enzymes was performed according to Shaw and Prasad (6) and Allendorf et al. (1).

The nomenclature follows a modified form described by Richmond (5) such that isozymes for the enzymes SKDH, TPI, GPI, IDH, PGD, PEP-PAP and PGM are designated as Skdh, Tpi, Gpi, Idh, Pgd, Pep-pap and Pgm, respectively. Numerals refer to isozymes numbered from the most cathodal to the most anodal region of the gel. For each enzyme, the most common allele was designated as 100. As an example, the combination of homomeric protein products of the 2 singlebanded electromorphs, 2 (100) and 3 (110), at the Tpi locus (which has at least 4 single-banded electromorphs), produce a heteromeric product which is designated Tpi 2,3 with the relative isozyme mobilities of 100/110.

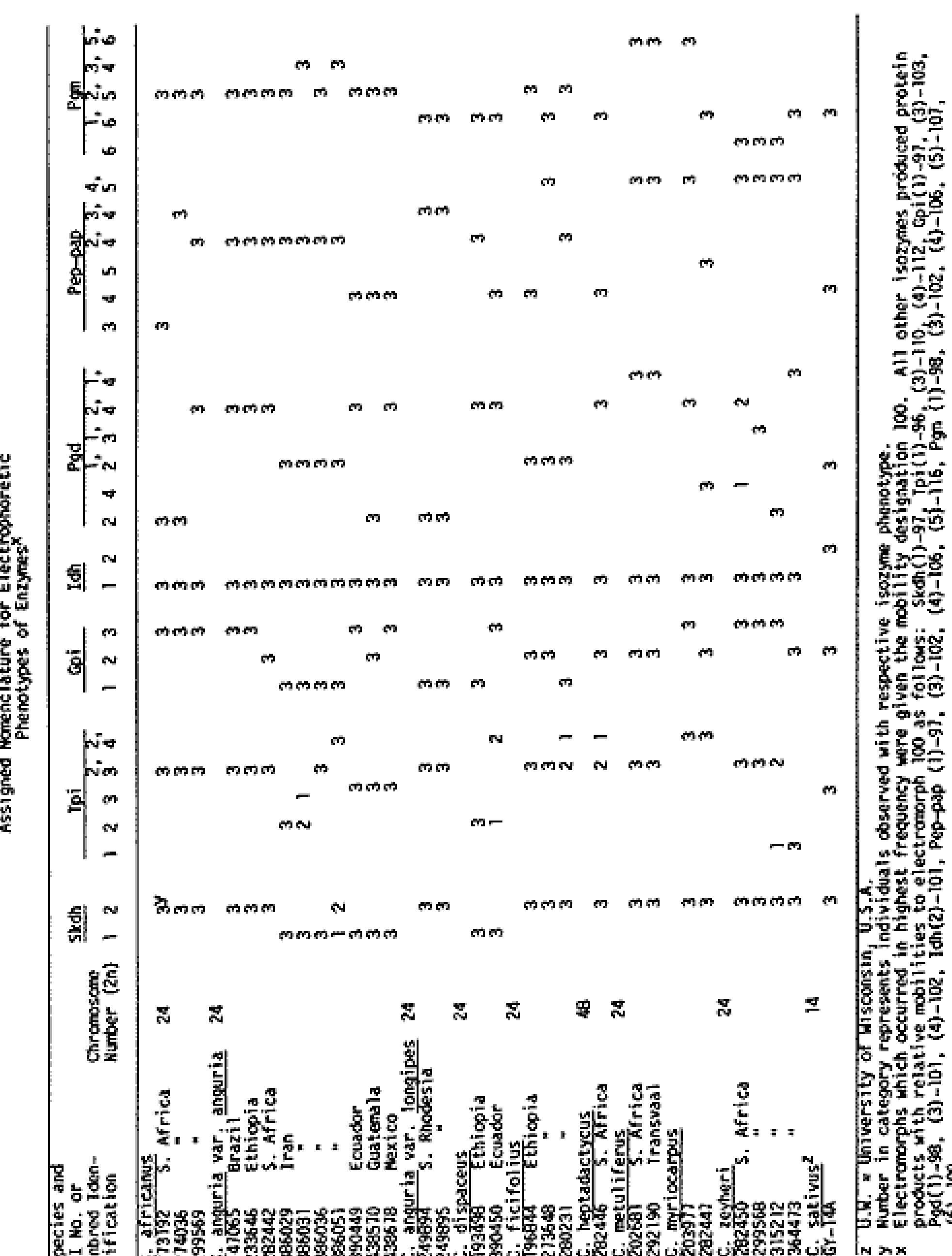
Electrophoretic variation was observed within and between cross-compatible and cross-incompatible groups for all enzyme systems with the exception of IDH which was monomorphic. All the species examined are apparently fixed for Idh 1 (100), while Gy 14 possesses Idh 2 (101) which appears to be characteristic of *C. sativus* var. *sativus* (7). Variation for SKDH exists within *C. anguria* var. *anguria* which possesses both Skdh 1 and 2, while all other species exhibit Skdh 2 except for C. dipsaceus which produced only Skdh 1 electromorphs. All species appeared to possess Tpi 2 (100) and/or 3 (102) except for . *anguria* var. *anguria* PI 386051, *C. dipsaceus* PI 390450, *C. ficifolius* PI 280231, *C. heptadactylus* PI 282446 and *C. myriocarpus* PI 203977 and PI 282447 which produced the electromorph 4 (112).

Tpi 1 (96) was found exclusively in *C. zeyheri* PI 315212 and PI 364473. Gpi staining produced 3 single-banded electromorphs for which C. africanus was monomorphic for Gpi 3, *C. metuliferus* for Gpi 2 and *C. anguria* var. *longipes* for Gpi 1. While *C. anguria* var. *anguria* exhibited the isozyme phenotypes Gpi 1, 2 and 3, the other species segregated 1 and 3

(*C. dipsaceus*), 1 and 2 (*C. ficifolius*) and 2 and 3 (*C. zeyheri* and *C. myriocarpus*). *C. dipsaceus*, *C. metuliferus* and *C. ficifolius* were monomorphic for Pgd 2,4, Pgd 1,4 and Pgd 1,2, respectively. Only *C. zeyheri* PI 299568 showed evidence of Pgd 3 (101). Evidence for Pep-pap 3 (102) was exclusively observed in C. africanus and *C. anguria* var. *longipes*, indicating a closer relationship than had previously been thought. Likewise, evidence for Pep-pap 5 (116) was uniquely recorded in *C. metuliferus*, *C. myriocarpus*, *C. ficifolius* and *C. zeyheri*, suggesting a comparatively close relationship between these species. Evidence for Pgm 5 (107) was observed in *C. africanus*, *C. anguria* var. *anguria*, *C. ficifolius, C. myriocarpus* and *C. metuliferus*. In contrast, *C. metuliferus* and *C. myriocarpus* possessed Pgm 6 (109) which was also recorded in all species except *C. africanus*, and *C. anguria* var. *anguria*. On the other hand, *C. metuliferus* and *C. myriocarpus* exhibited for Pgm 5 (107) which was also present in *C. africanus* and *C. anguria* var. *anguria*.

It appears from these preliminary data that the ancestry of C. metuliferus and *C. myriocarpus* may be relatively close. It is also interesting to note that several C. anguria var. anguria accessions from Iran showed isozyme variations which set them apart from the rest of the var. *anguria* collections. Moreover, var. *longipes* and var. *anguria* are different for PEP- PAP and PGM, confirming (2) their varietal difference.

Table 1. Electrophoretic Variation Observed for Shikimic dehydrogenase (SKDH), triose phosphate isomerase (TPI), glutamic pyruvic transminase, glucosephosphate isomerase (GPI), phosphogluconate dehydrogenase (PGD), peptidase with phenyl-alanyl-proline (PEP-PAP) and phosphoglucomutase (PGM) in 8 *Cucumis* species.



Assigned Nomenclature for Electrophoretic Phenotypes of Enzymes[x]

Species and PI No. or Inbred Identification	Chromosome Number (2n)	Skdh 1	Skdh 2	Tpi 1	Tpi 2	Tpi 3	Tpi 2, 3	Tpi 2, 4	Gpi 1	Gpi 2	Gpi 3	Idh 1	Idh 2	Pgd 2	Pgd 4	Pgd 1, 2	Pgd 1, 3	Pgd 2, 4	Pgd 1, 4	Pep-pap 3	Pep-pap 4	Pep-pap 5	Pep-pap 2, 4	Pep-pap 3, 4	Pep-pap 4, 5	Pgm 6	Pgm 1, 6	Pgm 2, 5	Pgm 3, 4	Pgm 5, 6
C. africanus																														
273192 S. Africa	24		3[y]				3				3	3		3						3								3		
274036 "			3				3				3	3		3										3				3		
299569 "			3				3				3	3						3					3					3		
C. anguria var. *anguria*	24																													
T47065 Brazil			3				3				3	3						3					3					3		
233646 Ethiopia			3				3				3	3						3					3					3		
282442 S. Africa			3				3			3		3						3					3					3		
386029 Iran		3			3				3			3				3							3					3		
386031 "		3			2	1			3			3				3							3						3	
386036 "		3					3		3			3				3							3					3		
386051 "		1	2					3	3			3				3							3						3	
390449 Ecuador		3				3					3	3						3			3							3		
438570 Guatemala		3				3				3		3		3							3							3		
438678 Mexico		3				3					3	3						3			3							3		
C. anguria var. *longipes*	24																													
249894 S. Rhodesia			3				3		3			3		3										3			3			
249895 "			3				3		3			3		3										3			3			
C. dispaceus	24																													
193498 Ethiopia		3			3				3			3						3					3				3			
390450 Ecuador		3			1			2			3	3						3			3						3			
C. ficifolius	24																													
196844 Ethiopia			3				3			3		3				3					3							3		
273648 "			3				3			3		3				3									3		3			
280231 "			3				2	1	3			3				3							3					3		
C. heptadactycus	48																													
282446 S. Africa			3				2	1		3		3						3			3						3			
C. metuliferus	24																													
202681 S. Africa			3				3			3		3							3						3					3
292190 Transvaal			3				3			3		3							3						3					3
C. myriocarpus																														
203977			3					3			3	3						3							3					3
282447			3					3		3		3			3							3					3			
C. zeyheri	24																													
282450 S. Africa			3				3				3	3			1			2							3	3				
299568 "			3				3				3	3					3								3	3				
315212 "			3	1			2				3	3		3											3	3				
364473 "			3	3						3		3							3						3		3			
C. sativus[z]	14																													
GY-14A			3			3				3			3			3					3						3			

z U.W. = University of Wisconsin, U.S.A.
y Number in category represents individuals observed with respective isozyme phenotype.
x Electromorphs which occurred in highest frequency were given the mobility designation 100. All other isozymes produced protein products with relative mobilities to electromorph 100 as follows: Skdh(1)-97, Tpi(1)-96, (3)-110, (4)-112, Gpi(1)-97, (3)-103, Pgd(1)-98, (3)-101, (4)-102, Idh(2)-101, Pep-pap (1)-97, (3)-102, (4)-106, (5)-116, Pgm (1)-98, (3)-102, (4)-106, (5)-107, (6)-109.

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Estimates of genetic variances and covariances of three fresh-market cucumber populations.

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An effective plant breeding program depends on the existence of genetic variability, and the estimation of genetic variance and gene effects are vital in formulating the most effective breeding procedures for the traits in question. Comstock and Robinson (1) provided several methods for obtaining information and estimates of variability and gene effects in plant populations. These provide the breeder with useful information about the breeding populations available to him. This study was undertaken because no estimates of genetic variance components are available for fresh-market cucumbers (*Cucumis sativus* L.) or for cucumber populations varying in degree of genetic diversity. The objectives of this study were to obtain estimates of the genetic variance components for fruit yield and quality traits in 3 freshmarket cucumber populations, and to predict gains from selection for each population based on the above estimates.

Methods. Three North Carolina fresh-market (slicer) cucumber populations were used for this experiment: NC Elite Slicer 1 (NCES1), NC Medium Base Slicer (NCMBS), and NC Wide Base Slicer (NCWBS). The 3 populations were developed with increasing genetic diversity. A North Carolina Design I was used to estimate the variance components in the 3 reference populations. The construction and analysis of this design was given by Comstock and Robinson (1). In this study, 72 SO plants from each population were chosen at random and designated as males. Each male was mated with 3 S_O plants chosen at random and designated as females. In order to estimate genotype x environment interactions, 2 environments were used in 1984 -- spring and summer. The seeds produced by the mating design were planted at the Horticultural Crops Research Station near Clinton, NC using a nested design with full-sib families (females) nested in half-sib families (males). Fruit were harvested at the green stage as described by Wehner and Miller (4) for optimum efficiency in measuring yield in a once-over harvest. Plots were defoliated using Paraquat 1,1'-dimethyl-4,4'-bipyridinium ion) as recommended by Wehner et. al. (5) to make data collection at harvest stage more efficient. Total and marketable (total fruit number - number of culls) fruit yield per plot were estimated by counting as recommended by Ells and McSay (2). Early yield was measured by counting the number of oversized fruit (<50mm dia.) per plot. Fruit shape, seedcell size, and overall impression were rated on a scale of 1 to 9 with 1=poor, 5=average, and 9=excellent. Color was rated on a scale of 1 to 9 with 1=white, 5=light green, and 9=very dark green.

For each of the 3 populations, 9 variables were calculated as described by Hallauer and Miranda (3) (Table 1). These were the mean (Mean-O), additive genetic variance (Var-A), dominance variance (Var-D), additive by environmental variance (Var-AxE), dominance by environmental variance (Var- DxE), environmental variance (Var-E), heritability of half-sib selection (Hert.-hs), mean after 5 selection cycles (Mean-5), and mean after 15 selection cycles (Mean-15).

Results. Means for the 4 yield and 4 fruit quality traits differed, as expected, among populations with the elite population having the highest means and the wide base population having the lowest. The one exception was for early yield where the wide base population was the highest and the elite and medium base populations were equal. Additive variance was predominant for shape and overall impression in the elite and medium base populations and for seedcell size and early yield in the wide base population. Dominance variance predominated for color in the elite population, for percent culls in the medium base population, and for total yield and marketable yield in all populations. Heritabilities were low to moderate (0.00-0.23) in the 3 populations for all traits studied. Heritabilities of the wide base population were generally higher than heritabilities observed in the elite and medium base populations, except for overall impression which was higher in the elite and medium base populations, and shape which was much higher in the medium base population than the other populations.

After 5 cycles of full-sib family selection, the predicted means for total yield were highest in the wide base population, but the

elite population had the highest predicted means for all other traits except shape. After 15 cycles of full-sib family selection, predicted means for total, marketable, and early yield were 59,45, and 5 fruits/plot for the elite population, respectively; 60,37, and 5 fruits/plot for the medium base population, respectively; and, 75, 59, and 27 fruits/plot for the wide base population, respectively. Predicted means for fruit quality ratings ranged from 6 to 10 for the elite population, 6 to 14 for the medium base population, and 7 to 12 for the wide base population after 15 cycles of selection. The wide base population means surpass the elite and medium base population means after 15 selection cycles for all traits except percent culls, shape and overall impression. The low gain per selection cycle for overall impression in the wide base population may be caused by the large number of families with very low quality ratings which may have caused a downward bias in the estimate of additive variance in this population.

The wide base population is the best population for improving the traits measured in this study because it had the highest predicted means for all traits except percent culls, shape, and overall impression; and although the predicted means for overall impression and shape were not the highest, they were at an acceptable level (a mean score of 8) after 15 cycles of selection.

Table 1. Means, genetic variances, heritabilities and predicted gains for 4 yield and 4 quality traits studied in 3 cucumber populations (elite, medium and wide) differing in genetic diversity.

	Fruit Yield (No./plot)				Fruit Quality Score[x]			
Component[z]	Total	Market -able	Early[y]	% Cull	Shape	Color	Seedcell	Overall Impression
				Elite				
Mean-0	24	19	3	23	6	8	6	6
Var-A	20.22	12.68	0.34	0.01	0.27	-0.16	0.27	0.30
Var-D	24.91	15.99	1.26	0.00	-0.09	0.61	0.29	-0.42
Var-AxE	11.77	14.54	4.00	0.01	0.59	0.55	0.53	1.14
Var-DxE	-6.79	-11.01	-3.40	-0.01	-0.46	-0.92	-0.82	-1.14
Var-E	101.66	128.02	11.70	0.02	1.26	0.24	0.90	1.94
Hert-(fs)	0.18	0.15	0.03	0.13	0.14	0.00	0.12	0.11
Mean-5[w]	35	28	3	23	7	8	7	7
Mean-15	59	45	5	22	10	8	9	9
				Medium				
Mean-0	22	17	3	24	6	7	6	6
Var-A	23.20	9.03	0.50	-0.02	0.66	0.23	0.06	0.81
Var-D	11.96	11.78	0.10	0.98	-0.41	0.19	0.68	-1.18
Var-AxE	25.95	24.09	5.46	0.02	0.08	0.24	0.77	1.70
Var-DxE	-31.43	-36.34	-5.78	-0.02	0.08	0.46	-1.37	-3.10
Var-E	69.48	92.73	7.41	0.03	0.67	0.17	0.42	0.61
Hert-(fs)	0.19	0.12	0.05	0.00	0.30	0.13	0.03	0.11
Mean-5	35	24	3	24	9	8	6	6
Mean-15	60	37	5	24	14	10	7	7
				Wide				
Mean-0	21	14	5	37	5	6	4	4
Var-A	33.63	20.84	7.48	0.03	0.62	0.54	0.60	0.28
Var-D	-0.42	0.38	-1.54	-0.01	0.34	0.30	-0.12	0.53
Var-AxE	20.21	21.29	11.11	0.05	0.10	0.31	0.92	0.44
Var-DxE	-18.39	-26.13	-9.50	0.00	0.12	-0.51	-1.38	-0.75
Var-E	64.23	91.41	24.54	0.01	0.93	0.01	-0.34	1.67
Hert-(fs)	0.25	0.22	0.20	0.25	0.22	0.20	0.19	0.11
Mean-5	39	27	12	36	7	6	6	5
Mean-15	75	59	27	35	12	10	11	8

[z]Var-A is the additive variance, Var-D is the dominance variance, Var-AxE is the additive by environmental variance, Var-DxE is the dominance by environmental variance, and Hert-(hs) is the heritability based on half-sib family means.

[y]Early yield is the number of oversized fruits (<50 mm dia.) per plot at harvest.

[x]Scored 1 to 9 (1=poor, 5=average, 9=excellent; except color which was scored 1=white, 5=light green, 9=very dark green). Scores above 9 indicate improvement in fruit quality traits to levels not now observed.

[w]Mean-0, -5, -15 is the population mean after 0,5, and 15 cycles of selection, respectively.

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Effects of Location and Grade Size on the Length/Diameter Ratio of Pickling Cucumbers

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The length/diameter ratio (L/D) of pickling cucumber fruit is important to the cucumber processing industry. For small grade size fruit (less than 27 mm dia), which are packed whole by the processing industry, a L/D of approximately 2.9 is desired. If the L/D is significantly greater than 2.9, the cucumbers bridge as they are being packed in a jar; and it is not possible to obtain the desired fruit count per jar. For larger size fruit 27 to 51 mm dia), an L/D of 2.9 to 3.2 is acceptable. The bulk of the larger diameter fruit are cut into spears or hamburger chips and the bridging associated with-small size whole pack cucumbers is not a problem.

It has been observed that for a particular cucumber variety, the L/D decreases as the diameter of a fruit increases. In discussing this observation with Dr. Todd Wehner of North Carolina State University, we agreed that neither of us were aware of any published data supporting this observation.

In our 1981 cucumber trials, we collected extensive data on L/D for the 6 grade sizes used commonly in the processing industry. L/D values for 3 cultivars common to the 3 testing locations in 1981 are presented in Table 1. Each trial location was harvested a total of 10 times and the L/D values for each size were averaged for the first 2 harvests and through all 10 harvests.

The data supports the observation that as cucumber fruits increase in diameter, the L/D decreases. It has also been generally observed that for hand picked production, the L/D within a grade size increases as the season progresses (i.e., the lowest L/D values are observed in the earliest harvests). The data collected at the Ohio location supports this observation; however, the data collected in Georgia and California do not. For all grade sizes in Georgia, the L/D values averaged through 2 harvests are greater than or equal to the L/D values averaged over all 10 harvests. For California grade sizes 32 mm or less, the L/D values averaged through 2 harvests are greater than or equal to the L/D values averaged through 10 harvests. However, for sizes 32 mm in diameter and greater, the L/D values averaged through 2 harvests are less than or equal to the L/D values averaged through 10 harvests.

The general conclusion from this data is that L/D values are influenced by grade size and environment. Therefore, in selecting a cultivar to obtain a desired L/D for a specific location, the most we can look for are general trends such as: Spear-it consistently has greater L/D values than NK811, and NK811 consistently has greater L/D values than Earlipik 14 across all locations.

Table 1. Mean L/D values for cucumber cultivars by grade size for multiple hand-pick trials at 3 locations.

Cultivar	Number of harvests	Grade size (diameter range in mm)					
		<19	19-27	28-32	33-38	39-44	45-51
		Napoleon, Ohio					
Earlipik 14	2	2.9	2.8	2.6	2.6	2.6	2.4
	10	3.0	3.0	2.9	2.8	2.7	2.7
NK 811	2	2.9	2.9	2.8	2.7	2.5	2.4
	10	3.2	3.1	3.1	2.9	2.9	2.9
Spear It	2	3.0	2.8	2.8	2.8	2.8	--

	10	3.2	3.2	3.1	3.0	2.9	2.8
Cairo, Georgia							
Earlipik 14	2	2.9	2.8	2.8	2.7	2.7	2.7
	10	3.0	2.8	2.8	2.7	2.7	2.6
NK 811	2	3.2	3.1	3.1	3.0	2.8	2.6
	10	3.2	3.0	3.0	2.9	2.8	2.7
Spear It	2	3.4	3.2	3.0	3.0	2.9	2.5
	10	3.2	3.0	3.0	3.0	2.9	2.8
King City, California							
Earlipik 14	2	3.4	3.2	3.0	2.7	2.6	2.6
	10	3.1	3.0	2.9	2.8	2.7	2.6
NK 811	2	3.2	3.1	3.0	2.7	2.6	--
	10	3.2	3.1	3.0	2.9	2.8	2.7
Spear It	2	3.5	3.2	2.8	2.7	2.2	--
	10	3.2	3.1	3.0	2.9	2.6	2.6

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A Standard System for Making Comments While Collecting Data in a Cucumber Evaluation Program

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In the North Carolina State University cucumber breeding program, numerous hybrids, lines and families are evaluated each year in field trials. Most of the data collected is numeric, involving measurement of yield, earliness, fruit quality, fruit size, and disease resistance. However, frequently it is useful to make comments on the overall performance and suitability of a line for potential use in commercial production. I used to note my impressions (various adjectives and nouns) on the data sheet, but 2 things happened as a result of that. First, it was sometimes difficult to fit all of the words in the space allocated for comments on the data sheet, and second, it was difficult to analyze and summarize such data in the yearly report. After a few seasons of making comments, it occurred to me that the same set of words was used over and over. Therefore, I decided to abbreviate these comments so that they would be easier to record and analyze. What evolved was the set of single-letter comments described here.

In developing the single-letter comments, I tried to use a letter that would bring to mind the word(s) being abbreviated. Occasionally, the letter that was best suited for the abbreviation of a word was already used, so it was necessary to select the next best letter. The comments work well for process- ing and fresh-market types in both multiple-harvest trials and once-over harvest trials. Generally, 2 comments are assigned to each line in each of 3 different harvests (making a total of 6 comments) for a multiple-harvest trial, and 2 comments in the single harvest of a once-over harvest trial. The comments assigned represent the 2 worst defects noted for that particular plot. If there is only one obvious comment for a plot, then both of the letters written on the data sheet will be the same. If there are too many bad comments to note, then I comment that it is to be rejected. If there is nothing wrong with the plot, then I comment that it is a plot to keep. Not all of the comments are used in a particular year or trial. The comments are analyzed along with the numeric data adding all comments together for a given line. A trend is often visible when the comments are reviewed, showing how the line varied over replications and/or harvests.

All but 2 of the 26 letters in the alphabet were used in the single-letter system. Plots where no data can be taken are given a • in the comment columns to indicate missing data. The letters used in the system and their definitions are as follows (summarized in Table I): A-fruits excessively warty, B-many fruits have blossom end defects, C-large number of crooked fruits, D-many fruits have dogbone shape, E-line is early maturing, F-fruits often have four carpers, G-fruits are long, H-fruits are short, I-fruits have lengthwise stripes, J-(not used), K-keep (no obvious defects), L-line is late maturing, M-fruit skin is mottled color, N-many nubs, O-mixture of offtype fruits (or segregating for size and shape), P-many fruits with placental hollows, Q-(not used), it-reject (too many defects), S-many fruits with separated carpers, T-fruits have tapered ends, U-fruit are uniform green (not necessarily a defect depending on intended use of the cultivar), V-many varicolor fruits (dark green at the peduncle end and light green or yellow at the blossom end), W-many white fruits, X-fruits have necks (characterized by the tapered peduncle ends of fruit of Dutch greenhouse cucumbers), Y-many yellow fruits, Z-many fruits with diseased areas on them.

Table 1. An abbreviated key for the single-letter system for comments in multiple and once-over harvest trials used to evaluate fresh market and pickling cucumber lines for horticultural performance.

Letter	Definition	Letter	Definition
A	wArty fruits	O	Offtype fruits (mixture)
B	Blossom-end defects	P	Placental hollows in fruits
C	Crooks excessive	Q	-
D	Dogbone-shaped fruits	R	Reject (fruits poor)

E*	Early-maturing line	S	Separated carpels in fruits
F	Four-celled fruits	T	fruits Tapered at ends
G	lonG fruits	U	fruits Uniform green
H	sHort fruits	V	Varicolor fruits
I	StrIped fruits	W	White fruits
J	-	X	neCKS on fruits
K	Keep (fruits excellent)	Y	Yellow fruits
L*	Late-maturing line	Z	diSeased fruits
M	Mottled-colored fruits	•	missing data
N	Nubs excessive		

*Used only in once-over harvest trials.

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Inheritance Mode of Melon Fruit Characters

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In 1983 we started a program to study the genetics of various characters important in melon breeding. The inheritance mode of nine quantitative melon fruit characters ant eleven qualitative fruit characters were studied for 8 cultivars of different origin as well as for 9 of their hybrids.

The experiment was carried out in two different environments: open-air (Murcia) and plastic-house (Malaya). Possible environmental influences were deduced by comparing parents' and hybrids' behavior in the two environments.

Effects owed to dominance towards the greatest parental were detected for the quantitative characters: weight, width, yield, and skin index (in %, expressed as: 200 x thickness of rind zone/width), while dominance acts in the oposite direction in the case of central cavity index (in %, calculated as 100 x wideness of central cavity/width). Inheritance was intermediate for refractometric index and for fruit shape expressed as relationship width/length. Apparently, the increase fruit weight of hybrids is due to the increase in their width and decrease in the size of the central cavity.

Environmental influences were found for the characters weight, width, and skin index, so that when growing under plastic-house, fruits are lighter, narrower and show lower skin index than in the open-air.

The following qualitative characters were studied: skin color, ribbing, netting, writing!, rugosity, flesh color, pistilar scar deformation, fruit cracking, skin spots, and mucilage consistence. Effects owed to dominance were detected for all the characters, except for cracking and for pistilar scar deformation. Dominance was total for rugosity and easy fruit abscission. Cracking inheritance seems to be complex, as effects owed to genie interaction are involved. No environmental influences were observed for the studied characters, except for fruit cracking which only occurred under plastic-house.

[1]In Spain the word "escrito" is used to describe the set of lines or marks that generally appear on the fruit skin and which look like letters or features made by a pen or some other very thin cutting object, and thereby the word "escrito" has been literally translated into english ("writing").

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Inheritance of Resistance to Downy Mildew in *Cucumis melo* PI 124111

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Downy mildew of cucurbits incited by *Pseudoperonospora cubensis* (Berk. & Curt.) Rost. is a devastating foliar disease world-wide (3). Major economic hosts include *Cucumis sativus* L. (cucumber) and *Cucumis melo* L. (muskmelon), although *Cucurbita* sp. (squash and pumpkin), *Citrullus lanatus* (watermelon) and others are also affected (3, 4). In 1944, Ivanoff (2) reported that four cantaloup varieties of West Indies origin were resistant to downy mildew under south Texas conditions. In an incomplete study, he concluded that resistance was partially dominant when crossed to susceptible cultivars. Thomas (4) found that among *C. melo* PI's and cultivars, PI 124111 (PI) expressed the highest resistance to downy mildew under field conditions in south Texas. This paper reports the reaction to downy mildew of this PI, its F_1, F_2, and BC_1 reciprocal crosses to the susceptible commercial cultivars 'Hemed' (H) and 'Ananas-Yokneam' (AY) under growth chamber-greenhouse and field conditions.

Methods. A high degree of resistance to both downy and powdery mildews was stabilized in the PI by five generations of selection and inbreeding. This inbred of the PI was used as the resistant parent. The commercial cultivars H and AY were used as susceptible parents.

A local race of *P. cubensis*, collected from cucumber cv. 'Bet-Alfa' in 1979, was used for all inoculations. Inoculations of 2-leaf stage plants were conducted in chambers by spraying the adaxial leaf surfaces with a suspension of 2000 sporangia/ml. After inoculation plants were kept in a dew chamber at 17C in the dark for 30 hr and were then placed in the greenhouse (22-27C) for 7-8 days. Inoculations of 10-leaf stage plants in the field were done in a similar manner at about 2000-2100 hr, when relative humidity was 85% and temperature 22C.

Resistance in 2-leaf stage plants was assessed according to reaction type (1) and degree of sporulation at 7-8 days after inoculation. In the field, percentage leaf area mildewed was determined at about the 20-leaf stage. Fungal sporulation was determined from potted infected plants after a 20-hr incubation period in a moist atmosphere at 18C ± 1 in the dark. Leaves were removed to a fixative solution and the number of sporangia counted with a cytometer.

Results. Reaction type and fungal sporulation in AY, the PI, and their F_1 reciprocal crosses are presented in Table 1. While AY supported luxuriant sporulation of the pathogen, these were limited on the PI. In F_1 plants, fungal sporulation was markedly inhibited, especially in progeny with the PI as the female parent. Intermediate resistance was also observed in F_1 plants of the crosses between H and the PI (Table 2). Resistant reaction type in the PI was better expressed in leaf 2, but the maternal effect of the PI on reducing sporulation was expressed only in leaf 1. In the field, F_1 plants exhibited about a 50% reduction in percent leaf area infected compared to H, while the PI showed some "pinpoint" (&Mac178; 1 mm) yellow lesions which did not support sporulation. F_2 and some BC_1 populations were examined for reaction type only (Table 3). With either AY or H as susceptible parents, ratios of 6:9:1 susceptible, moderately resistant, and resistant were observed in some F_2 populations. BC_1 resulted in a 3:1 ratio of moderately resistant to resistant plants in the populations inoculated.

Table 1. Sporulation of *Pseudoperonospora cubensis* on *Cucumis melo* PI 12411 (PI), 'Ananas-Yokneam' (AY), and their F_1 and reciprocal crosses.[a]

Feature	AY	AY x PI	PI x AY	PI
Sporangia per cotyledon, x 10^3	141.6 ± 38.6	67.2 ± 47.0	6.0 ± 7.1	0.5 ± 0.8
Sporangia per cm^2 leaf 2, x 10^3	56.4 ± 22.6	13.7 ± 7.1	3.8 ± 3.3	0

[a]Cotyledon tests conducted at 10 days after planting and leaf-2 tests on 3- week-old plants, both at 20C. Ten plants/treatment. In crosses, first parent (on the left) served as the female parent.

Table 2. Sporulation of *Pseudoperonospora cubensis* and reaction type to downy mildew in *Cucumis melo* PI 124111 (PI), 'Hemed' (H), and their reciprocal crosses.

Feature	H	H x PI	PI x H	PI
Sporangia per cm^2, x 10^3				
Leaf 1	78.6 ± 33.4	54.3 ± 22.3	20.3 ± 8.9	5.4 ± 5.9
Leaf 2	70.6 ± 32.0	5.7 ± 5.7	7.8 ± 5.6	0.3 ± 0.6
Reaction type[a]				
Leaf 1	1.0 ± 0	1.0 ± 0	1.0 ± 0	1.9 ± 0.4
Leaf 2	1.0 ± 0	1.4 ± 0.7	2.9 ± 0.5	4.0 ± 0
% leaf area infected in the field	66.0 ± 18.3	31.4 ± 11.1	33.0 ± 12.7	0[b]

[a]l = highly susceptible; 4 = highly resistant (see citation 1 for details); 24-51 plants/treatment.

[b]Pinpoint yellow lesions on lower leaves.

Table 3. Segregation of the reaction of F_2 and BC_1 progenies from reciprocal crosses of PI 124111 (PI) with 'Ananas-Yokneam' (AY) and 'Hemed' (H) to downy mildew (*Pseudoperonospora cubensis*) at the two-leaf stage.[a]

Generation	Pedigree	Observed S : MR : R	Expected ratio S : MR : R	Chi-square	df	P
F_2	(PIxAY) x (PIxAY)	31 56 8	6 9 1	1.4398	2	.3-.5
	(AYxPI) x (AYxPI)	28 90 7	6 9 1	13.1973	2	.001-.01
	(HxPI) x (HxPI)	67 91 10	6 9 1	0.4074	2	.8-.9
	(PIxH) x (PIxH)	46 93 18	6 9 1	9.8960	2	.001-.01
	Combined	172 330 43	6 9 1	9.2654	2	.001-.01
	Homogeneity			15.6751	6	.01-.02
BC_1	PI x (PIxAY)	50 16	3 1	0.0202	1	.8-.9

PI x (AYxPI)	44 22	3 1	2.4444	1	.1-.2
(AYxPI) x PI	52 17	3 1	0.0048	1	.9-.95
Combined	146 55	3 1	0.5987	1	.3-.5
Homogeneity			1.8707	2	.3-.5

[a]Reaction types 11, 12, 13 grouped as susceptible - S; types 22, 23, 24, 33 grouped as moderately resistant - MR; types 34, 44 grouped as resistant - R; according to citation 1.

Discussion. PI 124111 has been used in the peat in cantaloupe breeding programs, especially as a source of resistance to powdery mildew (Bohn, personal communication and Thomas, unpublished). The high level of resistance in this PI against downy mildew, expressed as reaction type 4, has not been utilized. The evidence presented here indicates that two incompletely dominant genes condition the highly resistant reaction of this PI to the Israeli race of *P. cubensis* since a) F_1 plants showed intermediate levels of resistance; b) some F_2 populations segregated in a ratio of 6:9:1 (susceptible:moderately resistant:resistant); and c) BC_1 populations segregated in a ratio of 3:1 (moderately resistant:resistant). Differences in resistance levels of the reciprocal crosses in F1 plants as expressed by pathogen sporulation, point to the possible involvement of cytoplasmic factors. These differences were not observed in the other parameters used to measure resistance in these populations. Additional studies are needed to verify the existence of such factors. At this time, we cannot fully explain the deviations from the expected ratio in some F2 populations.

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Characterization of Melon Cultivars

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An evaluation of several melon cultivars was started in 1983, as a preliminary step in melon breeding studies. Native cultivars, as well as foreign cultivars from several origins, have been studied.

The experiments were carried out throughout 1983 and 1984 at two different locations (Murcia and Malaga) and under two different environmental conditions (open-air and plastic-house).

Seventeen qualitative characters and the following nine quantitative characters were studied: yield, weight, fruit shape (expressed as relationship width/length), flesh index (calculated on the fruit cross- section as the flesh length percentage in relation to width), skin index (expressed as the rind thickness percentage in relation to whole width), refractometric index (° Brix) and the weight of 100 seeds.

In addition, in a few experiments, eight vegetative and two agronomic characters were also evaluated.

Multivariant analysis methods of principal components were used to determine the quantitative characters of high discriminatory value and to establish groups of cultivars.

Some associations between qualitative characters were found, too. These associations were verified through a contingency test applied to the cultivars.

In all, 96 cultivars have been studied: 36 are of Spanish origin, 17 are from North America, and 43 from other countries (European, Asiatic, and American).

High correlations between the weight, the length and the fruit width have been founded on the one hand, and, on the other, between the fruit width, the central cavity diameter and the thickness of the flesh. These results suggest that it could be possible to obtain a simplified characterization by using only the weight and fruit length, the refractometric index and the yield.

In addition, a set of associations between qualitative characters were deduced. We emphasized the following associations:

a) Ribbing/Ease of stem obscission
b) Flesh salmon color/Strong netting
c) Strong netting/Ease of stem abscission

d) Skin white color/Absence of skin spots

Finally, the analysis of principal components has allowed us to establish some groups of cultivars:

In one experiment, the following four groups of cultivars were found:

a) Perita and Amarillo Pintado
b) Tokyo Giant and Tokyo Early
c) Hilo Carrete, Coco-melon, Ogen and Amarillo Oro
d) Punjab Sunheri, melon Tapetate, Perlita (IPB), Cantaloupe de Westland, Imperial-45, and Gulf Stream

In another experiment, the following six groups of cultivars were obtained:

a) China-1 and China-4
b) Israel and Bathalla
c) Krim and Perlita (Asgrow)
d) Suditalien and Piel de Sapo
e) Shipsmaster, Split/Dalmatien, Sudbalkan-5, and Ogen
f) Blanco, De olor antiguo, Tam Perlita, and Cantaloupe Amarelo

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Cold Germinability of *Cucumis melo*

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Low soil temperatures in the early portion of the growing season, can severely limit muskmelon seed germination and early seedling development. In fact, low soil temperatures can often kill young seedlings. Our first step in a program to improve cold tolerance of muskmelon is the identification of cold tolerant germplasm.

Reported here are the results of low temperature germination tests of commercial cultivars and plant introductions obtained from the Regional Plant Introduction Station in Georgia. The following observations were made during germination tests: 1) mean number of hours until radical emergence, hypocotyl elongation, and cotyledon expansion, and 2) development of root hairs and lateral roots.

Two replications of ten seeds each were germinated at 30° and 15°C. The following observations were made at 48 hour intervals over a period of 96 hours for the warm treatment and 336 hours for the cold treatment: A) radical emergence longer than 1 mm, B) hypocotyl elongation beyond the peg, C) cotyledon expansion beyond the seed coat, D) root hair development, 0-4 scale, and E) lateral root development, 0-4 scale. Indices for mean hours to emergence, hypocotyl elongation, and cotyledon expansion were computed using the formula (Loy, 1979):

$$\text{Index} = \frac{S_1T_1+S_2T+S^3T^3+\ldots S^nT^n}{S_1+S_2+S_3+\ldots S_n}$$

where "S" equals the number of seeds showing the trait of interest and "T" equals the time in hours.

The lines were grouped into three classes on the basis of emergence indices: 'cold tolerant' (> 231 hours), 'moderate cold tolerant' (231-291 hours), and 'cold sensitive' (< 291 hours or no response) (Table 1). In most cases, although not all, lines exhibiting early radical emergence also developed faster with respect to hypocotyl elongation and cotyledon expansion.

In Fall of 1983, initial selections were made and planted in the glasshouse. Since making the initial selections, lines have been identified which appear more cold tolerant. These plants were self-pollinated, the seed harvested, and then tested as previously explained. Comparison of the emergence indices of the initial screening and the S_1 generation suggests that the response is stable since the indices of the six lines examined were nearly identical, with the exception of NH53-1-4 (Table 2).

Table 1. Representative classes of cold tolerant, moderately cold tolerant, and cold sensitive *C. melo* cultivars.

			Index			Developmental Rating^z			
Cv or P.I.#	**code#**	**15°C %germ.**	**emer.**	**hyp.**	**cot.**	**192hr**	**240hr**	**288hr**	**336hr**
Cold Tolerant									
126190	159	75	221.2	250.2	273.6	1,0	1,1	2,2	2,3
126197	161	100	217.7	241.5	253.1	4,0	4,2	4,4	4,4
126200	162	100	218.7	243.1	279.2	0,1	0,1	0,2	1,3
126202	163	90	215.5	243.6	256.6	3,1	3,2	2,3	3,4
127575	183	80	230.7	254.5	270.7	4,1	4,2	4,3	4,4
140762	224	95	216.0	237.0	261.8	2,1	2,2	2,2	3,4

Moderately Cold Tolerant									
136197	202	70	252.8	273.2	288.0	0,0	1,0	2,1	2,1
194052	397	70	251.7	298.4	332.6	0,0	0,0	0,1	0,1
201581	413	70	251.1	287.6	322.0	1,0	3,0	3,0	3,0
Pers. 202	450	100	240.0	264.0	285.6	1,0	1,0	0,1	2,1
Cold Sensitive									
182937	350	35	304.0	336.0	336.0	0,0	0,0	0,0	1,0
211955	442	15	316.0	0.0	0.0	0,0	0,0	0,0	0,0
Del. 51	200	0	0.0	0.0	0.0	0,0	0,0	0,0	0,0

[z]Rating 0-4: Root Hair, Lateral Root. Scale: O - not present, 1 -present on a few roots, 2 - present on 0.5 of the roots, 3 - well developed on >0.5 of the roots, 4 - extremely well developed on &Mac179;0.75 of the roots.

The data in Table 1 suggests that early radicle emergence may not indicate cold tolerance during later stages of seedling development. The accession "Persia 202" a reported cold tolerant line (Nerson et al. 1982) seems to support this idea. Additionally, it appears there are lines available which may be more cold tolerant than "Persia 202".

The results of this initial study have shown that there seems to be enough diversity in the low temperature germinability and early seedling development to warrant additional study. Areas for future investigating are the inheritance of cold tolerance, the evaluation of how reliable petri dish germination tests are when compared to germination tests conducted in soil, and the relationship between cold tolerant germination and later seedling development.

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Effect of Inoculation with *Myrothecium roridum* Tode ex Fries on Seed Germination and Early Seedling Growth of 12 Cultivars of Muskmelon (*Cucumis melo*)

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Myrothecium roridum Tode ex Fries, a common soil fungus that produces mycotoxins, has been reported to be pathogenic to several plant species. McLean and Sleeth (4) reported that symptoms of pathogenicity of *M. roridum* on muskmelon included leaf spots, stem decline and postharvest rind decay of fruits. Recently Bruton (1) reported the devastating economic effect of the pathogen in Texas, where fruit losses occurred up to 30%. As soilborne pathogens are also known-to affect seed germination (2,3), this study was initiated to ascertain the influence of the pathogen on seed germination and seedling growth of muskmelon.

Myrothecium roridum (ATCC#52485) was isolated from a diseased melon fruit in Texas and maintained on potato dextrose agar (PDA). Twelve muskmelon cultivars were used: 'Amarelo' (AMR), 'Big Daddy' (BDY), 'Don Juan' (DJN), 'Early Dawn' (EDN), 'Hale's Best' (HBT), 'Harmony' (HAR), 'Hearts of Gold' (HOG), 'Iroquois' (IRQ), 'Jumbo Hale's Best' (JHB), "PMR 45' (PMR), 'Schoon's Hardshell' (SHS), and 'Summet' (SUM).

Seed Treatment: A 14-day culture of *M. roridum* on a PDA slant was washed twice in sterile water and a spore suspension containing 10^6 spores/ml prepared. Seeds were soaked for 8 hrs in either the spore suspension or sterile water.

Soil Treatment: 125 gm of sterilized oat grains were inoculated with 10 ml of a 10^6 spores/ml solution of *M. roridum* in 250 ml flasks. The cultures were grown for 25-30 days with daily agitation of the flasks for uniform fungal growth. The oat grain mixture containing the spores was then mixed with sterile sand at a ratio of 1:10 (oats/sand, w/w) in a cement mixer for 30 min.

Each treatment was sown in a randomized complete block design with 4 replications of 10 seeds each. Seeds were considered germinated when cotyledons were visible. A germination index (5) was calculated for each experiment, and seedling growth was evaluated by recording shoot dry weight after 8 weeks of growth in the greenhouse.

Analyses of variance of the results revealed significant differences among cultivars for both germination and seedling growth (Table 1). The pathogen effect was more pronounced in the seed treatment study, and cultivar responses were similar to our results with leaf tissue inoculation using *M. roridum*.

Table 1. Effect of *Myrothecium roridum* on seed germination and seedling growth of muskmelon after seed and soil treatment.

Treatment	Cv.	Germination Index			Shoot Dry Weight (g)		
		Treatment	Control	% of Control	Treatment	Control	% of Control
Soil	AMR	11.2^z	14.Oa	80.0	0.308c	0.352c	87.5
	BDY	10.4b	13.4b	77.6	0.215h	0.289f	74.4
	DJN	10.0bc	11.3de	88.5	0.212h	0.233h	91.0
	EDN	11.5a	11.8d	97.5	0.386a	0.398a	97.0
	HBT	10.3b	11.7d	88.0	0.234g	0.242g	96.7

	HAR	11.6a	13.7ab	84.7	0.187i	0.233h	80.3
	HOG	6.6e	9.7g	68.0	0.278d	0.337d	82.5
	IRQ	9.5c	11.7d	81.2	0.246fg	0.311e	79.1
	JHB	8.3t	10.1f	82.2	0.366b	0.382b	95.8
	PMR	10.5b	11.1e	94.6	0.370b	0.389b	95.1
	SHS	4.1f	7.4h	55.4	0.105j	0.194i	54.1
	SUM	6.5e	12.5e	52.0	0.261e	0.337d	90.0
Seed	AMR	7.5d	14.7a	51.0	0.283b	0.383a	73.9
	BDY	6.1e	10.8e	56.5	0.240f	0.367c	65.4
	DJN	7.9d	13.2bc	59.8	0.269cd	0.337e	79.8
	EDN	11.4a	12.6c	90.5	0.343a	0.368bc	93.2
	HBT	8.6c	12.7c	67.7	0.258d	0.295h	87.5
	HAR	3.8g	13.9b	27.3	0.159h	0.257i	61.9
	HOG	7.3d	10.4e	70.2	0.255d	0.362cd	70.4
	IRQ	5.8ef	11.6t	50.0	0.246ef	0.358d	68.7
	JHB	8.6c	13.8b	62.3	0.269c	0.331f	81.3
	PMR	10.6b	11.6d	91.4	0.345a	0.380ab	90.8
	SHS	3.2g	7.4f	43.2	0.121i	0.219j	55.3
	SUM	5.3f	14.3a	37.1	0.192g	0.319g	60.2

[z] Mean separation in columns by Duncan's Multiple Range Test, 5% level.

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AC-70-154, A Gummy Stem Blight Resistant Muskmelon Breeding Line With Desirable Horticultural Characteristics

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Gummy stem blight (GSB) caused by *Didymella bryoniae* (Auersw.) Rehm (=*Nycosphaerella citrullina* C. 0. Smith) is a serious disease of *Cucumis melo* L. (1,3,7,8,13), and causes considerable crop losses in Alabama (3). Wall and Grimball (16) state that GSB is of sufficient severity in the Southern United States to warrant the attention of plant breeders. Severe economic losses have been reported in the field, in transit and in storage (1,2,7,12,17).

Initial symptoms of infection are the formation of circular black or tan spots on the leaves. Small infected seedlings usually die as they emerge. If the plants escape damage at this stage, the disease may develop on the stem near the crown or stem axis causing elongated, water-soaked oily green lesions at the nodes. Soon after lesion formation, a canker develops with a reddish gum being exuded. Diseased areas develop a large number of black fruiting bodies followed by wilting and death.

High temperature and humidity enhance development of the disease. Temperature relation studies (4,15) have shown that the pathogen grows rapidly when cultured at 19°-29°C but makes maximum growth at 24°C. Relative humidity is more important for further development of the disease than temperature after infection with *D. bryoniae* has been established.

Cotyledons and young leaves of muskmelons and watermelons are susceptible to GSB infection (1,14). Muskmelon and watermelon remain susceptible to *D. bryoniae* throughout the growing season. The leaves of young squash and cucumber plants are resistant but may become susceptible with age, especially at high temperature and humidity.

All commercial muskmelon cultivars except Gulf coast, Chilton, and AUrora (5,6,9) are susceptible to infection by GSB. Sowell screened several hundred plant introductions and found that PI 140471 was highly resistant (11). PI 140471 was found to be cross compatible with commercial types of muskmelon (10).

Single plant selections of *C. melo* introduction, PI 140471, which were resistant to *D. bryoniae*, and the susceptible cultivar 'Georgia 47' were used as parents. All controlled pollinations necessary to obtain F_1, F_2, and succeeding generations were made in the greenhouse.

Selection of resistant plants was made from controlled greenhouse inoculation experiments. The *D. bryoniae* isolate, 464-8, described previously was used for this study (13). Cultural and inoculation techniques developed by Sowell and Pointer (12) were used in the tests. Seedlings were inoculated in the 2- leaf stage by spraying to drip with 2×10^5 spores per ml suspension. The plants were immediately placed in an incubation chamber at 25°C ± 2° and 100% relative humidity for 48 hours, and were then transferred to greenhouse benches. A modification of the technique used by Sowell et al. (13) was used to rate the damage from *D. bryoniae* 21 days after inoculation. A disease index that ranged from O (no infection) to 5 (highly susceptible) in 1.0 increments for each 20% increase in infection was used.

Seedlings were also evaluated in field plantings. Seedlings were inoculated in the 2-leaf stage by spraying to drip with 2×10^5 spores per ml suspension. The plants were rated for damage from *D. bryoniae* 21 days after inoculation by using the above disease index.

PI 140471, with a disease index rating of 0, showed a high degree of resistance under greenhouse conditions conducive to severe infection. All plants of 'Georgia 47' were damaged and had a disease index of 5 (Table 1). A backcrossing and disease screening program was followed with selection of disease resistant seedlings that produced high yields of excellent quality fruit.

In addition to resistance to gummy stem blight, resistance to downy mildew and powdery mildew was incorporated into the breeding line. Resistance to gummy stem blight was secured from PI 140471 (11,13). Resistance to downy mildew and powdery mildew was obtained from 'Georgia 47'. AC-70-154 has been rated high for resistance to downy mildew, gummy stem blight, and powdery mildew in Alabama and other Southern States, Table 1. Multiple disease resistance of AC-70-154 plants has been excellent in field planting.

The fruit of AC-70-154 are round to oblong round in shape. They measure 15 to 18 cm in diameter and have an average weight of 1.59 kg (Table 2). However, some variation in size, shape, and netting is present in the breeding line. Fruit size varies at different fertility levels and in different production areas. AC-70-154 fruit are comparable in size to other "Jumbo" melons commonly grown and hauled loose without the use of boxes or crates. Therefore, it should sell well on the open market in competition with other large size melons.

The fruit mature in 70-75 days. They are slightly ribbed and well covered with a medium net. The flesh is thick, deep orange in color, and of excellent flavor and aroma. The seed cavity is small.

The fruit is firm and adapted to harvesting and handling. The flesh is firm at the full slip stage; however, it will soften to an excellent condition for dessert quality 3 to 4 days after harvest.

AC-70-154 compares favorably with established Jumbo type cultivars in yield, ability, shipping quality, and edible quality as indicated by taste and soluble solids, Table 2.

A limited quantity of seed is available for distribution to muskmelon breeders as a germplasm release of the Alabama Agricultural Experiment Station. Seed may be secured from Joseph D. Norton, Department of Horticlture, Auburn University, A1 36849.

Table 1. Disease index ratings for downy mildew, powdery mildew, and gummy stem blight, Auburn, AL.

	Disease Index[1]			
Variety	**Downy Mildew**	**Gummy Stem Blight[2]**	**Powdery Mildew[2]**	**Average**
AC-70-154	1.0	1.0	1.0	1.0
AUrora	1.0	2.0	1.0	1.4
Chilton	1.0	1.5	1.0	1.2
Edisto	1.5	5.0	1.5	2.7
Gulfcoast	1.0	1.5	1.0	1.2
Mainstream	1.5	4.0	1.5	2.3
Planters Jumbo	1.5	4.0	1.5	2.3
Hales Best Jumbo	3.5	5.0	3.5	4.0

[1]Disease index: O = no injury, up to 5 = all plants severely damaged.
[2]Greenhouse screening tests.

Table 2. Average yield, fruit weight, and soluble solids of cantaloupe cultivars, E. V. Smith Research Center, Shorter, Ala., 1977-1984.

Cultivar	**Yield Per Hectare**	**Fruit Weight**	**Soluble Solids[1]**
	kg	kg	Pct.
AC-70-154	37,667a[2]	1.59b	12.3b
AUrora	38,384a	1.90a	11.90bc
Chilton	32,022b	1.32c	12.91a

Edisto 47	26,408c	1.96a	11.85bc
Gulfcoast	32,938b	1.38c	12.14bc
Mainstream	25,949c	1.23d	10.56c
Planters Jumbo	22,041d	1.64b	10.63c

[1]Total soluble solids determined with a Bausch and Lomb refractometer, O to 25% scale.
[2]Mean separation within columns by Duncan's Multiple Range Test, 5% level.

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Genetic Linkages in Muskmelon

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We have continued the work presented in the 1984 CGC report (5) on the research of genetic linkages in muskmelon.

1. Necrotic spot virus resistance (*nsv*)

This gene was already found independent from genes belonging to linkage groups 2 to 6 (5). Its linkage with bush (*b*) (group 1) was investigated. In a F_2 progeny between VA 435 (*nsv b*+) and Topmark bush (*nsv*+ *b*) we have observed: 226 virus susceptible and long internode plants, 81 susceptible and bush, 59 resistant and long internode and 32 resistant and bush. With a chi- square value equal to 5.877 (Prob. = 12%) we conclude to the independence between *nsv* and *b*. The gene for nsv being independent from the 6 linkage groups already described is alone in linkage "group" 7.

2. Localization of *Pale* mutant (*Pa*)

Pale (*Pa*) is a semi dominant marker (3). Homozygous *Pa/Pa* (white pheno-type) ia lethal. Only *Pa*/*Pa*+ (yellow phenotype) and *Pa*+/*Pa*+ (normal green) have been observed for linkage with other characters.

The following genes have been used:

a. *Pale* (*Pa*) is 30567 (supplied by J. D. McCreight)
b. *bush* (*b*) in Topmark bush (F. W. Zink)
c. *glabrous* (*gl*) in Arizona glA (R. E. Foster)
d. *Zucchini yellow mosaic* resistance (*Zym*) in PI 414723 (G. W. Bohn)
e. *Flaccida necrosis* (*Fn*) and *Fusarium oxysporum f. melonis* resistance
(*Fom-1*) in Doublon.

Pa was found linked with *gl* (linkage group 3) and independent from *b* (group 1), *Fn* (group 2), *Zym* (group 4), and *Fom-1* (group 5) (Table 1).

Four genes belong to linkage group 3: *red stem* (*r*), *male sterile-1* (*ms-1*), *gl*, and *Pa*. *Pa* and *r* have been found independent (2). Distance between *r* and *ms-1* was estimated to 25.6 ± 0.8 (2) and between *r* and *gl* to 30.9 ± 3.6 (5). Distance between *Pa* and *gl* was estimated on the test cross F1 (*Pa*/*Pa*+ *gl/gl*+) x (*Pa*+/*Pa*+ *gl/gl*). We have observed 167 [*Pa gl*+], 174 [*Pa*+ *gl*], 22 [*Pa gl*], and 19 [*Pa*+ *gl*+]. The distance can be estimated to 10.7 ± 1.6.

In linkage group 3 *gl* is very probably between *r* and *Pa*. The position of *ms-1* is under study.

3. Localization of *halo* marker (*h*)

Halo cotyledons (*h*) gene has been still found independent from *glabrous* (*gl*) and *yellow green* (*yg*) (4).

We found *halo* independent from *b* (linkage group 1), *Fn* (group 2), *r* (group 3), and *nsv* (group 7) but linked with *Zym* (group 4) (Table 2). The distance may be estimated using the maximum likelihood method to 15.0 ± 7.5. *Zym* was already found linked with *andromonoecious* (*a*) and one gene for *powdery mildew* resistance (*Pm-x*). The order between *Zym*, *a*, *h*, and *Pm-x* in group 4 is unknown.

4. Localization of *male sterile-2* (*ms-2*)

Male aterile-2 (*ms-2*) has been described as independent from *male sterile-1* (*ms-l*) (1). *Male sterile-2* (*ms-2*) was found independent from *b* (group 1), *gl* (group 3), *h* (group 4), and *nsv* (group 7) but linked with *yg* (group 6) (Table 3). The linkage between *ms-2* and *yg* is very loose as the distance may be estimated to 37.1 ± 5.4. The order in linkage group 6 (*Fom-2* - *yg*

- *ms-2*) is unknown.

5. Research for other linkages

Linkages between *virescent* (*v*) (supplied by P. E. Nugent) and other genes were investigated. Virescent plants (*v/v*) may sometimes die before turning green. So there may be a deviation from the 3:1 expected ratio from normal: virescent in F_2 progenies. We only present in Table 4 the segregation for the second character among the normal green plants.

The results indicate the *v* segregates independently from *Virus aphid transmission* resistance (*Vat*) (group 2), *r* (group 3), *ms-2* (group 6), and *nectarless* (*n*).

We also found no linkage between *nectarless* (*n*) (in 40099 supplied by J. D. McCreight) and *Vat* (group 2), *a* (group 4), *yg* (group 6), and *nsv* (group 7) (Table 5).

6. Conclusion

The linkages described in muskmelon may be summarized as follows:

group 1 : *b* - *yv*
2 : *Vat* - *Fn*
3 : *r* - *g1* - *Pa* - *ms-1* (place of *ms-1* unknown)
4 : *Zym* - *a* - *h* - *Pm-x* (order unknown)
5 : *Wmv* - *Fom-1*
6 : *yg* - *Fom-2* - *ms-2* (order unknown)
7 : *nsv*

v is independent from group 2, 3, 6, and *n*
n is independent from group 2, 4, 6, 7, and *v*

Table 1. Segragation data for *Pale* (*Pa*) marker and *b*, *Fn*, *g1*, Zym, and *Fom-1* in F_2 progenies.

Genotypes	[yellow]	[normal green]	chi square (6:3:2:1)	
	Pa/Pa^+	Pa^+/Pa^+	Value	Probability
b^+/-	143	65		
b/b	35	26	3.342	34 %
Fn/-	94	41		
Fn^+/Fn^+	33	21	2.651	45 %
gl^+/-	104	10		
gl/gl	13	53	135.300	<.01 %
Zym/-	113	43		
Zym^+/Zym^+	40	27	6.964	7 %
Fom-1/-	83	24		
$Fom\text{-}1^+/Fom\text{-}1^+$	29	16	7.211	7 %

Table 2. Segregation data for *halo* (*h*) marker and *b*, *Fn*, *r*, *Zym*, or *nsv* in F_2 progenies.

Genotypes	[normal green]	[halo cotyledons]	chi square (9:3:3:1)	
	h^+/-	h/h	Value	Probability
b^+/-	160	54	0.446	93 %

b/b	54	15		
Fn/-	168	65	2.177	54 %
Fn^{+}/Fn^{+}	54	15		
r^{+}/-	148	53	1.505	68 %
r/r	48	12		
Zym/-	106	14	91.344	<.01 %
Zym^{+}/Zym^{+}	11	37		
nsv^{+}/-	185	47	2.860	41 %
nsv/nsv	56	19		

Table 3. Segregation data for *male sterile-2* (*ms-2*) and *b*, *g1*, *h*, *yg*, and *nsv* in F_2 progenies.

Genotypes	**[male fertile]**	**[male sterile]**	**chi square (9:3:3:1)**	
	$ms\text{-}2^{+}$/-	**ms-2/ms-2**	**Value**	**Probability**
b^{+}/-	118	41	3.568	31 %
b/b	33	7		
gl^{+}/-	141	53	4.306	23 %
gl/gl	34	16		
h^{+}/-	108	34	1.279	73 %
h/h	32	15		
yg^{+}/-	117	58	10.732	1 %
yg/yg	58	11		
nsv^{+}/-	104	39	1.742	63 %
nsv/nsv	42	15		

Table 4. Segregation data observed among the normal green plants in F_2 progenies segregating for *virescent* (*v*) and *Vat*, *r*, *ms-2*, or *n*.

Genotypes	**Segregation among the normal green plants**	**chi square (3:1) Value**	**Probability**
Vat/- : Vat^{+}/Vat^{+}	141 : 46	0.016	90 %
r^{+}/- : r/r	167 : 52	0.184	67 %
$ms\text{-}2^{+}$/- : ms-2:ms-2	134 : 44	0.007	93 %
n^{+}/- : n/n	175 : 49	1.167	28 %

Table 5. Segregation data observed in F_2 progenies between *nectarless* (*n*) and *Vat*, *a*, *yg*, or *nsv*.

Genotypes	[with nectar] $n^+/-$	[without nectar] n/n	chi square (9:3:3:1) Value	Probability
Vat/-	53	20	4.444	22 %
Vat^+/Vat^+	9	6		
$a^+/-$	50	18	3.420	49 %
a/a	9	5		
$yg^+/-$	94	39		
yg/yg	33	13	1.628	65 %
$nsv^+/-$	94	34		
nsv/nsv	31	10	0.226	97 %

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Cucurbit Genetics Cooperative Report 8:55-56 (Article 20) 1985

B-chromosome Variation in *Cucumis melo* L.

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The occurrence of B-chromosome (supernumerary chromosomes) in *C. melo* has been previously reported in the root tip cells in the cultivars 'Phut', or snap melon (*C. melo* var. *momordica*) and Hales Best Improved (4,5). The present communication deals with the range of variation of B-chromosomes in muskmelon and also reports for the first time its occurrence in pollen mother cells.

The squashing techniques employed for the study of chromosomes at mitosis and meiosis have already been described (3). Of the 41 cultivars and genetic stocks examined (2), four entries were found to carry B-chromosomes in root tip cells and one had in pollen mother cells also.

The variation in the number and size of B-chromosomes are given in Table 1. Among the four cultivars only 'Bokor', a bush variety from Hungary was having B-chromosomes in the root tip cells as well as in pollen mother cells. The number of B-chromosomes varied from 0-2 in root tip cells and 0-1 in pollen mother cells. The size ranges from 0.50-0.75. The pollen mother cells of 'Bokor' carried B-chromosomes in about 22.5% cases. The absence of B- chromosomes in the pollen mother cells of three cultivars and variation in the number of B-chromosomes in different cells can be attributed to their progressive elimination during cell division and development (1).

B-chromosome in pollen mother cells of the cultivar 'Bokor' does not pair with normal chromosomes. It would appear therefore, that the B-chromosome in it had an antique origin and must have undergone irreversible transition in its chromatin phase, resulting in less homology, with the putative chromosome. B-chromosome does not seem to have any effect on plant morphology or meiotic behavior of normal chromosome. Even though the cultivar 'Bokor' carrying B-chromosome in somatic and pollen mother cells was a bushy type, other three cultivars having B-chromosomes only in somatic cells were having normal viny growth habit.

Table 1. Number and size of B-chromosomes in muskmelon.

Variety	Source	Root tip cells		Pollen mother cells		Size of B-chromosomes
		No. of cells studied	Number of B-chromosomes 0 1 2	No. of cells	B-chromosomes 0 1	
Bokor	Hungary	16	6 10 -	80	62 18	0.50
Akra Jeet	Bangalore, India	12	2 2 8	80	80 -	0.50-0.75
C. melo var. *callosus*	Tamilnadu, India	20	7 8 5	80	80 -	0.50-0.75
Mon-4	New Delhi, India	15	0 4 11	80	80 -	0.50-0.75

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Cucurbit Genetics Cooperative Report 8:57 (Article 21) 1985

Silver Nitrate Induction of Perfect Flowers in onoecious Plants of Muskmelon (*Cucumis melo* L.)

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In 1979, we reported that staminate flowers have been induced on gynoecious lines of muskmelon by treatment with silver nitrate (Risser & Rode, 1979). So, as in cucumber, use of silver nitrate allows easy selfing of gynoecious lines of melon.

Is silver nitrate having the same effect on monoecious plants? Two trials were performed in 1984: monoecious plants were sprayed with silver nitrate (500 ppm in distillate water) at various vegetative stages. In both trials, perfect flowers appeared 3 weeks after treatments and could be selfed.

So, as the allele *a* does, silver nitrate induces perfect flowers in the place of female flowers whatever the allele at the other locus *g* that controls presence or lack of additional male flowers.

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A Preliminary Report on Screening Watermelons for Sensitivity to Ozone and Sulfur Dioxide

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Ozone (O_3) is the most common cause of air pollutant-induced crop injury (3). Sulfur dioxide (SO_2) can enhance or reduce the effects of O_3 on crop plants, and at higher concentrations over time, injure crop plants without the presence of other pollutants (4).

For the peat few summers, air pollution has been suggested as a probable cause for some of the different foliar in juries observed on watermelon (1). Controlled experiments were conducted to study the effects of exposures to O_3, alone and in combination with SO_2, on watermelon plants and to determine whether or not foliar injuries noted on field plants could be duplicated with these exposures.

Seeds of each of ten watermelon cultivars were planted in ten cm. plastic pots of Metro Mix 220 (a peat, vermiculite, perlite mixture) on July 11, 1984. Sixteen seedlings of each cultivar were transplanted into fifteen cm. pots and maintained in a charcoal-filtered greenhouse until transported to the field on August 8. Four plants of each cultivar were placed in each of four open-top chambers in which the concentration of O_3 could be monitored and regulated (2). Each chamber was used for one of the following treatments: carbon-filtered air, 0.02, 0.04, and 0.06 ppm O_3, each added to nonfiltered air. Exposures were conducted seven days a week, seven hours a day (1000 hours-1700 hours), for four weeks. Data were recorded every other week as percent of total leaf surface injured on each plant, and injury symptons were described. Table 1 gives final injury estimates.

Table 1. Mean Percent Leaf Surface Injured by O_3[z].

Cultivar	Carbon-Filtered Air	PPM O_3 0.02	Added to Nonfiltered Air 0.04	0.06
Baby Fun	0	35	53	50
Black Diamond	0	37	32	57
Calhoun Grey	0	25	22	57
Charleston Grey	0	10	13	43
Crimson Sween	0	10	40	43
Dixie Queen	0	10	35	50
Jubilee	0	23	20	43
Petite Sweet	0	32	58	70
Sugar Baby	0	43	70	82
Sugar Bush	0	40	43	63

[z]following 31 days of O_3 treatment.

Watermelon cultivars varied in their sensitivity to O_3, although almost all cultivars showed increased injury at the 0.06 level.'Charleston Grey' appeared to be less O_3 sensitive than the other cultivars. 'Petite Sweet,' 'Sugar Baby,' and 'Sugar Bush' appeared to be more sensitive to O_3 than the other cultivars tested. Injuries were very similar to those seen in the

field--interveinal chlorosis, followed by necrosis and whitening of the leaves.

'Charleston Grey,' 'Sugar Baby,' and 'Petite Sweet' were then chosen for studying the effects of O3 in combination with SO2. Seed were planted in Metro Mix 220 on September 7, 1984. Plants were transplanted into twenty liter containers and taken to the field site on October 1, 1984. Exposures started the following day and continued until frost, forty days later. Four levels of O3 (carbon filtered air, nonfiltered air, and 0.04 ppm or 0.06 ppm O_3 added to nonfiltered air) and three levels of SO_2 (0.0 ppm, 0.075 ppm, or 0.15 ppm SO_2 added to O_3 treatment) were used in the experiment. Plants were exposed to SO_2 for four hours (1000-1400 hours) and to O_3 for seven hours (1000-1700 hours) daily. Twenty-four open-top chambers were used in this experiment, and all treatments were replicated twice.

In order to obtain more objective injury data, plants were checked every other day, and leaves were tagged as soon as any pollutant injury developed. Table 2 shows the number of injured leaves per cultivar at harvest.

Table 2. Mean Number of Injured Leaves[z].

O_3	SO[x]	Petite Sweet	Sugar Baby	Charleston Grey
Carbon -	0.0	0.0	0.0	0.0
Filtered	0.075	0.0	0.0	0.0
Air	0.15	0.0	0.0	0.0
Nonfiltered	0.0	0.0	0.0	0.0
Air	0.075	0.0	0.0	0.0
	0.15	0.0	0.0	0.0
0.04y	0.0	4.5	4.0	3.3
	0.075	7.8	6.5	5.0
	0.15	9.0	6.5	1.8
0.06y	0.0	10.3	8.3	7.0
	0.075	10.8	8.3	5.3
	0.15	11.3	9.5	6.3

[z]following 40 days of exposures.

[y]ppm O_3 added to nonfiltered air.

[x]ppm SO_2 added to carbon-filtered or nonfiltered air.

No injury occurred on any of the plants in chambers where O_3 was not added, even at the highest concentration of SO_2. The number of injured leaves for all cultivars tended to increase as the O_3 concentration increased. The cultivar response to a combination of SO_2 and O_3 was not similar. 'Charleston Grey' may be less sensitive to O_3 when SO_2 is present. In all cases, damage symptoms resembled O_3 injury.

These results reflect preliminary work. Cultivar differences apparently exist, but more replication and larger plant samples are needed to reduce error in injury estimates. We were able to reduce interference from most cultural factors with the container-grown plants, but other factors--like differing plant maturity rates among the cultivars--need to be examined in relation to pollutant sensitivity. Also, experiments need to be conducted in order to determine the effects of pollutant-induced injury on yields.

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Interaction of Commercial Watermelon Cultivars with Regional Isolates of *Fusarium oxysporum* f. sp. *niveum*.

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Cirulli (3), Crall (4), and Netzer (6) have suggested different physiological races of *Fusarium oxysporum* f. sp. *niveum* are present. Armstrong and Armstrong (1) reported the isolates used by Crall (4) and 1 isolate from South Carolina varied only in the level of virulence, not in susceptible cultivar range.

Field studies by Barnes (2), and Elmstrom and Hopkins (5) noted different resistance levels among cultivars. 'Calhoun Gray' and 'Summit' had high levels of resistance to wilt, compared to moderate levels in 'Crimson Sweet' and 'Charleston Gray'. 'Sugar Baby' was susceptible. Differential response of 'Calhoun Gray' and 'Summit' to isolates from Florida and California versus isolates present in Israel was the basis for the suggestion by Netzer (6) that a race of *F. oxysporum* f. sp. *niveum* different than the races reported by Cirulli (3) and Crall (4) was present in the Middle East. This study was conducted to assess resistance levels among commercial watermelon cultivars, and among different seed sources of the same cultivar, after inoculation with isolates obtained from different watermelon production areas in the U. S.

Single spore isolates of *F. oxysporum* were obtained from Carnation Leaf Agar (7) cultures of 'Sugar Baby' seedlings that expressed symptoms of wilt when grown in soil samples from South Carolina and Florida. A Texas isolate was isolated from a "resistant" cultivar that wilted in the field by Dr. R. D. Martyn, Texas A & M University, and forwarded to the Edisto Experiment Station on PDA. Inoculum of each isolate was produced on CLA and diluted to concentrations of 10^6 spores/ml.

Separate sets of 5 seedlings representing different seed lots of 6 watermelon cultivars at the first leaf stage were inoculated with 1 of the 4 isolates via dipping the root system in the inoculum suspension for 1 minute. Each seedling set was transplanted to a pot in the greenhouse and assessed for wilt for 42 days. Each combination of isolate and seedling set was replicated 5 times. Association between *F. oxysporum* and each wilted seedling was verified by plating the seedling on CLA and observing fungal cultures present 7 to 10 days later for *F. oxysporum* morphology.

Fusarium oxysporum was observed in culture for every seedling that wilted after inoculation. Percent mortality for each seed lot and isolate combination is listed in Table 1. Seed lots of 'Crimson Sweet' reacted similarly to each isolate. 'Jubilee' #2 and 'Jubilee' #1 performed generally the same after inoculation with each isolate, though mean mortality in 'Jubilee' #2 was higher than in 'Jubilee' #1 (48.7% versus 28.9%, LSD $_{.05}$). Seed lots of 'Charleston Gray 133' reacted the same to the South Carolina and Florida isolates. However, 'Charleston Gray 133' #1 showed more than double the level of mortality than 'Charleston Gray 133' #2 after each was inoculated with the Texas isolate.

The Texas isolate was the most virulent, based on mean mortality across the 9 seed lots. 'Calhoun Gray' and 'Summit' were not susceptible to the Edisto 2 and Leesburg 33 isolates. 'Summit' showed 10% mortality after inoculation with Edisto 56. Both cultivars were highly susceptible to the Texas isolate. The differential reaction of the 2 cultivars to the Texas isolate versus the response to the other isolates is similar to the results observed by Netzer (6). Texas X1 may be a different race of the pathogen than is represented by the Florida and South Carolina isolates.

Table 1. Percent mortality among commercial watermelon cultivars 42 days after inoculation with isolates of *Fusarium*

oxysporum f. sp. *niveum.*

Cultivar[y]	Isolate: Edisto 2[z]	Edisto 56[z]	Leesburg 33[z]	Texas X1[z]
Calhoun Gray	O.Oa	O.Oa	O.Oa	80.0 cd
Summit	O.Oa	lO.Oa	O.Oa	77.9 bcd
Crimson Sweet #1	16.Oa	16.9a	12.6a	48.Oab
Crimson Sweet #2	28.Oab	16.Oa	8.Oa	45.8ab
Charleston Gray 133 #1	16.5a	25.lab	O.la	83.9 cd
Charleston Gray 133 #2	25.8ab	49.6 bc	22.2ab	35.4a
Jubilee #1	30.Oab	35.0 b	10.7a	40.Oab
Jubilee #2	50.0 bc	60.0 bc	30.Oab	55.Oabcd
Sugar Bab	76.0 c	80.0 c	44.0 c	88.0 d
Mean of 9 seed lots[z]	26.9a	32.2a	14.2a	61.5 b

[y]Crimson Sweet #1 = Hollar & Co., Lot 9770; Crimson Sweet #2 = Asgrow Seed Co., Loy VGY 366; Jubilee #1 = Hollar & Co., Lot 9998; Jubilee #2 = Wilhite Seed Farms, Lot 2498; Charleston Gray 133 #1 = Hollar & Co., Lot 10590; Charleston Gray 133 #2 = Wilhite Seed Farms, 2485.

[z]Means within each column followed by a common letter are not significantly different at LSD $_{.05}$. Separate tests of significance conducted on means of 9 seed lots at LSD $_{.05}$. Differences among isolates within each seed lot can be determined; if &Mac198; mortality > 27, then % mortality values are significantly different (pairwise comparisons, P > .05).

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Cucurbit Genetics Cooperative Report 8:66 (Article 24) 1985

Obtention of Embryos and Plants from *In Vitro* Culture of Unfertilized Ovules of *Cucurbita pepo*

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Unfertilized ovules of *Cucurbita pepo* have been *in vitro* cultured to obtain haploid plants from the embryo-sac cells. In our first experiments we obtained embryos coming from the internal part of the ovule without callus formation. The best results were obtained in culturing ovules excised one or two days before flowering. At this stage the ovules are not fertilized. The most efficient culture media were very similar to those used in our laboratory for pepper and eggplant anther culture (2,3). Under optimal conditions we could obtain the regular mean rate of 4 to 7 plants per 100 cultured ovules. The embryos directly gave plantelets after transfer to an hormone-free medium (1). Plants were then transplanted to soil.

Most of the plants were diploids but some were haploid-diploid chimeras, aneuploids or polyploids. The genetic analysis of the diploid plants is underway. Plants obtained from 8 heterozygous F_1 cultivars were not similar to the mother donor plant. From each F_1 cultivar, the regenerated plants showed different phenotypes. So, they did not come from maternal tissues. The first selfed progenies were observed and seemed homogeneous.

Further studies are under progress for:
-increasing the embryo production
-obtaining plants from different cultivars
-genetical and cytological analysis

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Differential Sensitivity of *Cucurbita pepo* Cultivars to Ethephon

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Initial reports of the effects of ethephon on both squash and cucumber were concerned with the ease with which relatively low concentrations were effective in converting the normally monoecious plants to femaleness for a given length of time. Later, George (1) reported that different genetic backgrounds of cucumbers exhibited differing degrees of conversion to temporary femaleness by ethephon, from easily converted to partially converted to virtually unaffected. Shannon and Robinson (4) reported that higher concentrations and more than one application were needed to convert summer squash (*Cucurbita pepo* L.) plants to femaleness under field conditions. They attributed this largely to the higher temperatures and longer days of summer field conditions, environmental factors which had previously been reported to favor maleness in *C. pepo* (2).

In the present investigation 2 *C. pepo* cultivars were compared for ease of conversion to femaleness under winter greenhouse conditions in Israel. One of these, 'Table Queen', was reported by Robinson et al. (3) to be easily converted to temporary femaleness by 250 ppm ethephon. The responsiveness of the other, 'Vegetable Spaghetti', to ethephon has not been previously described.

Seeds of 'Table Queen' were provided by Joseph Harris Co. and those of 'Vegetable Spaghetti' were acquired from Sakata Co. They were sown in the greenhouse on 14 January 1984 in 5-liter plastic pots that were filled with a mix of 1 soil: 1 peat: 1 vermiculite. For each of the cultivars there were 5 plants per treatment and 4 treatments: (a) control; or spraying to run-off with (b) 250 ppm ethephon at the 2-leaf stage, (c) 500 ppm at the 2-leaf stage, or (d) 500 ppm at the 2-leaf stage and again at the 4-leaf stage. Side branches and young fruits were removed during the course of the experiment. Flower sex and day of opening was recorded until the 30th node of each plant.

'Table Queen' produced more female flowers and had a higher ratio of female to male flowers than 'Vegetable Spaghetti' (Table 1). 'Table Queen' was also more easily converted to temporary femaleness. A concentration of 250 ppm was sufficient to suppress male flowering in terms of node of first male flower to reach anthesis, days from emergence to anthesis of first male flower, and number of male flowers to reach anthesis. This same concentration had no . significant effect on male flowering of 'Vegetable Spaghetti'. A concentration of 500 ppm suppressed male flowering in 'Table Queen' to such an extent that there was a 16-day span of anthesis of the first female to the first male flower. This concentration did not significantly lower the number of nodes to the first female flower, increase the number of female flowers, or hasten anthesis of female flowers. At 500 ppm, the changes that occurred in 'Vegetable Spaghetti' paralleled those that occurred in 'Table Queen' at 250 ppm, that is, there was some suppression of male flowers. With 2 applications of 500 ppm to 'Vegetable Spaghetti', the changes that occurred paralleled those in 'Table Queen' at 1 application of 500 ppm, that is, there was strong suppression of male flowers.

In this experiment sex conversion by ethephon was accomplished by suppressing male flowering but not by promoting female flowering. Of the 2 cultivars tested, the cultivar that was more strongly male was less easily converted to femaleness with ethephon than was the more strongly female cultivar. This situation is consistent with that reported for cucumbers (1) and that reported for 3 private inbreds of *C. pepo* (4). For hybrid seed production, each prospective female parent needs to be tested before commercial planting for its relative responsiveness to ethephon. 'Table Queen' and 'Vegetable Spaghetti' are potentially useful as checks for easy-to-convert and difficult-to-convert genotypes, respectively.

Table 1. Effects of ethephon on flowering and sex expression of 2 squash cultivars under winter greenhouse conditions.

Nodes to	Days from	Number

Cultivar	Ethephon concn. (ppm)	first open flower		emergence to 1st open flower		of open flowers		Ratio Female to Male flowers
		Male	Female	Male	Female	Male	Female	
	0	1.6 a	10.6 ab	35.4 a	31.4 a	20.0 d	12.2 c	1:1.6
Table	250	6.6 b	9.8 ab	39.4 b	31.0 a	15.2 c	9.0 b	1:1.7
Queen	500	18.6 c	8.4 a	48.8 d	32.2 a	8.6 b	9.4 bc	1:0.9
	2 x 500	18.7 c	13.6 c	45.7 cd	36.0 bc	1.0 a	11.8 c	1:0.1
	0	1.2 a	12.0 bc	36.4 ab	34.4 abc	19.6 d	8.B b	1:2.2
Vegetable	250	1.4 a	14.6 c	37.2 ab	37.4 c	21.8 d	6.0 a	1:3.6
Spaghetti	500	7.0 b	9.8 ab	41.4 bc	32.8 ab	16.6 c	7.0 ab	1:2.4
	2 x 500	21.6 d	13.0 bc	53.6 e	36.0 bc	7.2 b	9.0 b	1:0.8

Mean separations within columns by Duncan's Multiple Range Test, 5% level.

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Rapid TLC and HPLC Test for Cucurbitacins

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Recently, there have been reports (2,4) of serious illness and litigation due to a low incidence of a gene for bitter fruit in summer squash. In some cases, the frequency was estimated to be one plant in 10,000 with bitter fruit.

Such a low frequency makes it difficult for a seedsman to determine if a seed lot is free of the deleterious gene. In cucumber, plants with non-bitter fruit due to the *bi* gene can be detected in the seedling stage by tasting the cotyledons. Classification for the *cu* gene in *Cucurbita pepo* can also be made in the seedling stage by tasting the cotyledons or by feeding tests with *Diabrotica* beetles (3). While these methods are useful for breeding squash resistant to cucumber beetles, these seedling tests are not reliable methods to test for the frequency of *Bi*, the gene for bitter fruit. The cu gene reduces the cucurbitacin concentration in cotyledons sufficiently to prevent them from having a bitter taste but, unlike the *bi* gene of cucumber, it does not prevent cucurbitacins and bitterness from developing in the fruit.

Existing methods for analyzing cucurbitacins are too cumbersome for screening large squash populations for *Bi*, since a person can analyze less than 50 samples per day. A rapid test involving the application of crude chloroform extracts to filter paper with antimony bichloride was reported by Andeweg and de Bruyn (1) to fluoresce under U.V. light when cucurbitacin C was present. However, we found that results of this test did not agree with those obtained by tasting cotyledons in a cucumber F_2 population segregating for bit The test did not work even when applied to cucurbitacin C, for which the test was specifically developed. We also found that the cucurbitacin concentration in *C. pepo* cv Blackjack cotyledons quantified with this test showed no correlation with cucurbitacin concentration determined by the HPLC method reported by Ferguson (3).

We developed a new test in which leaf, fruit, or cotyledon tissues are sampled simply by pressing the tissue against a TLC plate (5x20 silica gel with fluorescent indicator) so Juice is expressed on the absorbent. Fifteen to twenty samples can be placed 1.5 cm from the bottom of the long dimension of the plate. Sampling can be done in the field. The plates are developed about 3 cm with a methanol:water (45:55) solvent (5). After drying, the chromatograms are observed under a 254 nm U.V. lamp. (It is best to view the plates in subdued light while wearing protective lenses to protect eyes from exposure to U.V. radiation). Most interfering compounds, including chlorophyll which also absorbs U.V. light, remain at the starting point. All cucurbitacins move near the solvent front and appear as dark spots due to quenching of fluorescence. Pure standards of cucurbitacins B, D, E and I and the glycoside of E can be detected at 1 nanogram per spot. Leaf and cotyledon tissues usually contain other fluorescnet-quenching substances and the TLC test can be used as a rough preliminary method for selection of high and low cucurbitacin individuals. However, fruit placental tissue contains only traces of interfering compounds, and sap expressed from this tissue can be used for selection of more precise classes of cucurbitacin concentrations.

The TLC test can be used for screening large populations in breeding programs and for varietal purity tests. Several hundred samples can be screened each day at a materials cost of 2-3 cents per sample.

Fruit placental sap samples can also be used for quantitative HPLC determinations of cucurbitacins. Since there are very low levels of interfering compounds, it is only necessary to add methanol to sap (8:2), and filter to remove precipitated materials. The filtered solution can be injected directly into the HPLC. Although not as fast as the TLC method, this method can be used for rapid and accurate estimates of different cucurbitacins in fruit. The number of analyses is limited by the rate of HPLC output.

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Cucurbit Genetics Cooperative Report 8:71-73 (Article 27) 1985

Cucurbitacin Concentrations in Different Plant Parts of *Cucurbita* Species as a Function of Age.

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Cucurbitacins (Cucs) are of concern to breeders due to their relation to insect resistance and fruit bitterness. When evaluating lines for Cucs, it is important that all samples are of the same plant part and of uniform age. Large differences in concentrations of Cucs were found in the placenta (locule contents, excluding seeds), flesh, and rind of fruit of *Cucurbita equadorensis* and the F_1 hybrids of *C. equadorensis* x *C. maxima* and *C. pepo* x *C. texana* (Table 1) as well as *C. texana* (Table 2). In each genotype, the concentrations of Cucs was much higher in the placenta than in other parts of the fruit. Squash breeders using *C. equadorensis* as a source of virus resistance should be aware that, although the fruit flesh of this species is not bitter, the placenta contains toxic levels of Cucs; this is particularly of concern for summer squash derived from a cross with *C. equadorensis*, since the placenta is not often discarded as it is with winter squash.

Bitterness in the fruit of *C. texana* can be detected at anthesis by sampling placental tissue (Table 2). Cuc concentrations in placenta, flesh, and rind increased rapidly with age.

Concentrations of Cucs in the cotyledons and roots of *C. pepo* cv Blackjack changed rapidly during seedling development (Fig. 1). Because of these large differences in Cucs as a function of age and plant part sampled, it is important to specify the age, organ, and tissue sampled when reporting results.

We have used the HPLC method described by Ferguson et al. (1), with a modification in the method of extract purification. We use a single solvent (methanol:water, 45:55) to separate Cucs from most of the contaminants on silica plates with fluorescent indicator. Cucs are detected by quenching of fluorescence under 254 nm U.V. radiation (2).

Table 1. Localization Of cucurbitacins within fruit.

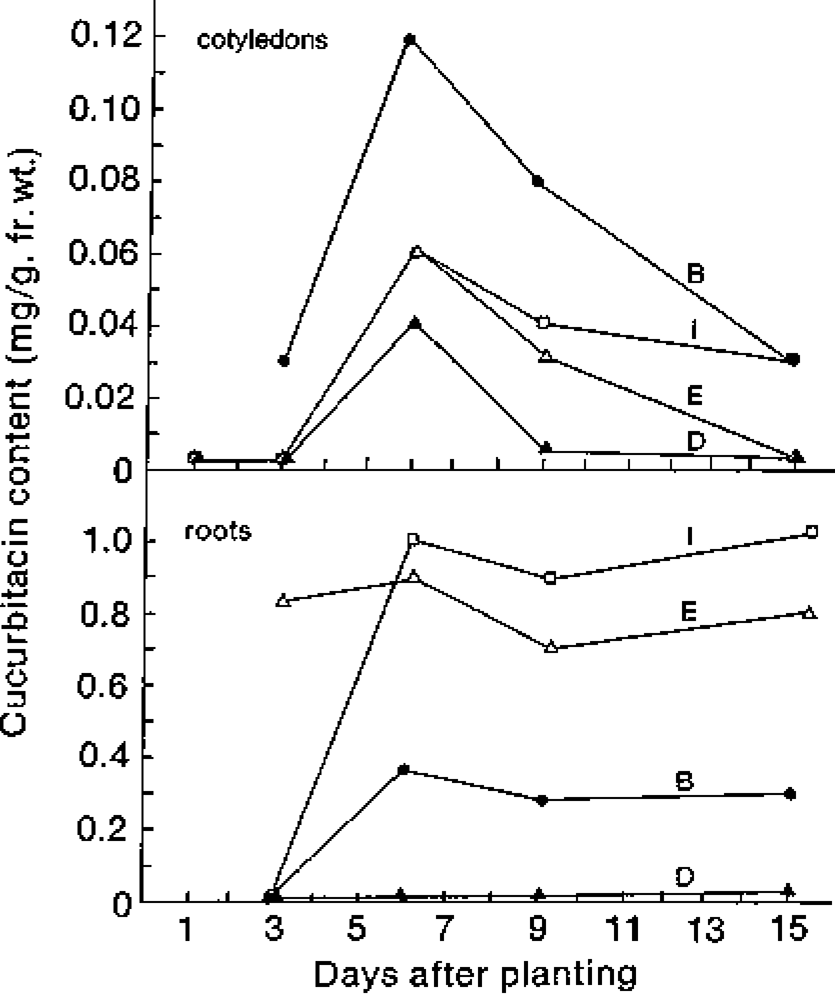
Genotype	Fruit part#	Cucurbitacins (µg/g fresh wt.)				
		E Glycoside	D	I	B	E
C. equadorensis	P	tr	500	60	140	30
	F	0	10	tr	6	tr
	R	0	20	tr	20	tr
(*C. maxima* cv	P	tr	390	50	350	60
Buttercup x	F	O	tr	tr	tr	tr
C. equadorensis)F_1	R	O	2	2	1	1
C. pepo cv	P	tr	O	O	O	O
BlackJack	F	O	O	O	O	O
	R	O	O	O	O	O
(*C. pepo* cv	P	290	tr	50	O	tr
Blackjack x	F	10	O	tr	O	O
C. texana)F_1	R	10	O	tr	O	O

*P=placenta, F=flesh, R=rind.

Table 2. Cucurbitacins in developing *C. texana* fruit.

		Cucurbitacins (µg/g fresh wt.)				
Days after anthesis	**Fruit part#**	**E Glycoside**	**D**	**I**	**B**	**E**
O	P	364	0	161	200	tr
	F	69	0	34	15	tr
	R	tr	0	tr	tr	tr
4	P	454	0	46	52	198
	F	32	0	52	47	tr
	R	13	0	6	11	tr
14	P	1040	0	106	15	146
	F	42	0	34	tr	tr
	R	13	0	3	tr	tr
28	P	3560	0	284	tr	116
	F	83	0	37	tr	tr
	R	38	0	1	tr	tr
42	P	5920	0	2920	63	228
	F	266	0	1480	4	tr
	R	48	0	1	tr	tr

#P=placenta, F=flesh, R=rind



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* On leave from Dept. of Biochemistry, Institute of Soil S

Cucurbit Genetics Cooperative Report 8:74-75 (Article 28) 1985

Breeding for Resistance to Cucumber Mosaic Virus in Courgette and Vegetable Marrow

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Cucumber mosaic virus (CMV) is the only economically important virus infecting courgette and vegetable marrow (*C. pepo*) plants in the UK. There are no resistant cultivars available but a resistance breeding programme was started at the NVRS in 1980. We decided not to use a wild species as a source of resistance because this would require a lengthy backcross procedure and since other groups of workers were already working along these lines (6, 7, 8) there seemed little point in duplication. Also unlike those workers who are breeding for resistance to Watermelon mosaic virus (WMV) 1 and 2 in addition to CMV, we are only concerned with CMV resistance. We therefore decided to screen for resistance within *C. pepo*. Resistance has been reported previously (2, 3, 10) but apparently this was not incorporated into any recently released commercial cultivars.

Plants for screening were grown in an aphid-proof glasshouse and mechanically inoculated at the cotyledon stage. They were scored for systemic infection, on a O (no symptoms) to 5 (severe mosaic and stunting, necrosis or early death) scale, 10 to 14 days later. Symptomless plants were rechallenged by inoculating all leaves and those still scored as O were tested for virus content by back-inoculation to plants of *Chenophodium quinoa*. Plants were considered resistant if CMV could not be detected by back-inoculation from uninoculated leaves. Plants that developed local lesions on their inoculated cotyledons (indicating a successful inoculation) but no systemic infection were also considered resistant.

Screening of 64 accessions of *C. pepo* from Europe, UK, USA and Mexico revealed resistant plants in several open-pollinated cultivars. The highest frequency was in the cv. Cinderella (9), a bush-type Halloween pumpkin bred by Dr. A. M. Rhodes, University of Illinois, Urbana, from the cross Uconn x Connecticut Field (CF) with 3 or 4 backcrosses to CF. CF is susceptible to CMV (9) so that the resistance is presumably derived from Uconn, however, we have not tested this cultivar. In addition to symptomless plants there were plants with symptom scores 1 to 4 indicating the resistance is quantitative, however, at present we have no information on the genetics of the resistance.

The resistance of Cinderella was increased by selection of resistant plants (9) and appears to be fixed at the S_4 generation. The resistance is effective against eight strains of CMV known to differ in their pathogenicity and virulence (4) and will hopefully prove to be durable in the field. However, our first attempt at evaluating the resistance in the field failed because establishment of the virus in the spreader plants was poor and there were too few aphid vectors present in the plot. The resistance is influenced by the environment and is more effective at higher temperatures and higher light intensities (5), which is fortunate since the resistance will therefore be enhanced in the field.

It is unfortunate for us that resistance was found in a pumpkin since a backcross programme is now necessary (at least we are starting with something that is edible!). We are at the first backcross generation using several courgette cultivars as recurrent parents. Some of these possess the silvery- leaf trait and in view of the possible role of this in giving protection against aphid vectors (1) we intend to combine this trait with the resistance. Although we are not actively breeding for resistance to powdery mildew we are selecting against increased susceptibility to this disease.

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Cucurbit Genetics Cooperative Report 8:76-77 (Article 29) 1985

Lack of Resistance to Zucchini Yellow Mosaic Virus in Accessions of *Cucurbita maxima*

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Zucchini yellow mosaic virus (ZYMV) is one of the most destructive pathogens infecting cucurbits, and although of recent identification (1981), it is known to be present in 15 countries on five continents (1, 2, 3, 5). Epidemics have occurred in Europe, the Middle East, and in the United States and particularly devastated were melon (*Cucumis melo*) and summer squash (*Cucurbita pepo*) (1,5, 6). Efforts to find sources of resistance in accessions of *C. pepo* have been unsuccessful, however, *C. ecuadorensis* and an accession of *C. moschat*a are resistant (1, 5).

The search for additional sources of resistance or tolerance to ZYMV in other *Cucurbita* species has continued, and this report deals with the evaluation of the *C. maxima* collection available at the USDA Northeast Regional Plant Introduction Station, Geneva, New York. This collection comprises 418 accessions, of which 386 bear the Plant Introduction numbers (P.I.), and 32 the Geneva State numbers (G). These accessions were originally collected in 35 countries on six continents, and they are listed in the Northeast Regional Plant Introduction Station Serial Publications N° 24 (1975) and N° 24C (1983).

In screening for resistance to ZYMV, ten plants of each accession were mechanically inoculated at the first leaf stage with each of the two known strains of the virus present in the United States: ZYMV-CT and ZYMV-FL (5). Plants which failed to develop symptoms after the first inoculation were reinoculated with the pertinent strain. All tests were conducted in an insect-free greenhouse maintained at 25-30 C.

None of the 418 accessions tested was resistant or tolerant to either strain of ZYMV. All plants develop a persistent and rather prominent mosaic, foliar distortion and severe stunting.

Considering the number of lines involved, their origin and diversity, the lack of resistance or tolerance in *C. maxima* is disappointing. However, some accessions of this species were demonstrated to be resistant or tolerant to other cucurbit viruses (4).

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Cucurbit Genetics Cooperative Report 8:78-79 (Article 30) 1985

Breeding High Female Lines Through Interspecific Hybridization of *Cucurbita*

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The genetic variation available in *C. maxima* appears insufficient for high femaleness in sex expression. Interspecific crosses have been shown to increase genetic variation in Cucurbita (3). Crosses of *C. pepo* with *C. maxima* display reduced compatibility in comparison to crosses between C. moschata and *C. maxima*. The development of PM lines has successfully combined the high femaleness of *C. pepo* with superior flesh quality of *C. moschata* (1). In 1983 we initiated a program to develop *C. maxima* germplasm with a high female/male flower ratio.

The line, 'PM 143', that resembles *C. moschata* in most characteristics, was crossed with the pollen parent, *C. maxima* cv. 'Kuri' or 'Ebisu' which is a typical cultivar in Japan. 'PM 143' X 'Kuri' cross produced a few seeds with fully developed embryos, while the 'PM 143' X 'Ebisu' cross yielded no viable seeds. Fluorescence microscopic observations on pollen tube growth showed that pollen tubes of 'Kuri' penetrate deeper into the styler canal than those of 'Ebisu'. A backcross breeding method was applied to combine the high femaleness of 'PM 143' with the flesh quality of 'Kuri'.

The hybrids obtained were intermediate to their parents in characteristics of fruit and leaf shape. The leaves of all F_1 hybrids were mottled. The mottled leaves of 'PM 143' appear dominant to the non-mottled leaf characteristic of 'Kuri'. The F1 hybrids were quite different from their parents in sex expression. They bore their first female flowers at lower nodes with more female flowers to the 20th node than their parents (Figure 1). These results are consistent with a previous report (2). Normal-appearing male flowers had reduced amounts of normal pollen, so F_2 plants were not obtained. When backcrossed with 'Kuri', the hybrids produced about 30 seeds with fully developed embryos. Segregates in the BC_1 population are likely to differ from their parents in sex expression. In the BC_2 population, a few segregates had high femaleness although cultivated under long day and high temperature conditions. These results indicate that high femaleness may be dominant to low femaleness in this species cross.

In the BC_2, we selected a few plants having a high female/male flower ratio, with a promising fruit shape, and have selfed them. New lines through interspecific hybridization are expected.

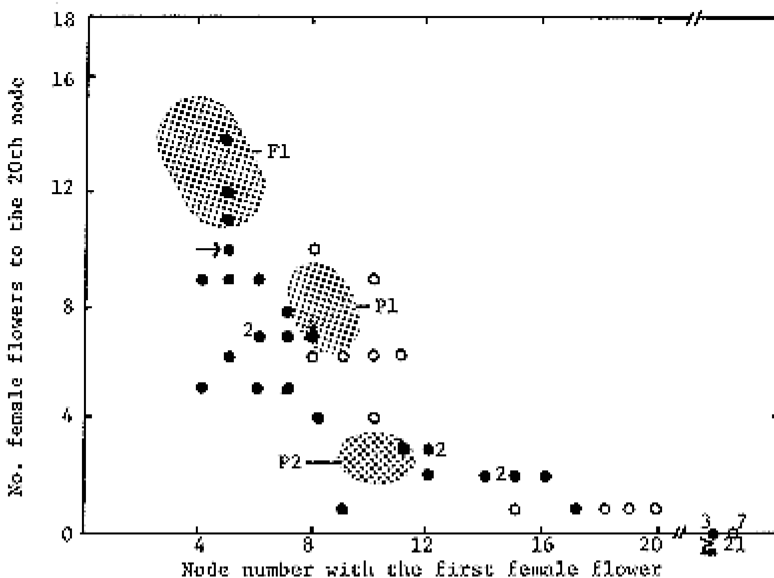

Figure 1. Relationship between node number with the first female flower and the number of female flowers to the 20th node in the parents, F1, BC1 and BC2. Dotted areas represent the distribution areas of P1, P2 or F1. P1, 'PM 143'; P2, 'Kuri'; F1, P1 X P2; ● , BC1 (F1 X P2); o , BC2 (BC1 X P2); ⟶ , selected plant for BC2.

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Cucurbit Genetics Cooperative Report 8:81 (Article 31) 1985

Use *of Cucumis anguria* as a vegetable in Brazil

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"Maxixe" is the common name for *Cucumis anguria*, used in the traditional and popular soup "maxixada" in north and northeastern Brazil. *Cucumis anguria* was introduced into Brazil by African slaves about 300 years ago. It became semi- wild and was disseminated in all tropical areas of Brazil as a weed because of its seed dormancy. *Cucumis anguria* germplasm displays wide variation in Brazil, especially in fruit characteristics (Figure 1).

Immature, non-bitter fruit, are used like fresh cucumbers. Mature fruit are prepared and cooked as the basic ingredient of a soup called "maxixada". Other ingredients are meat, mature squash (*Cucurbita moschata* or *C. Maxima*), okra (*Abelmoschus esculentus)*, roselle (*Hibiscus sabdariffa*), and Chinese amaranth (*Amaranthus tricolor)*. Seasonings may be added. The soup has a sourish taste. There are regional variations of the recipe depending upon the availability of the secondary ingredients.

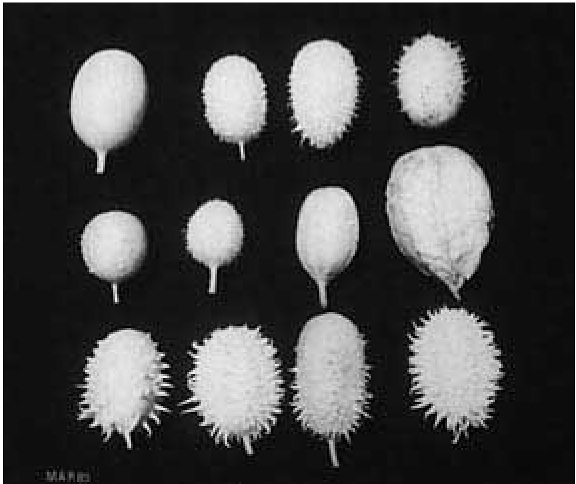

Figure 1. Mature fruit of *Cucumis anguria*.

Cucurbit Genetics Cooperative Report 8:82-84 (Article 32) 1985

Resistance to Acute Gamma Irradiation of Pollen of *Cucumis* Species

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The technique of in vivo egg cell transformation (3) requires that following a high dose irradiation (1 kGy and higher) pollen of the donor species is still vital enough to penetrate the embryo sac and deposit (some of) its DNA content into the egg cell. Additionally, development of endosperm is needed to ensure the initial survival of the pathenogenetic or (partly) hybrid embryo. At the IVT we are evaluating the above technique in order to introduce into the cucumber valuable resistances, which occur in non-crossable *Cucumis* species.

As a first step, in vitro pollen germination was examined of nine wild *Cucumis* species in relation to irradiation dose to assess their potential as donor species for in vivo egg cell transformation of the cucumber. Pollen germination and pollen tube growth in vitro gave a reasonable indication of the capacity of irradiated pollen to germinate and penetrate in vivo the style and ovules of *C. sativus* (1). The accessions used are listed below with their IVT-Genebank number:

la C. ficifolius 2x	*1801*	*5 C. africanus*	*1788*
lb C. ficifolius 4x	*1729*	*6 C. metuliferus*	*1775*
2a C. anguria	*0307*	*7 C. dipsaceus*	*1728*
2b C. anguria var. longipes	*1735*	*8 C. melo var. agrestis*	*2160*
3a C. zeyheri 2x	*0181*	*9 C. meeusii*	*1800*
3b C. zeyheri 4x	*1807*	*10 C. figarei*	*1804*
4 C. sativus var. hardwickii	*0777*	*11 C. myriocarpus*	*0202*

Male flowers of these accessions were irradiated by a cobalt source with 0, 1, 2, 3 or 4 kGy (1 Gy = 100 rad). Soon afterwards four pollen samples per treatment were germinated in vitro during 2 hours at room temperature and 100% RH in the light. Three hundred pollen grains were counted per treatment to calculate the germination percentage. The length of the pollen tubes of 60 germinated grains was measured to determine the average tube length. All treatments were carried out twice, in June and July 1984. Data were analysed by a multivariate analysis of variance (2). Quadratic dose-response functions for germination percentage and pollen tube length were constructed with parameters N (level), L (slope) and Q (curvature). The L-values are the best indication of the resistance of the pollen to an increasing irradiation dose. These L-values are negative because a higher irradiation dose normally leads to a diminished germination and pollen tube growth.

The L-values for the germination percentage (L_1) were significant for all but one species, *C. melo* var. *agrestis*. Only a few L-values for pollen tube length (L_2) deviated significantly from zero, probably because of large, nonsystematic differences between the two sampling dates. this awaits further analysis. Both accessions of *C. anguria* were very sensitive to irradiation. By contrast, *C. figarei* was hardly affected. The L_1- and L_2-values were not significantly correlated (r = 0.32)[1].

Correlations were calculated between the L-values and the total amount of DNA per nucleus per species as determined in interphase cells by Ramachandran (4). These values are not always of the same accession, but variation within a species appeared to be small (4).

L_1 for 11 species was not correlated with DNA amount (r = 0.36), but the correlation between L_2 and DNA amount was appreciable (r = 0.60). With 9 degrees of freedom this r is just not sifnificant at 5%, but significant at 10%. Therefore about one third of the variation amongst the species with respect to resistance of pollen tube growth against irradiation is explained by variation in the amount of DNA per nucleus, the species with a higher amount being more resistant (see Figure 1).

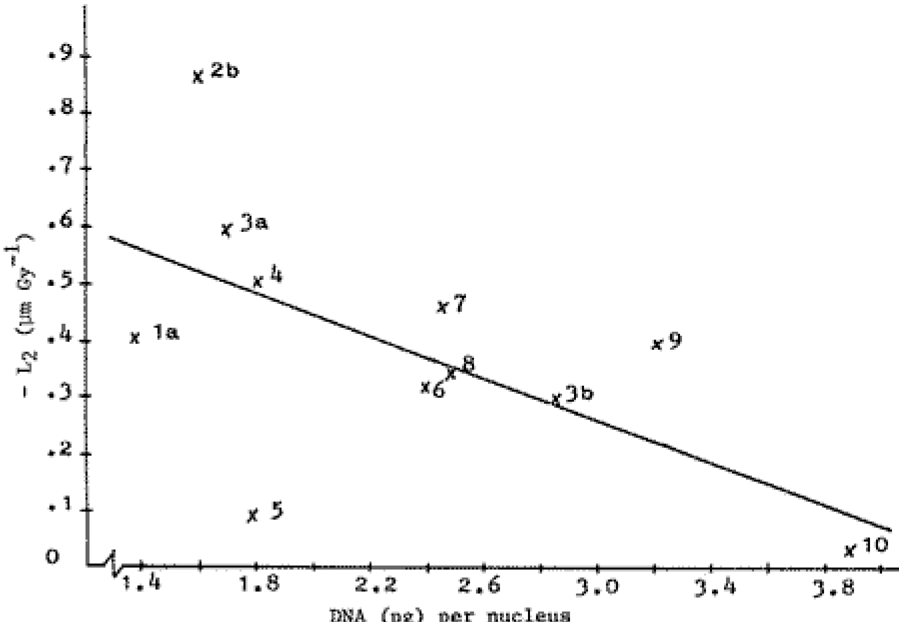

Figure 1. Relation between DNA amount per nucleus and sensitivity of pollen tube growth to irradiation of 11 *Cucumis* species.

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Cucurbit Genetics Cooperative Report 8:85 (Article 33) 1985

Stocks and Germplasm Desired or for Exchange

Stocks Desired

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I am in the process of collecting lines of all known genes of cucumber in order that we do not lose these valuable resources. There are 88 different (presumably) genes in *Cucumis sativus* that have been described to date. I would like to begin by making a complete collection of the genes, then increasing seed supplies of them for distribution to those of you who would like to use them in research and breeding programs, and finally, begin some research on linkage and allelism.

Please send me all of the single gene mutants (including those that may not have been published) that you have in your collections so that I may provide this service to cucumber researchers throughout the world. If you are unable to send me an inbred line (with a particular gene in it) for reasons of protecting proprietary material, then send me a hybrid or segregating family that I could use to isolate the gene by self-pollination.

Cucumis Species of Interest to Muskmelon Breeders

T. W. Whitaker

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The material is from Zambia, Africa and was collected in 1984. Interested persons should contact Dr. George White, Plant Introduction Officer, USDA, ARS, Germplasm Resources Laboratory, BARC-WEST, Beltsville, MD 20705, (301-344-3663).

Species	Collection #	Species	Collection #
Cucumis sp. (wild)	5030	*Cucumis sativus*	5335
	5078	*Cucumis* sp. (wild)	5350
	5086	*Cucumis melo* (?)	5364
	5092		5370
Cucumis sp. (*melo*?)	5213	*Cucumis* sp. (wild)	5377
	5306	*Cucumis melo*	5390
Cucumis melo	5317	*Cucumis anguria* (?)	5404

The collections have extremely small seeds and are evidently uncultivated forms of *C. melo* or its relatives. They deserve to be grown and tested for genes that may be of value in a muskmelon breeding program.

Cucurbit Genetics Cooperative Report 8:86-96 (Article 34) 1985

Gene List for Cucumber

Lists of the known genes for the Cucurbitaceae have been published previously in 3 installments (16, 17, 49). However, in the interest of updating and collecting the information on cucumber in one place, following is a complete list of the 88 known genes for *Cucumis sativus* L. We hope to continue this practice, and publish a complete list for cucumber every 4 years.

Gene symbol	Previous symbol	Character description	Reference
a		*androecious*. Produces primarily staminate flowers if recessive for *F*.	31
ap		*apetalous* male sterile.	22
Ar		*Anthracnose resistance*. One of several genes for resistance to *Colletotrichum lagenarium*.	9
B		*Black* or brown spines. Dominant to white spines on fruit.	64
B-2	*C*	*Black spines-2*. Interacts with *B* to produce F_2 of 15 black:1 white spine.	56
B-3	*C*	*Black spines-3*. Interacts with *B-4* to produce F_2 of 9 black:7 white spine. *B-3* from LJ90430, *b-3* from MSU 41.	15
B-4		*Black spines-4*. Interacts with *B-3* to produce F_2 of 9 black:7 white spine. *B-4* from LJ90430, *b-4* from MSU 41.	15
bi		*bitterfree*. All plant parts lacking cucurbitacins.	6
bl	*t*	*blind*. Terminal bud lacking after temperature shock.	12
Bt		*Bitter* fruit. Extremely bitter flavor.	8
bu		*bush*. Shortened internodes.	47
Bw		*Bacterial wilt* resistance. Resistance to *Erwinia tracheiphila*.	42, 51
c		*cream* color of mature fruit. Interaction with R is evident in the F_2 ratio of 9 red (*R*+):3 orange (*Rc*):3 yellow(++):1 cream (+*c*).	25
Cca		*Corynespora cassicola* resistance. Resistance to target leaf spot; dominant to susceptibility.	4
Ccu		*Cladosporium cucumerinum* resistance. Resistance to scab.	3, 5, 7
cd		*chlorophyll deficient*. Seedling normal at first, then becoming light green; lethal unless grafted.	11
cl		*closed flower*. Flowers do not open; male sterile.	23
cla		*Colletotrichum lagenarium* resistance. Resistance to race 1 of anthracnose; recessive to susceptibility.	4
Cm		*Corynespora melonis* resistance. Resistance to *C. melonis*; dominant to susceptibility.	20
Cmv		*Cucumber mosaic virus* resistance. One of several genes for resistance to CMV.	63
co		*green corolla*. Green petals and enlarged reproductive organs; female sterile.	24
cp		*compact*. Reduced internode length, poorly developed tendrils, small flowers.	27
cr		*crinkled* leaf. Leaves and seed crinkled.	43
D	*g*	*Dull* skin of fruit. Dull skin of American cultivars, dominant to glossy skin of most European cultivars.	59, 60
de	*l*	*determinate* habit. Short vine with stem terminating in flowers; modified by *In-de* and other genes; degree of dominance depends on gene background.	18, 25, 44
df		*delayed flowering*. Flowering delayed by long photoperiod; associated with seed dormancy.	58

dl		*delayed growth*. Reduced growth rate; shortening of hypocotyl and first internodes.	35
dm	*P*	*downy mildew* resistance. One of several genes for resistance to *Pseudoperonospora cubensis*.	61
dvl	*dl*	*divided leaf*.	41
dw		*dwarf*. Short internodes.	48
Es-1		*Empty chambers-l*. Carpels of fruits separated from each other, leaving a small to large cavity in the seed cell.	34
Es-2		*Empty chambers-2*. Carpels of fruits separated from each other, leaving a small to large cavity in the seed cell.	34
F	*Acr* *acr,* *D, st*	*Female*. High degree of female sex expression; interacts with *a* and *M*; strongly modified by environment and gene background.	60
Fba		*Flower bud abortion*. Preanthesis abortion of floral buds, ranging from 10 to 100%.	36
Foc		*Fusarium* oxysporum f. sp. *cucumerinum* resistance. Resistance to fusarium wilt; dominant to susceptibility.	38
g		*golden* leaves. Golden color of lower leaves.	60
gb	*n*	*gooseberry* fruit. Small, oval- shaped fruit.	60
gi		*ginko*. Leaves reduced and distorted, resembling leaves of *Gingko*; sterile.	26
gl		*glabrous*. Foliage lacking trichomes; fruit without spines.	48
glb		*glabrate*. Stem and petioles glabrous, laminae slightly pubescent.	68
gy	*g*	*gynoecious*. Recessive gene for high degree of female sex expression.	33
H		*Heavy* netting of fruit. Dominant to no netting and completely linked or pleiotropic with black spines (*B*) and red mature fruit color (*R*).	25, 60
I		*Intensifier* of *P*. Modifies effect of *P* on fruit warts.	60
In-de	*In*(*de*)	*intensifier* of *de*. Reduces internode length and branching of *de* plants.	21
In-F	*F*	*intensifier* of *female sex expression*. Increases degree of female expression of *F* plants.	30
l		*locule* number. Many fruit locules and pentamerous androecium, 5 locules recessive to the normal number of 3.	71
1h		*long hypoctyl*.	50, 67
ls	*gc*	*light sensitive*. Pale cotyledons, reduced growth; lethal at high light intensity.	67
m	*a, g,* *mo*	*andromonoecious*. Plants are andromonoecious if *m*+; ++ monoecious; +*F* gynoecious; *mF* hermaphroditic.	52, 60
m-2	*h*	*andromonoecious 2*. Bisexual flowers with normal ovaries.	33
mp		*multi-pistillate*. Several pistillate flowers per node, recessive to single pistillate flowers per node.	37
ms-1		*male sterile-1*. Male flowers abort before anthesis, partially female sterile.	57
ms-2		*male sterile-2*. Male flowers abort.	66
n		*negative* geotropic peduncle response. Pistillate flowers upright; recessive to pendent position of most cultivars.	44
O	*V*	*Orange*-yellow corolla color Dominant to light yellow.	60
P		*Prominent tubercles*. Prominent tubercles on yellow rind of *Cucumis sativus* var. *tuberculatus*. Incompletely dominant to brown rind without tubercles.	60
Pc	*P*	*Parthenocarpy*. Sets fruit without pollination.	45, 65
pl		*pale lethal*. Pale green cotyledons; lethal.	68
pm-1		*powdery mildew* resistance. Resistance to *Sphaerotheca fuliginea*.	28

pm-2		*powdery mildew* resistance. Resistance to *Sphaerotheca fuliginea*.	28
pm-3		*powdery mildew* resistance. Resistance to *Sphaerotheca fuliginea*.	28
pr		*protruding* ovary. Exserted carpels.	71
ps1	*p1*	*pseudomonas lachrymans* resistance.	19
R		*Red* mature fruit color. Inter- acts with *c*; linked or pleio tropic with *B* and *H*.	25
rc		*revolute cotyledon*. Cotyledons short, narrow, and cupped downwards; enlarged perianth.	70
ro		*rosette*; short internodes muskmelon-like leaves.	54
s	*f,a*	*spine* size and frequency. Many small fruit spines, characteristic of European cultivars such as 'Everyday'; recessive to the few, large spines of most American cultivars.	59, 64
sc	*cm*	*stunted* cotyledons. Small cotyledons; stunted plants; abnormal flowers.	55, 56
Sd		*Sulfur dioxide* resistance. Less than 20% leaf damage in growth chamber. *Sd* from 'National Pickling'; *sd* from 'Chipper'.	10
sp		*short petiole*. Leaf petioles of first nodes 20% the length of normal.	39
T		*Tall* plant height. Incompletely dominant to short plant height.	23
td		*tendrilless*. Tendrils lacking; associated with misshaped ovaries and brittle leaves.	53
te		*tender skin* of fruit. Thin, tender skin of European cultivars; recessive to the thick, tough skin of most American cultivars.	46, 59
Tr		*Trimonoecious*. Producing male, bisexual, and female flowers in this sequence during plant development.	32
Tu		*Tuberculate* fruit. Warty fruit, characteristic of American cultivars; dominant to the smooth, nonwarty fruits of most European cultivars.	46, 59
u	*M*	*uniform* immature fruit color. Uniform color of European cultivars such as 'Everyday' recessive to the mottled or strippled color of most American cultivars.	5, 59
ul		*umbrella* leaf.	40
v		*virescent*. Yellow leaves becoming green.	46, 60
vvi		*variegated virescent*. Yellow cotyledons, becoming green; variegated leaves.	2
w		*white* immature fruit color. Recessive to green.	13
wf	*w*	*white flesh*. Intense white flesh color; recessive to dingy white; acts with *yf* to produce F_2 of 12 white: (++ and + *wf*): 3 yellow (*yf* +): 1 orange (*yf wf*).	29
Wmv		*Watermelon mosac virus* resistance. Resistance to strain 2 of watermelon mosaic virus.	14
Wmv-1-1		*Watermelon mosaic virus-1* resistance. Resistance to strain 1 of watermelon mosaic virus. Dominant allele in 'Surinam'.	62
yc-1		*yellow cotyledons-l*. Cotyledons yellow at first, later turning green.	1
yc-2		*yellow cotyledons-2*. Virescent cotyledons.	69, 70
yf	*y*	*yellow flesh*. Yellow (*yf* +) or orange (*yf wf*) flesh color.	29
yg	*gr*	*yellow-green* immature fruit color. Recessive to dark green and epistatic to light green.	71
yp		*yellow plant*. Light yellow green foliage.	2

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It is hoped that scientists will consult the above list as well as the rules of gene nomenclature for the Cucurbitaceae (17, 49) before choosing a gene name and symbol. Thus, inadvertent duplication of gene names and symbols will be prevented. The rules of gene nomenclature were adopted in order to provide guidelines for the naming and symbolizing genes previously reported and those which will be reported in the future. Scientists are urged to contact members of the Gene List Committee regarding questions in interpreting the nomenclature rules and in naming and symbolizing new genes.

Gene List Committee

- Cucumber: T. C. Wehner
- Muskmelon: J. D. McCreight
- Watermelon: W. R. Henderson
- *Cucurbita* spp.: C. A. John
- Other Genera: R. W. Robinson

Cucurbit Genetics Cooperative Report 8:97-100 (Article 35) 1985

Covenant and By-Laws of the Cucurbit Genetics Cooperative

ARTICLE I. Organization and Purposes

The Cucurbit Genetics Cooperative is an informal, unincorporated scientific society (hereinafter designated "CGC") organized without capital stock and intended not for business or profit but for the advancement of science and education in the field of genetics of cucurbits (Family: Cucurbitaceae). Its purposes include the following: to serve as a clearing house for scientists of the world interested in the genetics and breeding of curcurbits, to serve as a medium of exchange for information and materials of mutual interest, to assist in the publication of studies in the aforementioned field, and to accept and administer funds for the purposes indicated.

ARTICLE II. Membership and Dues

The membership of the CGC shall consist solely of active members; an active member is defined as any person who is actively interested in genetics and breeding of cucurbits and who pays biennial dues. Memberships are arranged by correspondence with the Chairman of the Coordinating Committee.

The amount of biennial dues shall be proposed by the Coordinating Committee and fixed, subject to approval at the Annual Meeting of the CGC. The amount of biennial dues shall remain constant until such time that the Coordinating Committee estimates that a change is necessary in order to compensate for a fund balance deemed excessive or inadequate to meet costs of the CGC.

Members who fail to pay their current biennial dues within the first six months of the biennium are dropped from active membership. Such members may be reinstated upon payment of the respective dues.

ARTICLE III. Committees

1. The Coordinating Committee shall govern policies and activities of the CGC. It shall consist of six members elected in order to represent areas of interest and importance in the field. The Coordinating Committee shall select its Chairman, who shall serve as a spokesman of the CGC, as well as its Secretary and Treasurer.

Approvals: W. Bemis, J. D. Norton, R. W. Robinson, W. R. Henderson, M. L. Robbins, R. L. Lower

2. The Gene List Committee, consisting of five members, shall be responsible for formulating rules regulating the naming and symbolizing of genes, chromosomal alterations, or other hereditary modifications of the cucurbits. It shall record all newly reported mutations and periodically report lists of them in the Report of the CGC. It shall keep a record of all information pertaining to cucurbit linkages and periodically issue revised linkage maps in the Report of the CGC. Each committee member shall be responsible for genes and linkages of one of the following groups: cucumber, *Cucurbita* sp., muskmelon, watermelon, and other genera and species.

3. Other committees may be selected by the Coordinating Committee as the need for fulfilling other functions arises.

ARTICLE IV. Election and Appointment of Committees

1. The Chairman will serve an indefinite term while other members of the Coordinating Committee shall be elected for ten-year terms, replacement of a single retiring member taking place every other year. Election of a new member shall take place as follows: A Nominating Committee of three members shall be appointed by the Coordinating Committee. The

aforesaid Nominating Committee shall nominate candidates for an anticipated opening on the Coordinating Committee, the number of nominees being at their discretion. The nominations shall be announced and election held by open-ballot at the Annual Meeting of the CGC. The nominee receiving the highest number of votes shall be declared elected. The newly elected member shall take office immediately.

In the event of death or retirement of a member of the Coordinating Committee before the expiration of his/her term, he/she shall be replaced by an appointee of the Coordinating Committee.

Members of other committees shall be appointed by the Coordinating Committee.

ARTICLE V. Publications

1. One of the primary functions of the CGC shall be to issue an Annual Report each year. The Annual Report shall contain sections in which research results and information concerning the exchange of stocks can be published. It shall also contain the annual financial statement. Revised membership lists and other useful information shall be issued periodically. The Editor shall be appointed by the Coordinating Committee and shall retain office for as many years as the Coordinating Committee deems appropriate.

Approvals: W. Bemis J. D. Norton R. W. Robinson

W. R. Henderson M. L. Robbins R. L. Lower

2. Payment of biennial dues shall entitle each member to a copy of the Annual Report, newsletters, and any other duplicated information intended for distribution to the membership. The aforementioned publications shall not be sent to members who are in arrears in the payment of dues. Back numbers of the Annual Report, available indefinitely, shall be sold to active members at a rate determined by the Coordinating Committee.

ARTICLE VI. Meetings

An Annual Meeting shall be held at such time and place as determined by the Coordinating Committee. Members shall be notified of time and place of meetings by notices in the Annual Report or by notices mailed not less than one month prior to the meeting. A financial report and information on enrollment of members shall be presented at the Annual Meeting. Other business of the Annual Meeting may include topics of agenda selected by the Coordinating Committee or any items that members may wish to present.

ARTICLE VII. Fiscal Year

The fiscal year of the CGC shall end on December 31.

ARTICLE VIII. Amendments

These By-Laws may be amended by simple majority of members voting by mail ballot, provided a copy of the proposed amendments has been mailed to all the active members of the CGC at least one month previous to the balloting deadline.

ARTICLE IX. General Prohibitions

Notwithstanding any provision of the By-Laws or any other document that might be susceptible to a contrary interpretation:

1. The CGC shall be organized and operated exclusively for scientific and educational purposes.

2. No part of the net earnings of the CGC shall or may under any circumstances inure to the benefit of any individual.

3. No part of the activities of the CGC shall consist of carrying on propaganda or otherwise attempting to influence legislation of any political unit.

Approvals: W. Bemis J. D. Norton R. W. Robinson

W. R. Henderson M. L. Robbins R. L. Lower

4. The CGC shall not participate in, or intervene in (including the publishing or distribution of statements), any political campaign on behalf of a candidate for public office.

5. The CGC shall not be organized or operated for profit.

6. The CGC shall not:

(a) lend any part of its income or corpus without the receipt of adequate security and a reasonable rate of interest to;

(b) pay any compensation in excess of a reasonable allowance for salaries or other compensation for personal services rendered to;

(c) make any part of its services available on a preferential basis to;

(d) make any purchase of securities or any other property, for more than adequate consideration in money's worth from;

(e) sell any securities or other property for less than adequate consideration in money or money's worth; or

(f) engage in any other transactions which result in a substantial diversion of income or corpus to any officer, member of the Coordinating Committee, or substantial contributor to the CGC.

The prohibitions contained in this subsection (6) do not mean to imply that the CGC may make such loans, payments, sales, or purchases to anyone else, unless authority be given or implied by other provisions of the By-laws.

ARTICLE X. Distribution on Dissolution

Upon dissolution of the CGC, the Coordinating Committee shall distribute the assets and accrued income to one or more scientific organizations as determined by the Committee, but which organization or organizations shall meet the limitations prescribed in sections 1-6 of Article IX.

W. Bemis
(Cucurbits sp.)

W. R. Henderson
(Watermelon)

J. D. Norton
(Muskmelon)

M. L. Robbins
(Cucumber)

R. W. Robinson
(Other genes and species)

CGC 8:100 (1985)

R. L. Lower, Chairman

Cucurbit Genetics Cooperative Report 8:101-110 (Article 36) 1985

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Financial Statement - Cucurbit Genetic Cooperative

June 1985

Prior to publication of Report No. 8

Item		**Amount**
Balance - June, 1984		+$2,402.20
Receipts - June, 1984 through June, 1985		
	Dues and Back Issues	+752.50
	Interest	+67.89
TOTAL		+$3,222.68
Expenditures		
	Reprinting Reports 1, 2, 3, 4	-557.70
	Miscellaneous Supplies	-20.79
BALANCE		+$2644.19