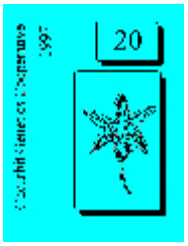
Cucurbit Genetics Cooperative



Report No. 20

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20th Annual CGC Business Meeting (1996)

The 20th Annual CGC Business Meeting was held Sunday, 6 October 1996, at the Hyatt Regency Lexington in Lexington, Kentucky, in conjunction with the Annual Meeting of the American Society for Horticultural Science. Sixteen members and other interested individuals were in attendance.

Tim Ng, CGC Chair, presented an update on the CGC membership, and provided detailed information on the CGC Reports. CGC Report No. 19 (1996) as well as the Call for Papers for CGC Report No. 20 (1997). The discussion then turned to the CGC site on the World Wide Web, which had been updated recently with a new homepage utilizing an animated graphic file. Progress was reported as being slow in converting back issue to html format for web posting, primarily due to the need to proofread scanned materials to ensure accuracy of the information. CGC Report No. 7 (1984) was the first volume to have all of its research papers posted on the web, and Tim (who did all of the html-encoding for CGC No. 7) described additional issues which needed to be discussed concerning the archiving of back issues electronically. For instance, species names have changed since CGC was first formed in 1977 (e.g., *Luffa cylindrica* is now *Luffa aegyptica*, *Cucurbita mixta* is now *Cucurbita argyrosperma*). In old reports dealing with these species, should the web article contain the old or the new species name? Should typographical errors be corrected, or should the article remain the same as it appeared in print? After some discussion, including Mile Havey's (Univ. Wisconsin)observation that he often conducts literature searches using the old species names as well as the original species name be retained in the CGC articles, but that the new species name should be included immediately afterwards in parentheses. There was general agreement that all typographical errors in the original manuscripts should be corrected prior to posting at the website.

Gene nomenclature and the CGC gene lists were discussed next. Harry Paris (Newe Ya'ar Expt. Sta.) had requested that the CGC Gene List Committee consider changing the CGC gene nomenclature rules such that the "+" designation no longer be used. The positive aspect of such a change would be to bring CGC more in line with international rules for designating genes and alleles. Potentially negative aspects were that it might become more cumbersome to list genotypes in research articles, and that CGC might no longer be "in step" with the other crop genetics cooperative rules. Although not at the meeting, Dick Robinson (Cornell University) later volunteered to prepare a memo listing the benefits of retaining the "+" designation; this issue will be discussed further at the 1997 CGC Business Meeting.

Another genetic issue which arose was whether CGC should seek to document cloned genes from cucurbit crops in the gene list updates. While there was interest in maintaining this type of documentation, there was serious concern over the curatory procedures for cloned genes. For instance, Mike Havey mentioned that the NPI collection of cucurbit RFLPs are no longer in existence. The final consensus was that the individuals who cloned genes would be listed as sources of the cloned gene should these lists be developed, and that there would be no designated CC curator for these genes such as there are for monogenic traits. A CGC subgroup will be looking further at this issue over the next year.

Jack Staub (Univ. Wisconsin) raised the issue of whether the "core: concept for germplasm collections should be raised again for the major cucurbit crops. Jack described the work he and Todd Wehner (N. Carolina St. Univ.) had conducted over the years in trying to define a core collection for cucumber, one which would maximize genetic diversity while minimizing the number of accessions in the collection. There was interest in this concept, but the general feeling was that it might perhaps be premature to put the effort into the other crops. Jack and Todd were strongly encouraged to continue their activities in this arena.

An announcement was made of the 1st International ISHS Symposium on cucurbits, to be held in Adana, Turkey, in May 1997. The first circular for this symposium was distributed.

It was then announced that the next CGC Coordinating Committee position up for appointment was for *Cucurbita* spp. The five members of the CGC Coordinating Committee serve staggered terms of 10 years each, with a new Coordinating Committee appointed every two years on a rotational basis. J. Brent Loy's (Univ. New Hampshire) term expires in 1997, and a new Coordinating Committee member will be elected for *Cucurbita* at the 1997 CGC Business Meeting, to be held July 1997 in Salt Lake City in conjunction with the ASHS annual conference.

Comments

From the CGC Coordinating Committee: The Call for Papers for the 1998 Report (CGC Report 21) will be mailed in September 1997. Papers should be submitted to the respective Coordinating Committee members by 31 January 1998, although late submissions may be considered if received prior to our processing deadline. The Report will be published by June/July 1998. As always, we are eager to hear from CGC members regarding our current activities and future direction of CGC.

From the CGC Gene List Committee: Lists of known genes for the *Cucurbitaceae* have been published previously in HortScience and in reports of the Cucurbit Genetics Cooperative. CGC is currently publishing complete lists of known genes for cucumber (*Cucumis sativus*), melon (*Cucumis melo*), watermelon (*Citrullus lanatus*), and *Cucurbita* spp. on a rotating basis.

It is hoped that scientists will consult these lists as well as the rules of gene nomenclature for the Cucurbitaceae before selecting a gene name and symbol. Thus, inadvertent duplication of gene names and symbols will be prevented. The rules of gene nomenclature (published in each CGC Report) were adopted in order to provide guidelines for the naming and symbolizing of 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.

From the CGC Gene Curators: CGC has appointed curators for the four major cultivated crops: cucumber, melon, watermelon and *Cucurbita* spp./ Curators are responsible for collecting, maintaining, and distributing upon request stocks of known marker genes. CGC members are requested to forward samples of currently held gene stocks to the respective Curator.

Watermelon Research and Development Group

17th Annual Meeting

Ray D. Martyn, Chairman

The Watermelon Research and Development Group (WRDG) met in Birmingham, AL on Sunday, 2 February 1997 for its 17t annual meeting. The meeting was held in conjunction with The Southern Association of Agricultural Scientists (SAAS) and the Southern Region: American Society for Horticultural Sciences (SR:ASHS). Approximately 40 people attended. Dr. Warren Barham of Barham Seeds, Inc., Gilroy CA, sponsored the refreshments at this year's meeting.

I. Research Updates

Tony Keinath [Tknth@clemson.edu], Department of Pathology and Physiology, Clemson University, Clemson SC, reported on his studies on benomyl resistance in isolates of *didymella bryoniae*, causal agent of gummy stem blight. In 1995, 85% of the isolates recovered from fields that had been treated with benomyl were resistant to benomyl, while only of the isolates recovered from fields that had not had benomyl treatments were resistant. Protective fungicides such as chlorothalonil were the best at managing gummy stem when applied on a 7 day schedule. Bravo was more effective than Manzate. A 7 day spray schedule reduced disease severity by 19% compacted to a reduction of only 10% when the spray schedule was 14 days. Yield also was increased with either a 7 day or 14 day spray schedule.

Bill Rhodes [*BRhodes@clemson.edu*], Department of Horticulture, Clemson University, Clemson, SC, reported on pollination studies with triploids. He indicated that bees visit both male and female flowers, but spend twice as much time on triploid male flowers than on triploid female flowers. Since there are about five times as many male flowers vs female flowers on triploids, the bee wastes approximately 10 times as much time on triploids than on diploids.

Ron Gitaitis [*path4@tifton.cpes.peachnet.edu*], Plant Pathology Department, University of Georgia, Coastal Plain Experiment

STation, Tifton GA, discussed his research on the use of immuno-density gradient centrifugation techniques for detection of the fruit blotch bacterium (*Acidovorax avenae* subsp,. *citrulli*). The basic procedure is to wash the seeds and incubate the washing with a specific antibody/antigen cocktail and then separate through a silicon oxide density gradient. The Ab/Ag cinokex (band) is eluted and then can be used for POCR amplification with primers or plated onto semi-selective medium for detection.

Frank Dainello [*FDainello@tamu.edu*], Department of Horticultural Sciences, Texas A&M University, College Station TX, discussed results from his hybrid and seedless watermelon variety trials. Tests were conducted in east Texas (Overton), north- central Texas (Stephenville) and southwest Texas (Uvalde). They are developing a standard format for reporting results to remove any bias in the evaluations. Approximately 21 hybrids and 17 seedless varieties were evaluated at the three locations. While most individual varieties performed relatively consistently across locations there were some significant differences. One hybrid, 'Big Stripe', was consistently at the top of each location. 'Desert Storm' was another variety that performed well across locations.

Don Hopkins, Plant Pathology Department, University of Florida, CFAREC, Leesburg FL, reported on results of copper spray (Kocide) studies on the control of fruit blotch. Disease pressure and progress was much less in 1996 than in 1995, in spite of an early 4 inch rain. Also, the median temperature was lower in 1996 than 1995. Copper sprays increased yield 2-10 fold over non-sprayed plots. The best treatment was 2 lb copper/week. At that rte, disease was decreased from 32% fruit blotch (no copper) to 10.8 T/A (with copper). Copper will not control fruit blotch symptoms on fruit, only on the foliage. No resistance to copper has been detected yet in the bacterium. Don also reported on the watermelon PI screening for fruit blotch resistance. In 1995, three PIs looked promising and were selfed in 1996. Resistance in 'Zambia' increased from almost none in 1995 (S) to moderately-resistant (MR) in 1996. 'Zimbabue' was rated resistant (% disease) in 1996.

Charlie Graham [*CJGraham@agctr.lsu.edu*], Louisiana State University, Calhoun Research Center, Calhoun LA, reported on the status and fate of the Southern Cooperative Watermelon Trials (SCWT). The SCWT were started in the 1960's and were primarily used by the public breeders. By 1978 there were 17+ cooperators evaluating melons at 18 sites in 12 states. In 1996, there were only 6 cooperators at 4 sites in 4 states. The primary user now is the private seed company breeder and the trials have turned into cultivar trials as opposed to breeding line trials. charlie would like some input as to what direction you think the trials should go. Please respond to him with your suggestions and comments.

Kevin Mataxa [*KMataxa @gaes.griffin.peachnet.edu*] and Dr. Bob Jarret, USDA, ARS, Griffin GA, reported on the regeneration of the S-9 watermelon germplasm collection at the station. There are a total of 1852 accessions, 1500 of which are at the Griffin station. The normal increase protocol is to grow 25 plants in the field and evaluate for Citron-types (*Citrullus lanatus citroides*) and Egusi-types (*C. lanatus lanatus*). Approximately 100 cages are required to increase all of the seed lines. This would take approximately 15 years to go through the entire collection. Kevin stressed the need for financial support from the watermelon community to buy more cages and the importance of maintaining the germplasm.

Todd Wehner [*Todd_Wehner@ncsu.edu*], North Carolina STate University, Raleigh NC, noted that he was taking on responsibility for watermelon breeding/evaluation in addition to his cucumber program.

II. Business Discussions

John Cross, Seed Specialists, Inc., Lexington KY, Chairman of the NWS Disease Research Sub-Committee met with us to discuss common and/or over-lapping responsibilities of our respective groups. It was concluded that the two groups serve different functions and perhaps would be best served as remaining separate entities. However, cooperation between the two groups was encouraged and appears to be no problem.

Mr. William Watson, Executive Director, National Watermelon Promotion Board, Orlando FL, reported on the establishment of a Research Evaluation Sub-Committee that was recently set up by the NWPB. A call for research proposals was sent out in March. A total of $12,000 was available to support research on watermelon production problems of imp9ortance to the national industry. A total of 12 proposals were received and three were funded.

III. Sympathy Notice

Dr. James Crall, University of Florida, Leesburg, passed away on 22 January 1996. Jim had a very long and distinguished career at the Leesburg Station developing and releasing numerous watermelon varieties. We wish his family all the best.

IV. Next Year's Meeting

Next year's meeting will be at Little Rock, AR, in conjunction with SR:ASHS, on 31 January - 4 February 1998.

1997 Pickling Cucumber Improvement Committee (PCIC) Meeting

28-29 October 1997

Ed Kee, Chair

The 1997 PCIC Meeting will be held in conjunction with the Pickle Packers International (PPI) Annual Meeting & Trade Show, to be held 28-30 October 1997 at Bally's Hotel and Convention Center in Las Vegas, Nevada USA. PCIC will meet on Tuesday, 28 October, from 1:00-5:00 p.m., and continue on Wednesday, 29 October, from 10:00 a.m. to 5:00 p.m.

PCIC is welcoming contributed papers for this meeting. Each presentation will be allotted 15 minutes: 12 minutes for the presentation and 3 minutes for questions. Abstracts should be no longer than one page and should be submitted by hardcopy and, if possible, on disk in either WordPerfect 6.0 or 6.1 format. Abstracts should be sent by 1 October 1997 to: Ed Kee, PCIC Chair, University of Delaware, ED6 Box 48, Georgetown DE 19947 USA (Phone: 302/856-7303).

In addition to the contributed paper sessions, a panel of growers and processors will meet on Tuesday, 28 October, at 3:15 p.m. to identify and discuss the pickle industry's needs, especially from an agricultural perspective. At the PCIC Meeting last year in Kentucky, the research community suggested that this panel would be useful towards obtaining a more comprehensive assessment of industry needs and enhancing their efforts in meeting those needs.

Information on Hotel Reservations and the PPI annual Meeting will be forthcoming from PPI, or from PCIC (P.O. Box 606, St. Charles IL 60174-0606 USA).

Cucurbitaceae '98:

Evaluation and Enhancement of Cucurbit Germplasm

2-6 December, 1998

James D. McCreight, Chair

Cucurbitaceae '98: Evaluation and Enhancement of Cucurbit Germplasm, will be held 206 December 1998 at the Asilomar Conference Center in Pacific Grove, California, USA. Cucurbitaceae '98 will be convened by the American Society for Horticultural Science (ASHS), the U.S. Department of Agriculture (USDA), the Cucurbit Genetics Cooperative and the Cucurbit Network. The conference will be organized by ASHS and USDA, and sponsors include the USDA Agricultural Research Service. The Scientific Committee will consist of James D. McCreight (Chair), Gary W. Elmstrom, Laura C. Merrick, Jack E. Staub, Claude E. Thomas, Susan E. Wenn and Todd C. Wehner. The official language will be English.

Rationale. Cucurbit crops (cucumber, melon, pumpkin, squash, and watermelon) comprise an important and varied portion of mankind's diet. Cucurbits have great realized and potential medicinal and industrial value. Economically viable and environmentally sustainable production of this group of crops is threatened by diseases, insects and nematodes, reduced soil and water and air quality, and increasingly stringent restrictions on water, fertilizer and synthetic chemicals, as well as restricted access to and loss of cucurbit genetic resources (germplasm). Our capacity to develop new cucurbits varieties

capable of producing high yields of high quality depends upon utilization of cucurbit germplasm. All persons engaged or interested in research in the collection, preservation, characterization, evaluation and enhancement of cucurbit germplasm are invited to participate in this symposium.

Scientific Program. The symposium will address six broad subject areas: Germplasm Resources, Genetics, Breeding, Pathology, Entomology and Production. The scientific program will consist of invited and contributed papers, and meetings of the Cucurbit Crop Germplasm Committee, the Cucurbit Genetics Cooperative, the National Muskmelon Research Group, the Watermelon Research and Development Group and the Cucumber Breeders Group.

Invited papers by recognized authorities will provide overviews and syntheses of recent developments and will be intended to stimulate discussion and exchange of ideas, and new questions for future research. contributed papers will be reviews, syntheses and reports of current research.

Call for Contributed Papers

Titles: Inclusion of tentative titles on your preliminary registration form will aid program development. Titles may be submitted up to the deadline for submission of manuscripts.

Manuscripts: Compiled manuscripts should be submitted by 1 June 1998 in both hardcopy and diskette forms; the diskette version can be in any standard word processing software format. All manuscripts should be sent to James D. McCreight, Chair, Cucurbitaceae '98, USDA/ARS, 1636 E. Alisal Street, Salinas, CA 93905 USA.

Proceedings. All invited and contributed and contributed presentations will be published in the proceedings as full papers. Copies of the proceedings will be included in registration packets distributed at the symposium. Additional copies may be purchased during and after the symposium.

Conference Facilities. The Asilomar Conference Center is a US National Historic Landmark, located on 44 hectares (109 acres) of pristine forest, dunes and beach. Established by the Young Women's Christian Association in 1913, Asilomar, which means "refuge by the sea," has provided groups of artists, humanitarians, educators, youths, and now cucurbit scientists with modern meeting, dining and sleeping accommodations in a dramatic setting at the edge of the Pacific Ocean. Pre- and post-meeting accommodations may be available upon individual request as Asilomar or at nearby motels and hotels.

Second Circular. A second circular containing more detailed information on the scientific and social program will be sent on 1 December 1997 to those who have returned the preliminary registration form by 1 November 1997. It will also include a final symposium registration and housing registration form and information on travel and off-site accommodations. If you do not have a copy of the preliminary registration form, you can send or email your request to: ASHS -Cucurbitaceae '98, 600 Cameron Street, Alexandria VA, 22314-2562 USA" (*meetings@ashs.org*). Please include the following information: name (first, middle, last), address, state (province), postal code, country, phone and Fax numbers and email address. Also, please indicate whether you wish to receive more information, plan to attend the symposium, or plan to submit a paper. (If the later, please indicate a tentative title.)

Upcoming Meetings of Interest to Cucurbit Researchers

MEETING	DATE	LOCATION	CONTACT
Cucurbit Genetics Cooperative (CGC)	25 July 1997	251G Salt Palace, Salt Lake City, Utah	Timothy J. Ng, (301) 405-4345, *tng@deans.umd.edu*
Squash Breeders Group	25 July 1997	251G Salt Palace, Salt Lake City, Utah	Linda Wessel-Beaver, (809) 832-4040, *l_beaver@rumac.upr.clu.edu*
Pickling Cucumber Improvement Committee (PCIC)	28-29 October 1997	Bally's Hotel and Convention Center, Las Vegas, Nevada	Ed Kee, Chair, (302) 856-7307

Pickle Packers International (PPI) Annual Meeting & Trade Show	28-30 October 1997	Bally's Hotel and Convention Center, Las Vegas, Nevada	Richard Hentschel, Exec. VP, (708) 584-8950
Cucurbit Crop Germplasm Committee (CCGC)	30 October 1997	Bally's Hotel and Convention Center, Las Vegas, Nevada	James D. McCreight, (408) 755-2684, *jmcreig@asrr.arusda.gov*
Watermelon Research & Development Group (WRDG)	31 Jan - 4 Feb 1998	ASHS: Southern Region Meeting, Little Rock, Arkansas	Ray Martyn, (765) 494-4615, *Martyb@btny.purdue.edu*
Cucurbitaceae '98	2-6 December 1998	Asilomar Conference Center, Pacific Grove, California	James D. McCreight, (408) 755-2684, *jmcreig@asrr.arusda.gov*

Cucurbit Genetics Cooperative Report 20:1-2 (article 1) 1997

Independent Segregation Among 11 Gene Loci in Cucumber

Todd C. Wehner and J. S. Liu

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Research on morphological gene mutants of cucumber (*Cucumis sativus* L.) has resulted in 146 loci being identified in six linkage groups (3). Although many studies have reported linked genes, information about genes that are not linked also is useful in helping geneticists avoid making crosses to study traits that will not provide significant linkage data.

The objective of this study was to analyze segregation data for a series of traits that were found to be unlinked as part of previous linkage studies.

Four families were used to study linkage in six inbred lines: NCG-091 x WI 2757, NCG-093 x NCG-101, NCG-091 x Wis. SMR 18, and NCG-042 x WI 2757. Eleven genes were segregating in the four families (Table1). The inbred lines used as parents were self-pollinated and grown in the greenhouse to verify and fix uniform trait expression. Seeds of the two parents, F1, F2, and BC1 to each parent were produced. There were 45 plants evacuated of each parent, 54 of the F1, 50 to 136 of the F2, and 28 to 72 of the BC1 per family. Seeds were planted in the greenhouse in flats of vermiculite to facilitate evaluation of the seedling traits. After seedling data were collected, plants were transplanted to the field for later evaluation of vegetative, flowering, and fruiting traits.

Data were collected on seedling traits before transplanting, on vegetative traits 30 to 40 days after transplanting, and on flowering and fruit traits 45 to 70 days after transplanting. Plants were evaluated for each trait using the published descriptions (2, 3), and the parental lines for comparison. Bitterfree (*bi*) was evaluated by tasting the cotyledons of single plants, rinsing the mouth with water after each plant, and eating a soda cracker after sampling bitter plants. Crinkled leaf (*cr*), glabrous-2 (*gl-2*), long hypocotyls (*lh*), and yellow cotyledon (*yc-1*) were evaluated at the seedling stage in flats. Plants were evaluated for femaleness (*F*), black spines (*B*), numerous spines (*ns*), orange fruit color (*R*), tuberculate fruit (*Tu*), and white fruit color (*w*) at the flowering and fruiting stages in the field.

Data were analyzed using the SASGENE, a SAS computer program for analysis of gene segregation and linkage relationships (1).

All of the 11 loci studies segregated properly as single genes. The 19 pairs of genes that could be tested all segregated independently (Table 2). Therefore, those gene loci should be located on separate chromosomes, or be at least 50 cM apart. Geneticists and plant breeders interested in those gene combinations can work without concern for having to break linkages.

Table 1. Gene designation and phenotypic description of cucumber cultivars and inbred lines tested in the gene linkage experiment.[z]

Trait (symbol)	Dominant	Recessive	SMR 18	WI 2757	NCG101	NCG091	NCG042	NCG093
Bitterfree (*bi*)	Bitter	Bitterfree	+	-	+	-	+	+
Black spines (*B*)	Black	White	+	-	-	-	-	+
Crinkled leaf (*cr*)	Smooth	Crinkled	+	+	+	+	-	+
Female (*F*)	Gynoeccious	Monoecious	-	+	-	-	-	+
Glabrous-2 (*gl-2*)	Pubescent	Glabrous	+	+	+	+	-	+
Long hypocotyls (*lh*)	Short	Long	+	+	+	+	-	+
Numerous spines (*ns*)	Few	Numerous	+	-	+	+	+	+

Orange fruit color (*R*)	Orange	Cream	+	-	-	-	-	+
Short petiole (*sp*)	Long	Short	+	+	+	+	+	-
Tuberculate fruit (*Tu*)	Warty	Smooth	+	-	+	+	+	+
White fruit color (*w*)	Green	White	+	+	-	+	+	+
Yellow cotyledon (*yc-1*)	Green	Yellow	+	+	+	+	-	+

[z] Genotype is listed as dominant (+) or recessive (-).

Table 2. Linkage relationships among 11 gene loci in cucumber as determined from F2 and BC1 segregation data.[z]

Gene pair	**Generation**	**Phase**	**A_B_**	**A_bb**	**aaB_**	**aabb**	**Chi-square**	**df**	**Prob.**	**RF**
bi--B	F2	R	73	27	27	9	0.4	3	0.94	I
bi--lh	BC1	C	14	14	21	19	2.2	3	0.52	I
Bi--ns	F2	C	43	17	13	2	1.7	3	0.63	I
bi--R	F2	C	31	17	17	7	5.4	3	0.14	I
Bi--w	F2	R	69	31	31	5	4.5	3	0.20	I
cr--F	F2	C	48	26	22	10	6.1	3	0.10	I
cr--ns	F2	R	55	27	28	12	7.1	3	0.06	I
F--gl-2	F2	C	25	11	16	3	4.4	3	0.22	I
lh--ns	F2	R	45	15	9	4	2.2	3	0.53	I
lh--R	F2	C	38	21	10	3	5.7	3	0.12	I
lh--Tu	F2	R	39	20	10	3	4.6	3	0.20	I
ns--gl-2	F2	R	26	11	9	4	0.7	3	0.87	I
sp--B	F2	R	78	24	22	12	2.0	3	0.56	I
sp--w	F2	R	71	31	29	5	3.5	3	0.32	I
w--B	BC1	C	21	15	14	22	2.8	3	0.42	I
w--B	F2	C	75	25	25	11	0.8	3	0.85	I
yc-1--cr	BC1	C	16	19	18	19	0.3	3	0.95	I
yc-1--F	BC1	C	14	11	16	13	1.0	3	0.81	I
yc-1--gl-2	BC1	C	9	7	9	3	3.4	3	0.33	I
yc-1--gl-2	F2	C	27	16	14	1	6.2	3	0.10	I
yc-1--ns	F2	R	58	26	25	13	6.1	3	0.10	I

[z] Phase is coupling (C) or repulsion (R); all gene pairs segregated independently (I).

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Cucurbit Genetics Cooperative Report 20:3-6 (article 2) 1997

Biochemical changes in Cucumber Seeds during Germination

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Introduction. It is very important to know what biochemical changes occur during seed germination. Such information is important for seed germination and seed physiology research, and for obtaining improved stand establishment of seedlings. Because information about germination of cucumber seeds is sparse, we report herein the concentration of several important biochemical constituents of cucumber seeds during germination.

Materials and Methods. The cultivar '$C_{1\text{-}7\text{-}6}$ ' was supplied by our cucumber research group, and these seeds were used in our experiment (harvested in 1995), Each seed sample was weighed before sowing, and then they were put in germination dishes and held at 25 $\pm$ 2 C. During germination, the ascorbic acid, free amino acid, soluble protein and soluble sugar content of the seeds was measured once every 12 hours until the experiment was terminated at 72 hours. The experiment had three replications. the content of ascorbic acid was determined using a method involving 2, 6-dichlorophenol indophenol titration, free amino acids were quantified by the ninhydrin reaction method, soluble protein were detected by colorimetric analysis using coomassie brilliant blue G-250, and soluble sugars were evaluated by colorimetric analysis using an anthrone reaction. The content of these selected seed constituents was calculated on a dry weight basis.

Results and Discussion. The results are shown in Table 1. (1) The content of ascorbic acid increased linearly during seed germination, except for a slight drop at 60 hours after sowing. (2) The total content of free amino acids in the seeds gradually increased during seed germination. Generally, the increase is less at the beginning (0-36 hr) of germination than at later stages of germination. (3) The content of soluble protein in seeds was low and constant from 0 to 24 hours during germination. However, protein content increases perceptively from 24 to 36 hours, and then rises dramatically from 48 to 72 hours. (4) Soluble sugar content decreased between 0 to 36hours after germination is initiated, and then increases dramatically.

In summary, the content of ascorbic acid and free amino acids in cucumber seeds increases during seed germination. However, the soluble protein and soluble sugar contents of the germinating seed increase slightly at the beginning of germination, and then increase dramatically.

Table 1. Biochemical changes in cucumber seeds during germination.

Stage of Germination (hr)	Seed constituent			
	Ascorbic acid (mg/100g)	Free amino acids (mg/100g)	Soluble protein (%)	Soluble sugar (%)
0	4.39 g F	61.32 e E	2.838 d D	2.749 bc B
12	11.11 f F	64.67 de DE	2.734 d D	2.572 c BC
24	31.25 e D	74.05 de DE	2.766 d D	2.576 C BC
36	115.85 d C	92.38 d CD	4.329 c C	2.049 D bc
48	169.68 b A	117.86 c C	4.345 c C	2.459 cd BC
60	125.58 c B	158.25 b B	6.227 b B	3.093 b B
72	177.55 a A	224.54 a A	7.935 a A	3.758 a A

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Ultra-weak Luminescence and Chilling-tolerance of Germinating Cucumber (*Cucumis sativus* L.) Seeds

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Phytoluminescence analysis (the technique of phytoultramicroanalysis) was developed in the 1970s. Ultra-weak luminescence (UWL) is highly susceptible to changes in plant metabolic activities and environment. It has been proven that UWL acts as a reliable index for stress-tolerance evaluation in different plant species [3, 5]. Other evidence has suggested that UWL may be useful for the identification of chilling-resistance in some crops (e.g., maize) [4]. The possible association of UWL and the degree of chilling-tolerance in cucumber is worth closer inspection. The UWL of various cucumber cultivar seeds during germination at normal temperature(25C) and low temperature (15°C) is described herein. Such a technique, if accurate and consistent could provide for a new selection tool for the development of chilling-tolerance germplasm in cucumber.

Materials and Methods. Three cucumber cultivars with different chilling-tolerances were used ['Pingli' (chilling- tolerant), 'Xinong- 145' (moderately tolerant) and 'Jinyan-4' (chilling- susceptible)]. Seeds were placed in culture dishes lined with two layers of filter paper. These dishes were transferred to an incubator at 25°C or 15°C. The number of germinated seeds was counted daily. Five uniform samples of germinating seeds were taken for measurement by UWL using an LS-9800 Liquid Scintillation Counter (Amer. Beckman Co.). At 15°C, UWL was measured for six days, and at 25°C for four days (cotyledons had turned green at the fourth day at normal temperature due to quenching effects). On the 8th day, radicles were measured and the experiment was terminated. All tests were replicated three times. UWL is expressed as luminescence intensity per milligram fresh weight.

Results. UWL has a dynamic state in germination cucumber seeds. UWL in dry seeds was weak. There was a sharp increase recorded during the seeds' hydration. With seeds imbibing and germinating, the metabolic activities intensified, and the luminescence signal became stronger.

Luminescence intensity at 15°C was lower than that at 25°C. Thus, low temperature had an inhibitive effect on luminescence. The UWL of dry seeds among the cultivars examined was not different. However, cultivar germinated seeds at 25°C and 5 to 6 days-old germinated seeds at 15°C. The most chilling-tolerant cultivar, 'Pingli', had the highest value (Fig. 1).

There appeared to be a relationship between UWL value and chilling-tolerance of germinating seeds. UWL intensity of 3-day-old germinated seeds at normal temperature (25°C), 5-day-old seeds at low temperature (15°C), and the index of seed vigor at (15°C) is shown in Table 1. The value of UWL (at 25°C or 15°C) was consistent with the germination rate (GR), germination vigor (GI) and vigor index (VI) at low temperature (15°C), and there was a significant difference detected between cultivars in UWL. Our results showed that UWL of germinating seeds (3-day-old at 25°C, and 5-day-old at 15°C) can act as a reliable index for identification of chilling-tolerant cucumber germplasm (Table 1).

Discussion. Plant UWL is a type of ultra-weak microphoton radiation given off by plants which is coupled with their development [2]. Its potential application to agriculture is therefore meaningful.

UWL occurs in cucumber seeds. This can be explained by the auto-oxidation of unsaturated fatty acids and oxidative enzymatic reaction of fatty acids which will produce peroxide-free-radicals in seeds during storage. Photons are released

when these radicals accumulate. During the imbibition of the seeds, the accumulation of radicals will accelerate, and the luminescence intensity will be enhanced dramatically. In germinating seeds, UWL is derived from a cell's during radiation mitosis. It had been thought that plant UWL is a negative feedback system in viable cells. Mitotic radiation of one cell can initiate or stimulate mitotic activities in surrounding cells [1], and as such indicates that UWL increases during seeds germination. A photon is a type of energy-releasing form of energy. If an adequate increase in free-radical energy is obtained, photons will be forced to an excited state. This excited state is unstable. When the free-radical returns to its basal state, it releases photon energy [1]. Thus, UWL reflects the intensity of plant metabolic activities.

Luminescence intensity differed among cultivars. Its intensity value is associated with the degree of chilling-tolerance during seeds germination. UWL method has many advantages. It is non-destructive to tissue, easy and convenient to operate, and many samples to measure one time. We suggest that UWL can be used as a reliable selection parameter for the development of chilling-tolerant cucumber germplasm.

Table 1. The relationship between UWL and seed vigor at low temperature (15°C).

	UWL (cpm/mg)		**15°C**		
Materials	**25°C**	**15°C**	**GR (%)1**	**GI2**	**VI3**
Pingli	60.7	58.7	96.0	8.8	2.2
Xinong-145	48.0	10.7	89.0	8.4	2.2
Jinyan-4	36.2	28.5	75.0	7.9	1.4

1 GR = germination rates.
2 GI = germination index.
3 VI = vigor index = germination rate x radicle length (at the 8th day).

Figure 1. The UWL dynamic state germination in three cucumber cultivars (*Cucumis sativus* L.).

Table 1. The relationship between UWL and seed vigor at low temperature (15 C).

Materials	UWL (cpm/mg)		15 C		
	25 C	15 C	GR(%)[1]	GI[2]	VI[3]
Pingli	60.7	58.7	96.0	8.8	2.2
Xinong-145	48.0	40.7	89.0	8.4	2.2
Jinyan-4	36.2	28.5	75.0	7.9	1.4

[1] GR = germination rates.
[2] GI = germination index.
[3] VI = vigor index = germination rate x radicle length (at the 8th day).

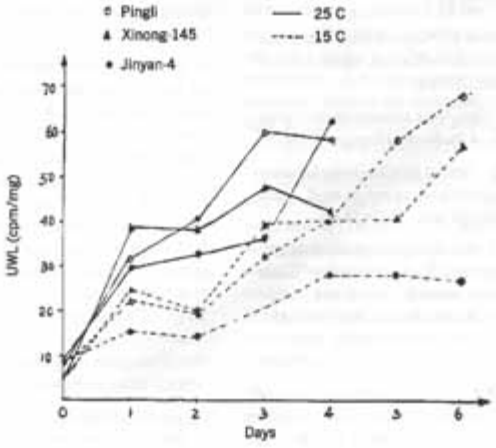

Figure 1. The UWL dynamic state germination in three cucumber cultivars (*Cucumis sativus* L.).

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Table 1. The relationship between UWL and seed vigor at low temperature (15 C).

Materials	UWL (cpm/mg)		15 C		
	25 C	15 C	GR(%)[1]	GI[2]	VI[3]
Pingli	60.7	58.7	96.0	8.8	2.2
Xinong-145	48.0	40.7	89.0	8.4	2.2
Jinyan-4	36.2	28.5	75.0	7.9	1.4

[1] GR = germination rates.
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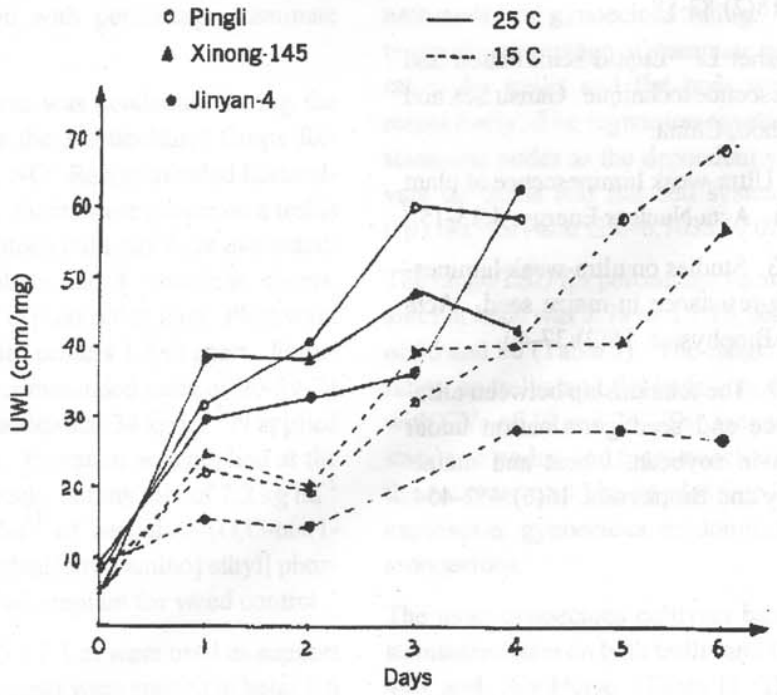

Figure 1. The UWL dynamic state germination in three cucumber cultivars (*Cucumis sativus* L.).

Cucurbit Genetics Cooperative Report 20:7-8 (article 4) 1997

Measurement of Sex Expression in Cucumber Using Percentage Staminate Nodes and a Subjective Rating for Gynoecy

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Most cultivars of cucumber (*Cucumis sativus* L.) grown in the U.S. are gynoecious hybrids. In order to produce hybrid seeds of those cultivars, one inbred parent must be highly gynoecious. Therefore, cucumber breeders are interested in a fast, accurate, and easy method for evaluating sex expression of plants in the field.

In North Carolina trials, we measure the sex expression of cucumber by counting the number of nodes with at least one staminate flower in the first five nodes above the cotyledon. Recently, we have been using a subjective rating system in order to provide a faster method that gives a better idea of the sex expression of plant. The rating scale is from 1 to 9, with 1=androecious, and 9=gynoecious.

The objective of this study was to evaluate the subjective rating system for sex expression with regard to error variation, and correlation with percentage staminate nodes.

Methods. The experiment was conducted during the summer season, 1995, at the Horticultural Crops Research Station at Clinton, NC. Recommended horticultural practices were used. Plants were grown on a trellis or a flat bed system. Eighteen cultivars were evaluated: 15 oriental trellis cucumbers and 3 American slicers. Each cultivar was planted in plots 6.0m long. Plots were on raised, shaped beds with centers 1.5m apart. Fertilizer was applied at the recommended rates of 90-39-74 kg ha^{-1} (N-P-K), with an additional 34 kg ha^{-1} N applied at the vine tip-over stage. Irrigation was applied at the rate of 25 to 40 mm per week. A tank mix of 2.2 kg ha^{-1} of naptalam and 4.4 kg ha^{-1} of bensulide (O, O-bis(1-methylethyl) S-[2-[(phenylsulfonyl) amino] ethyl] phosphorodithioate) was applied preplant for weed control.

Wooden posts 0.15 x 0.15 x 2.1 m were used as support for the trellis system. The posts were erected in holes 0.6 m deep, with a 3 m spacing between posts. The experiment had 6 rows of trellises, each 60m long. Two steel wires of 2 mm diameter were supported by the posts in each row at a height of 0.45 m and 1.5 m from the ground level. The wires were held tightly to a steel brace at either end of the row. Cotton twine was passed between the two steel wires. The plants were trained onto the twine.

The experiment was a randomized complete block design with 2 systems (trellis and flat bed), 18 cultivars, 3 replications, and 40 plants per plot, with a total of 108 field plots. Data were analyzed using the GLM and correlation procedures of SAS (SAS Institute, Inc., Cary, NC). Field plots for the cucumber cultivars on trellis and flat bed systems were rated for sex expression 7 weeks after planting. The percentage staminate nodes was counted on the first 5 nodes of 5 plants per plot. Gynoecious plants would have few or no male nodes. The gynoecious rating used a 1 to 9 scale (1-3=androecious, 4-6=monoecious, 7-9=gynoecious).

Results. No significant differences between the two production systems were observed for percentage staminate nodes or gynoecious rating. The correlation between the percentage of staminate nodes and gynoecious rating for trellis and flat beds were -0.27 and -0.39, respectively. The regression equation fitting percentage staminate nodes as the dependent variable for the cultivars on trellis and flat bed system were GR=5.4157-0.0118x%SN and GR=6.7033-0.023x%SN.

The range/LSD for percentage staminate nodes on trellis and flat beds was 2.79 and 3.18, respectively, with CVs of 35 and 30 (Table 1). The range?LSD for gynoecious rating on trellis and flat beds was 4 and 2, respectively, with CVs of 19 and 24. The range/LSD for percentage staminate nodes, and for gynoecious rating indicated that the cultivars could be divided into 2 to 4 groups for sex expression: gynoecious, predominately gynoecious, and monoecious.

The most gynoecious cultivars based on percentage of staminate nodes on both trellis and flat beds were 'Sprint 440' and 'Sky Horse' (Table 1). The most androecious cultivars on trellis support were 'XZ #17', 'Jin Za #2', and 'Tasty Green'. Based on gynoecious rating, the most gynoecious cultivars on trellis support were 'Sprint 440', 'Jin Chun #4', and 'XZ #17' and monoecious cultivars were 'Marketmore 76', 'Poinsett 76' and 'Tasty Bright'.

On flat beds the most androecious cultivars based on percentage of staminate nodes were 'Tasty Green', 'Jin Chun #4', and 'Yangzhou String'. Based on gynoecious ratings, the most gynoecious cultivars on trellis support were 'Jin Za #2', '89-211', and 'Sky Horse', and the monoecious cultivars were 'Marketmore 76', 'Tasty Bright', and 'Hongzhou Green 55' (table 1).

Although the two methods for measuring sex expression provided similar data, and were correlated, the correlation was not high. Therefore, it appears that the two methods were different things. Percentage staminate nodes was easier to standardize among workers since it is an objective method. However, we found the gynoecious rating to be faster and easier, and were able to use different workers by assigning each to a different replication. Finally, gynoecious rating gives sex expression for all nodes on the plants rather than just the first five, so is more useful for plant breeders working to develop stable, highly gynoecious inbreds.

Table 1. Compassion of sex expression in 18 cucumber cultivars grown on trellis and flat bed production systems using two different measurement methods.

Cultivar	**Source**	**Percentage staminate nodes**	**Gynoecious rating (1-9)**	**Percentage staminate nodes**	**Gynoecious rating (1-9)**
Sprint 440	Asgrow Seed	10	7	19	6
Jin Chun #4	Tianjin, PRC	65	6	89	4
Fengyan	Taiwan	45	5	77	6
Sky Horse	Japan	48	5	20	7
I 109	Japan	59	5	57	5
BAU #14	Beijing Agric. Univ.	61	5	69	5
Yangzhou String	Yangzhou, PRC	65	5	85	4
89-211	Japan	68	5	65	7
Jin Za #2	Tianjin, PRC	75	5	70	7
XZ #17	Shanghai, PRC	77	5	65	4
Tasty Bright	Sakata Seed	55	4	45	4
Summer Top	Takii Seed	62	4	41	6
Yangzhou Grn. Skn.	Yangzhou, PRC	65	4	61	6
Jin Yan #4	Tianjin, PRC	65	4	71	4
Hongzhou Green 55	Hongzhou, PRC	71	4	63	4
Tasty Green	Sakata Seed	71	4	89	4
Marketmore 76	Cornell Univ.	51	3	59	3
Poinsett 76	Cornell Univ.	61	3	63	5
Mean		60	5	62	5
LSD (5%)		24	1	22	2
CV		35	19	30	24

Cucurbit Genetics Cooperative Report 20:9-10 (article 5) 1997

The Effect of Low Temperatures on Leaves of Different Cucumber Cultivars

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Introduction. Cucumber is one of the most important temperature fruit vegetables worldwide. Recently in China, more attention has been placed on anti-season cultivation of cucumber. Thus, research on cold tolerance in cucumber related to this type of cultivation has increased (1-5). However, there have been no reports dealing with the reaction of leaves at different plant positions to low temperature exposure. Therefore, we report herein the effect of low temperatures on leaf position in cucumber.

Material and Methods. Tow cultivars, Jing Za No. 3 (spring season cultivation) and Autumn Chief (autumn season cultivation), were used in this experiment. Seedlings and plants were grown under polyethylene plastic film tent cultivation in the spring-summer season in China. Sample leaves were taken from plants when they reached maturity, cleaned and rinsed, and leaf discs (1.0 cm diameter) were prepared. Then, these discs were exposed to different temperatures (-4, -2, 0, 2, 4, 6 C) for 3 hours. The leakage (%) of electrolytes from leaf discs was measured by a conductivity gauge.

Results and Discussion. The results are provided in Table 1. (1) As the treatment temperature decreased, the electrolytes leakage percentage increased. This indicates that the destruction (degree) of cell membrane increases. There was only a slight difference between the temperature treatments of 6 C and 4 C, but electrolyte leakage sharply increased when temperature was decreased to 2 C or lower. Generally, the leakage rose to ~50% when the temperature was decreased to 0, -2 C or lower. (2) The electrolyte leakage from the leaf discs increased as the leaf position from the base of the plant increased. This indicates that the higher the leaf position, the more sensitive they are to low temperatures. This finding may be explained by the fact that the higher position leaves are growing in the higher temperature condition than lower leaves, and thus lack adaptability to the low temperatures. (3) The differences in cultivar tolerance to low temperature shows that electrolyte leakage from leaf discs of 'Jing Za No. 3' is lower. This means that 'Jing Za No. 3' is more tolerant to lower temperatures than the cultivar Autumn Chief.

Table 1. Electrolyte leakage (%) from cucumber leaves at different positions and when exposed to different temperatures.

Cultivar	Leaf position	Temperature (C)					
		6	4	2	0	-2	-4
Jing Za No. 3	5	21.3 ± 1.4	22.8 ± 0.7	28.8 ± 1.5	32.0 ± 3.0	47.3 ± 4.7	67.8 ± 3.2
	10	25.4 ± 3.3	26.2 ± 1.0	31.8 ± 3.0	36.3 ± 3.0	51.0 ± 2.6	57.2 ± 2.9
	15	28.3 ± 3.8	34.2 ± 6.6	34.4 ± 7.9	38.4 ± 2.3	46.4 ± 8.1	59.7 ± 3.3
	20	27.4 ± 2.5	30.2 ± 2.7	29.6 ± 1.2	33.9 ± 3.9	42.5 ± 8.4	-
	25	34.2 ± 2.3	35.0 ± 3.8	36.0 ± 1.9	37.1 ± 2.3	42.5 ± 0.9	40.7 ± 4.9
Autumn Chief	5	24.5 ± 2.3	24.7 ± 1.9	33.5 ± 2.5	35.3 ± 2.6	44.2 ± 9.8	63.6 ± 3.8
	10	28.4 ± 4.7	28.8 ± 2.6	33.6 ± 0.6	39.1 ± 3.8	47.0 ± 7.0	54.0 ± 1.3
	15	29.0 ± 2.7	32.8 ± 3.9	37.8 ± 2.9	43.7 ± 3.5	52.1 ± 2.6	57.4 ± 3.7
	20	34.2 ± 2.9	34.2 ± 2.0	37.2 ± 2.8	39.9 ± 6.2	51.4 ± 5.5	54.0 ± 0.9
	25	42.6 ± 9.0	46.8 ± 2.5	46.5 ± 4.5	53.1 ± 8.2	60.1 ± 3.4	57.6 ± 8.2

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Cucurbit Genetics Cooperative Report 20:11-12 (article 6) 1997

Effects of Water Stress on Fruit Quality in Cucumber

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Introduction. Cucumber vine growth, lateral branching, leaf area, fruit set, and growth rate are adversely affected when plants are subjected to soil moisture deficits (Cummins and Kretchman, 1975). Fruit yield and quality are also affect by plant water stress (Navazio and Staub, 1994; Staub et al., 1988; Thomas and Staub, 1992).

Cultivar differences in fruit quality have been observed in responses to water stress (Navaho and Stub, 1994; Stub et al., 1988). The plant response of different genotypes depends on the stress environment (Navaho and Stub, 1994). Moreover, although a plant may not exhibit symptoms of stress during periods of soil moisture deficits, it is possible that physiological responses may occur during incipient stress and cause poor fruit quality. The hypotheses as to cause and effect, and genetic background could be tested using nearly-isogenic lines differing in leaf size and plant architecture. Here we report the effects of water stress on seed size and fruit cavity size in nearly-isogenic lines differing plant habits to assess the role of genetic background during water stress.

Material and Methods. Three nearly-isogenic lines (*LLDeDe* = normal leaf, indeterminate; *lldede* = little leaf, determinate; *llDeDe* = little leaf, indeterminate) were compared for response to soil moisture deficits in the summer of 1996. Nearly-isogenic lines (BC6S3) received either adequate water during fruit enlargement (well-watered; control) or were subjected to low soil moisture tensions (water-withheld; stress).

The experiment was constructed at the University of Wisconsin Research Station, Hancock, Wis, on a plainfield loamy sand, typic updisamment; mixed mesic. Plants were arranged in adjacent, randomly-assigned treatment plots (control and water withheld) 4.0 m in apart. Each plot was divided into four 6.0 m rows, with end (1 m) and side (8 m) plot borders. Cucumbers was planted on 1.5 row centers and spaced approximately 10 cm apart in the row (67,000 plants/ha). Each treatment row was divided into 1 m segments and genotypes was randomized in each of five replications. Standard fertilization, spraying, and hand cultivation were practiced in all experiments.

After harvest (when 5% of the fruit were 5 cm in diameter) and postharvest storage, fruits were fresh-pack processed. Processed cucumbers were held for 12 to 14 weeks at 8 C prior to evaluation.

All fruits were halved in longitudinal section. Seed size and fruit cavity (endocarp) size of samplers were evaluated by eight people. Theses fruit characters were rated using 1 to 4 scale (1 = small seed and cavity size; 4 = large seed and cavity size). ANOVA and mean separation of evaluation seed development, and cavity size were performed separately using a split-split-split-plot analysis. Mean separations for all factors in all ANOVAs were performed with Fisher's protected LSD at the 5% level (Steele and Torrie, 1980).

Results and Discussion. Differences were observed among nearly-isogenic lines for seed size and seed cavity size (Figure 1). Although plant habit (*de vs. De*) had no affect on the fruit parameters evaluated, leaf size (*ll vs. LL*) did. The normal leaf line had significantly smaller seeds and cavity size when compare to its little leaf counter part either in determinate or indeterminate backgrounds. This suggests that seed in little leaf lines were maturing more rapidly than those in the normal leaf line. This accelerated maturation in fruit of little leaf lines was also evidenced by the presence of larger seed cavities in these fruit. Both of these observations are indicative of a response to water stress imposed by a soil moisture deficit. This response in little leaf germplasm is manifested by more rapid senescence (i.e., fruit maturation) when compared to well-watered controls and normal leaf germplasm.

Navazio and Staub (1994) observed that although normal leaf cultivars wilted when subjected to short periods of soil moisture deficits, little leaf lines did not. This result was confirmed in our study (data not presented). Thus, our results suggest that enlarging fruit of little leaf genotypes can be subjected to stress, even though the plant is not showing wilt symptoms.

Figure 1. Mean seed size and fruit cavity (endocarp) size rating (1 = small seed and cavity size; 4 = large seed and cavity size) differences among isogenic lines (*LLDeDe* = normal leaf, indeterminate; *lldede* = little leaf, determinate; *llDeDe* = little leaf, indeterminate) in response to water stress (control = watered, stress = unwatered).

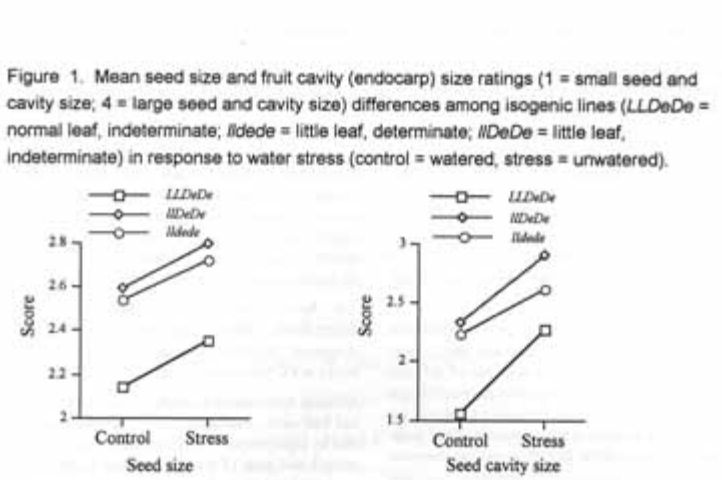

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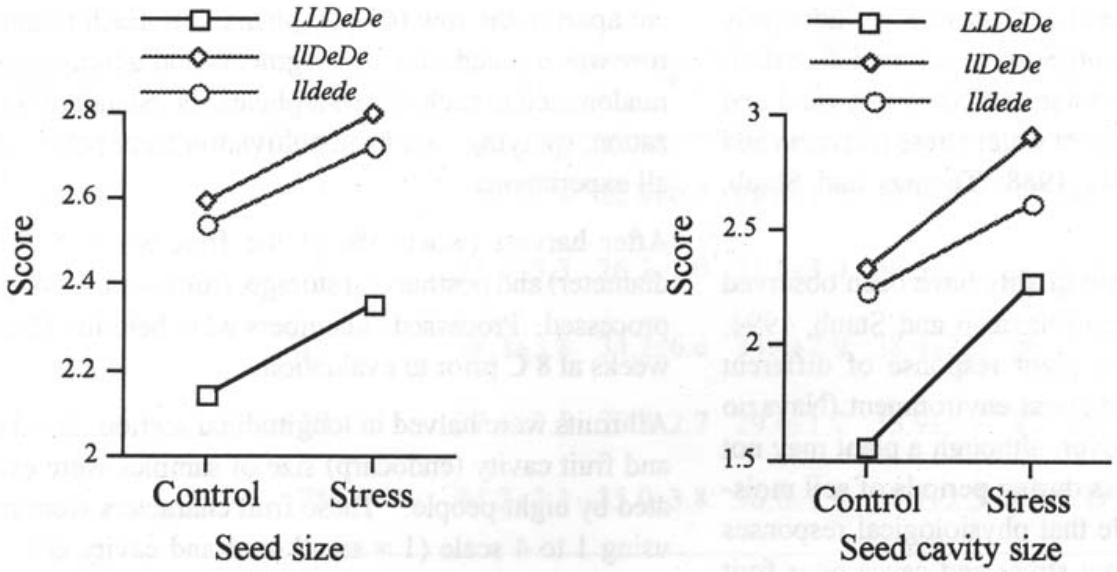
Figure 1. Mean seed size and fruit cavity (endocarp) size ratings (1 = small seed and cavity size; 4 = large seed and cavity size) differences among isogenic lines (*LLDeDe* = normal leaf, indeterminate; *lldede* = little leaf, determinate; *llDeDe* = little leaf, indeterminate) in response to water stress (control = watered, stress = unwatered).



Cucurbit Genetics Cooperative Report 20:13-15 (article 7) 1997

Seedling Tests for Belly Rot Resistance in Cucumber

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Introduction. Cucumber (*Cucumis sativus* L.) is an important vegetable crop of the Southeastern United States, supplying cucumbers to much of the country during the early summer and fall. Belly rot, caused by the soilborne fungus *Rhizoctonia solani* Kuhn AG-4, is an important cucumber disease in that area, particularly in the fall crop. In North Carolina, the average crop loss to belly rot was 5 to 10% (2). Losses in individual fields were reported as high as 80% (3). Nationwide, belly rot resulted in $4 to 5 million of losses per year (3).

Field and detached-fruit screening tests have been developed for belly rot resistance (6). Those tests require that plants be grown to the fruiting stage in the field. Therefore, the tests are time-consuming and must be run during the growing season. A seedling test method, if developed, could have three advantages over field tests of the fruits for resistance. Seedling tests are faster, permitting resistant plant to be identified before the time of pollination. They can be run off-season, permitting more than one generation per year using greenhouses or winter nurseries. And finally, seedling tests provide an additional measure of resistance, making it possible to distinguish between mechanical barriers such as netted fruits, or thick fruit skin.

Seedling tests have been developed for scab, a leaf-spot/fruit rot disease of cucumber caused by *Cladosporium cucumerinum* Ell. & Arth. (5). Wehner and Palmer (7) ran seedling tests using *R. solani* mycelium grown on agar and applied to cotyledons in a spray, drench, or agar disk treatment. Only the agar disk treatment gave differences among cultigens, and they were correlated with field and detached-fruit tests only at the 10% level.

The objective of this study was to evaluate several screening methods to identify a seedling test for belly rot resistance that was easy to run and correlated with field tests.

Methods. All seedling tests were conducted in a green-house in Raleigh, North Carolina, during the spring and summer of 1992. The experiment was a randomized complete block design in a split-plot treatment arrangement with five test methods as whole plots, and five cultigens as subplots. There were three runs of two replications and a four-plant subsample. Five cultigens differing in belly rot resistance were chosen for the experiment: 'Supergreen' (subsceptible middle- eastern slicer), 'Marketmore 76' (resistant American slicer), M 21 (resistant American pickle), PI 165509 (resistant wild type, netted skin), and PI 432855 (susceptible green-house slicer).

Plants were grown in 100 mm (370 ml volume) pots using Metro Mix 220 as a substrate. Two seeds were planted in each pot on three planting date (11 April, 25 May, 17 June), and each pot was thinned to one plant after one week. No fertilizer was used during the test. Day temperatures ranged from 27 to 35 C and night temperatures were not allowed to fall below 21 C. All plants were inoculated when the second true leaf had fully expanded. Inoculations for the three runs were on 28 April, 10 June, 1 July.

Five methods were evaluated in the seedling tests. Those included a potato dextrose agar disk placed on the second true leaf (referred to as the leaf disk method) and against the hypocotyl (referred to as the hypocotyl disk method), a leaf dip and a soil drench using a mycelial suspension, and a syringe inoculation, also using the mycelial suspension. Agar disks were produced by growing *R. solani* for 7 days at room temperature on 100 mm diameter petri plates containing 20 ml potato dextrose agar. A cork borer was used to punch 7-mm-diameter disks from the plates. The mycelial suspension was produced by blending the contents of a 100- mm-diameter petri plate with 100 ml of sterile water for 30 seconds in a blender (Hamilton Beach model 632-1, lowest speed). The leaf dip method was applied by dipping 60% of the second true leaf into a 100 ml beaker containing the mycelial suspension and a drop of Tween 20. The soil drench method consisted of applying 1 ml of the suspension to the substrate at the hypocotyl. The syringe injection technique involved injecting the plant stem 10 mm above the soil surface until the suspension began to ooze from the wound. After inoculation, the plants were placed in a growth camber for two days at 27 C with a fogger to maintain high humidity. The isolate used in this study (Rs-143-N) was of North Carolina origin.

Ratings were made 5 to 12 days after inoculation, depending on the rate of disease development for the three tests (10 May, 15 June, 7 July). Plants were rated on a 1 to 9 scale with a rating of 1 indicating no disease, and a rating of 9 indicating the plant was dead. Data were analyzed using the GLM procedure of SAS (4).

Table 1. Five seedling test methods compared with field performance.[z]

Cultigen	Fruit skin	Field (%)	Leaf disk	Leaf dip	Syringe	Hypocotyl disk	Soil drench
Marketmore 76	Thick	3	3	2	2	3	3
M 21	Thin	5	2	2	2	3	3
PI 165509	Netted	5	3	2	3	4	5
PI 432855	Thin	5	3	2	3	4	3
Supergreen	Thin	8	3	2	3	5	5
Mean		5	3	2	3	4	4
LSD (5%)		3	1	1	1	1	1
Correlation with field test		1.00	0.32	-0.34	0.77	0.75	0.65

[z] Fruit skin was thin, thick, or netted. Field test was the mean % of the fruit surface showing symptoms of belly rot. Seedlings were rated 1 to 9 (1=no disease, 9=plant dead). Methods evaluated were a 7-mm-diameter potato dextrose agar disk damaged with *R. solani* and placed on the second true leaf (leaf disk) and against the hypocotyls (hypocotyls disk), and, a leaf dip, a soil drench, and syringe injection using a mycelial suspension.

Results. Different levels of disease were observed in each of the three runs (data not shown). Variation in symptom expression was most evident in the leaf disk, leaf dip, and syringe methods, suggesting those methods were not reliable. The hypocotyls disk and soil drench methods provided more consistent symptom expression, and both methods appeared to be measuring the same reaction.

The methods producing consistent results over runs were the soil drench and hypocotyls disk (Table 1). Although they had the greatest range of the five methods, the differences were not correlated with field performance. Symptom expression resembled damping-off with lesions and girdling occurring at the soil line. The soil drench method was easier of the two to apply, and future studies might concentrate on refining the method to provide improved results.

In the soil drench method, the most resistant cultigen was ‘Marketmore 76’, ‘Supergreen’ was one of the most susceptible, and M 21 was intermediate. Those three cultigens were tested for damping-off by Booy et al. (1). In that experiment, ‘Marketmore 76’ and M 21 were among the most susceptible, and ‘Supergreen’ was among the most resistant of the cultigens tested. That suggests the soil drench and damping-off methods may be testing different resistance mechanisms.

Nonce of the seedling test methods we evaluated was correlated with field resistance for the cultigens tested. The soil drench method was one of the better methods for distinguishing resistance, and was easy to apply. In addition, it seemed to test the type of resistance not related to the mechanical barrier provided by the fruit skin. It would be beneficial to screen a larger number of cultigens using that method to determine the effectiveness of the method.

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Correlation of Damping-Off with Belly Rot Resistance in Cucumber

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Cucumber *(Cucumis sativus* L.) is an important vegetable crop in the United States, with a large production area in the southeast. North Carolina is the second leading state in the production of pickling cucumber (9), and fourth leading state in the production of slicing cucumber (8).

Belly rot is a severe problem in many cucumber-producing areas. In the southeast, the disease is often severe because of the warm and humid growing season, which favors disease development. Belly rot is caused by the soil- inhabiting fungus *Rhizoctonia solani* Kuhn, anastomosis group 4 (AG-4). In North Carolina, belly rot is present in 72% of all cucumber fields (6). Symptom development on apparently healthy fruits can occur in as little as 24 h. Symptoms appear as sunken, brown necrotic lesions, which often develop a hard, corky layer (2).

Traditional fungicides have been used in an attempt to control belly rot, but those methods do not provide complete control, and often are not economical (3,4). A better means of control would be genetic resistance. Resistant cultivars, along with proper cultural practices, should provide an economical means of controlling belly rot. Cucumber screening tests have been developed using field and detached-fruit studies (7) to identify resistant cultigens (breeding lines, cultivars, and plant introduction accessions). However, those tests required much time and resources, and the data are not obtained until after the plants flower. A seedling test that was correlated with field and detached-fruit tests would use less time and resources, and would permit identification of resistance in time to pollinate selected plants.

The objective of this study was to determine the value of *R. solani* damping-off tests of seedlings for prediction of resistance to belly rot in field and detached-fruit tests.

Methods. All damping-off tests were conducted in a greenhouse in Raleigh, North Carolina during the spring and summer of 1992. The experiment was a randomized complete block design with two runs, three replications, and six cultigens. Four cultigens were chosen that ranged in resistance for belly rot: ‘Supergreen’ (susceptible Middle

Eastern slicer), M 21 (resistant American pickle), PI 432855 (susceptible greenhouse slicer), and PI 165509 (resistant wild-type cucumber with netted skin). Two cultigens were chosen that ranged in resistance to damping off in a previous test (1): ‘National Pickling’ (resistant pickling type) and ‘Addis’ (susceptible pickling type).

Inoculum was produced by autoclaving flasks containing a 2:1 ratio (by volume) of oat grains and tap water two consecutive days for 90 min at 121 C. Disks were then punched out of *R. solani* cultures growing on potato dextrose agar in petri plates. The disks were transferred into the flasks which were kept at room temperature to allow the fungus to colonize the oat grains. Finally, the oat grains were air dried under a hood and refrigerated at 5 C until needed.

All damping-off tests were conducted in flats (505 x 365 x 50 mm) containing a 1:2:1 mix of sand, soil, and Metro Mix 220. The mix was watered prior to filling the flats. Flats were partitioned into two equal units (251 mm long). At the center of each half-flat a small depression was made, 25 oat grains colonized with *R. solani* were placed in the depression, and the oats covered with soil. Twenty-five uninfested oat grains were used in the control treatments. A template was then used to make 20 evenly-spaced holes in each half flat. A seed was then placed into each hole and covered with soil. The two runs were

planted on 28 April or 11 July.

Ratings for the two runs were made 14 days after planting, on 12 May or 25 July. Emergence was recorded and compared with the controls. Each plant was rated for damping-off on a 1 to 9 (1=healthy, 9=dead) scale, and treatment means were computed. Data were analyzed using the GLM procedure of SAS (5).

Results. There were no significant differences among cultigens for resistance to damping-off regardless of whether the analysis was done by run or pooled over runs. We were unable to distinguish 'Addis' and 'National Pickling', which were the most resistant and most susceptible, respectively, in previous damping-off tests run using a different method (1). In most cases, all plants near the centers of the flats (near the oat grains) died, while those around the edges were relatively free of disease. Emergence was not significantly reduced by the fungus, although there were significant differences among cultigens for emergence. Those differences in emergence were likely due to differences in seed quality.

It was interesting that, while the damping-off tests did not show significant differences among cultigens, there were significant correlations with field tests and detached fruit tests (Table 1). Booy et al. (1) used different methods to measure damping-off, and found no correlation with belly rot.

Future research might be done allowing more time for the oats to infest the soil prior to planting to allow better establishment of the fungus.

Table 1. Comparison of damping-off evaluations to belly rot resistance observed in the field.

				Damping-off	
Cultigen	**Field test[z]**	**Detached test[y]**	**Run 1**	**Run 2**	**Mean**
National Pickling	4.1	-	4.4	3.4	3.9
Addis	4.4	3.7	3.9	3.5	3.7
M 21	6.7	3.4	4.2	4.0	4.1
PI 165509	7.2	6.4	4.1	4.5	4.3
Supergreen	8.0	24.7	5.0	4.0	4.5
PI 432855	9.9	27.8	4.7	5.1	4.9
Mean	6.7	13.2	4.4	4.1	4.2
LSD (5%)	4.5	6.2	2.2	1.9	2.0
Correlation with field test	1.00	0.83	0.61	0.92**	0.97**
Correlation with detached test	0.83	1.00	0.91*	0.60	0.87*

[z] Ratings were based on the percentage of the fruit surface damaged averaged over 1991 and 1992 field tests.

[y] Detached fruit ratings are based on the percentage of the fruit surface damaged during 1991 experiments. Each value is based on the mean of nine fruits.

*,** indicates significance at 5 or 1 % level, respectively.

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Cucurbit Genetics Cooperative Report 20:18 (article 9) 1997

CMV Resistance in Cucumber – A Correction

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In a previous report published in the Cucurbit Genetics Cooperative Report (Havey 1996), I erroneously stated that the primary source of CMV resistance currently used commercially traced back to an accession of 'Tokyo Long Green'. Dr. Henry Munger, Cornell University, brought this error to my attention. Although 'Tokyo Long Green' shows resistance to CMV, research by Dr. Munger and colleagues (Munger and Newhall 1953) indicated that this source of resistance is less desirable than that of 'Chinese Long'. Porter observed CMV-resistant cucumber germplasm in China in 1926 and acquired the first accession of 'Chinese Long' (Porter 1932). CMV resistance from this accession was used to develop 'Shamrock', the first CMV-resistant commercial cucumber (Munger and Newhall 1953). 'Chinese Long' was also used by Dr. Munger to develop his CMV-resistant cucumbers'Table green' and 'Marketmore' and by Walker (Wasuwat and Walker 1961) to develop 'WI SMR12' and WI SMR18'. Shifriss et al. (1942) proposed that three genes may condition CMV resistance in 'Chinese Long' by 'Early Russian' (CMV susceptible) crosses, although Munger and Newhall (1953) indicated that inheritance of CMV resistance in 'Chinese Long' may be more complex. Wasuwat and Walker (1961) proposed that a single dominant gene conditioned CMV resistance in their pickling cultivars derived from 'Chinese Long'.

As described by Munger and Newhall (1953), Dolittle et al. (1939) discovered CMV resistance in 'Tokyo Long Green' and used this as the source of CMV resistance in Ohio 31, the first CMV-resistant pickling cucumber. Waker used 'Tokyo Long Green' and 'Chinese Long' as the sources of CMV resistance in 'WI SMR15' (Wasuwat and Walker 1961). Munger and Newhall (1953) described contrasting development of CMV symptoms in 'Chinese Long' and 'Tokyo Long Green'. 'Chinese Long' developed a slight mottling after inoculation and grew out of the symptoms to produce newer leaves with no transmission of the virus from the fifth or sixth leaves. 'Tokyo Long Green' showed less mottling on leaves two weeks after inoculation, as compared to 'Chinese Long'. However, the newer leaves of 'Tokyo Long Green' continued to show some mottling and did not develop symptomless newer leaves. Kooistra (1969) studied the inheritance of CMV resistance in material derived from 'Tokyo Long Green' and proposed three incompletely dominant resistance genes.

Dr. Munger shared unpublished results from the Ph.D. thesis (Cornell University, 1954) of his student, Lester Schaible. Munger and Schaible inoculated 37 F_2 progenies from 'Chinese Long' x ' Tokyo Long Green' with CMV. They observed segregation of CMV resistance, indicating that the same gene(s) were not conditioning CMV resistance in both populations. F_3 progenies from 27 of these F_2 plants were inoculated and reactions correlated well (0.89) with the parental phenotypes.

Acknowledgement: I gratefully acknowledge this correction and salient information provided by Dr. Munger.

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Cucurbit Genetics Cooperative Report 20:19-20 (article 10) 1997

Evaluation of *Cucumis sativus* var. *hardwickii* Cultigens for Resistance to Root-knot Nematodes

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Resistance to root-knot nematode has been identified in *Cucumis sativus* var. *hardwickii* cultigen LJ 90403 (2). Currently, that is the only cultigen identified that is cross-compatible with *Cucumis sativus* and also has multiple nematode resistance. A selection of LJ 90403, NC-42, was released for use in breeding because it had significantly higher resistance than check cultivars like 'Sumter' and 'Wisconsin SMR 18' (4). We were interested to find whether other cultigens of C. *sativus* var. *hardwickii* cultigens in our collection for resistance to root-knot nematode species *Meloidogyne javanica,* and *M. arenaria* races 1 and 2.

Three *C. sativus* var. *hardwickii* cultigens (LJ 90403, PI 215589, and PI 462379) were evaluated for resistance to three root-knot nematodes (*M javanica,* and *M. arenaria* races 1 and 2). The experiment was set up as a completely randomized design with three replications. Plants were grown using the split-root technique (3). Plants were transplanted with approximately one-third of the root system of each plant in each of three 10-cm plastic pots. Each pot was inoculated with 5000 eggs of one root-knot nematode (*M javanica,* and *M. arenaria* races 1 and 2). Ten weeks after inoculation, roots were rated for percentage galling from 0 % to 100 % (1). A cultigen was considered susceptible if it had a gall index above 25 %, and highly resistant if it had a gall index rating below 15 %.

As found in previous studies, LJ 90430 was resistant to all three nematodes (Table 1). The other two *C. sativus* var. *hardwickii* cultigens (PI 215589 and 462379) were resistant to *M. arenaria* race 1. However, LJ 90430 (and the NC-42 selection) is still the only known cultigen of *Cucumis sativus* with resistance to *M javanica.*

This study indicated that there are multiple sources of resistance to root-knot rnematodes. Additional cultigens of C. *sativus* var. *hardwickii* need to be collected and evaluated to determine whether even higher levels of resistance exist.

Table 1. Root-knot nematode resistance of three *Cucumis sativus* var. *hardwickii* cultigens and three check cultigens[z].

	Gall index rating for 3 root knot nematodes		
Cultigen	***M. Arenaria* race 1**	***M. Arenaria* race 2**	***M. javanica***
***hardwickii* cultigens**			
LJ 90430	11	8	8
PI 215589	45	14	46
PI 462379	9	6	60
Check cultigens			
NC-42 (LJ 90430)	11	5	6
Sumter	58	72	55
Wis. SMR 18	65	73	63
Mean	33	30	40
LSD (5%)	11	12	14
CV (%)	21	26	22

z

Data are means of 3 replications of plants tested in split-spots.

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In Vitro Colchicine Application of Haploid Cucumber Plants

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Introduction: Recently, haploid cucumber plants (n=7) have been obtained from in vitro haploid embryo culture. The recovery of haploid cucumber plants has been sufficient for their use in breeding programs (1). Although haploid plants can be used directly in genetic analysis, they should be converted to dihaploid plants (2n=14) via chromosome doubling in order to develop cultivars.

Colchicine has been effective for chromosome doubling in many species. Colchicine has been applied in situ or in vitro at various doses and durations depending upon the species used. Although in situ colchicine application often results in cytochimera formation (2), in vitro colchicine application can reduce chimera formation frequency (3). The objective of this research was to determine a suitable dose and duration for in vitro colchicine application in cucumber to obtain dihaploid plants.

Material and Methods: One month old in vitro cucumber plantlets (roots and some leaves removed) were treated by immersion in aqueous colchicine solution at 0.5% or 1% for 2 or 4 hr. The plantlets were then rinsed three times in sterile distilled water and laid on sterile paper towel to remove excess water. Since they were directly in contact with the colchicine solution, the basal and apical ends of the plantlets were trimmed slightly. These micro-cuttings possessed a single node and were transferred to test tubes containing E20A media. The healthy plants were acclimatized, and transferred to a mixture of peat and volcanic tuft under misting. The surviving plants were then planted in soil in a greenhouse. The ploidy levels of the established plants were determined by chromosome counting using root tips to verify the effectiveness of colchicine treatments.

Results and Discussion: The results of the experiment are summarized in Table 1. The percentage of surviving and healthy developing plantlets decreased after colchicination at the higher dose or longer duration. Water drops on microcuttings after rinsing in distilled water resulted in contamination that led high plantlet losses. Therefore, drying after rinsing is crucial for obtaining a high percentage of healthy plantlets.

The shoot growth of some colchicine treated plantlets was limited, and the period from colchicine application to recovery of the first micro-cuttings was longer at the higher dose (1%) than at the lower dose (0.5%).

The number of micro-cuttings per plant after 4 months (by two successive micro-cutting regenerations) ranged from 2.7 to 5.0. A total of 336 plants were obtained by micro- cuttings in this experiment. However, most of the transplants did not survive under greenhouse mist culture. Only 37 plants were established in soil in the greenhouse. The established haploid and dihaploid plants were grown for 5 months, and their ploidy levels were confirmed by their morphological features. Seeds were also extracted from fruits of dihaploid plants.

Treatment of plantlets with 0.5% colchicine for 2 hr had no effect on the production of dihaploids. We obtained dihaploids at a rate of 53% following treatment of plantlets with 0.5% dose for 4 hr, and 60% with treatment of 1% colchicine for 2 hr. Although colchicine applications with 1% dose for 4 hr produced only dihaploids, the number of the resulting plants was low (3 plants). This might be related to the higher percentage of unhealthy plants. In the light of these findings, it appears that dihaploid cucumber plants can be derived from haploids either by the application of colchicine with 0.5% dose for 4 hr or 1%

dose for 2 hr.

Table 1. The development of cucumber plantlets and their ploidy levels after in vitro colchicination.

	Colchicine doses (%) and durations (hr)			
	0.5%		1.0%	
Plant development	**2** hr	**4 hr**	**2** hr	**4 hr**
Number of microcuttings planted	41	49	38	38
Percentage of surviving plantlets	92.7	59.2	55.3	42.2
Percentage of healthy developing plantlets	68.2	51.0	55.3	36.8
Days for the first microcuttings	51	51	54	54
Number of microcutting per plant (in 4 months after colchicination)	5.0	3.8	2.7	4.1
Number of transplants	100	88	54	94
Number of haploid plants	5	9	4	-
Number of dihaploid plants	-	10	6	3

Figure 1. A doubled (dihaploid) plant after colchicination.

Figure 2. A plant still remaining haploid after colchicination. (Note floral morphology)

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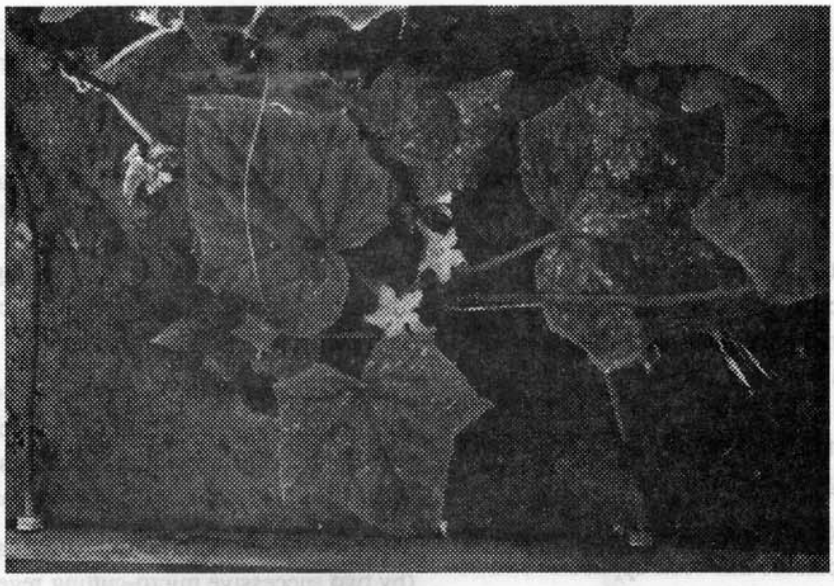

Figure 1. A doubled (dihaploid) plant after colchicination.

Figure 2. A plant still remaining haploid after colchicination. (Note floral morphology)

Cucurbit Genetics Cooperative Report 20:24-26 (article 12) 1997

Attempts at Colchicine Doubling of an Interspecific Hybrid of *Cucumis sativus* L. x C. *hystrix* Chakr.

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Introduction. Traditional approaches for interspecific hybridization have been used in *Cucumis.* These include growth regulator application (Custer and den Nijs, 1986), pollen irradiation (Beharav and Cohen, 1994), use of mentor pollen (Kho et al., 1980), and bud pollination (Chatterjee and More, 1991). We previously reported the successful hybridization and recovery of F_1plants (2n=19) by embryo rescue from a cross between *Cucumis sativus* L. (2n=2x=14) and *C. hystrix* Chakr. (2n=2x=24) (Chen et al., 1996; Chen et al., 1997). Reciprocal crossing of F_1plants to either parent and self-pollination indicated that the hybrids were male and female sterile.

Colchicine, an antimitotic substance has been used to double the chromosome number in several plant species in attempts to increase fertility (Tosca et al., 1995; Taira et al., 1991). Different ploidy levels exist in the genus *Cucumis* (Shifriss, 1942; Kubicki, 1962). Autotetraploid cucumbers have been produced by soaking seed in solutions of colchicine (Smith and Lower, 1973). However, the fertility of such tetraploid plants is about 1/5 that of the diploids from which they are derived. Since colchicine application has been used successfully for the induction of higher ploidy levels in cucumber a study was designed to double the chromosome number of interspecific hybrids of *Cucumis sativus* x *C. hystrix.* Doubled hybrids (2n=38) would then be evaluated for fertility restoration.

Materials and Methods. The initial parental germplasm used (*C. sativus* and *C. hystrix),* the method of interspecific hybridization, they embryo rescue procedures, and the culture of F_1plants have been reported previously (Chen et al., 1996; Chen et al., 1997).

Embryo treatment. Rescued F_1embryos were incubated on MS medium (Murashige and Skoog, 1962) containing 0.01-1.0% colchicine (Sigma) for 1-12 days at 25C. A factorial design was used in two experiments (each in different growing seasons; spring and fall 1996) to examine the effects of colchicine concentration (%) (Experiment 1: 0.0, 0.01, and 0.05%; Experiment 2: 0.0, 0.10, 0.50, and 1.00%) and treatment duration (Experiment 1: 0, 2, 4, 6 days in solution; Experiment 2: 0, 8, 10, 12 days in solution). A third experiment was conducted to determine the effect of preculture duration on the recovery rate of embryos from colchicine treatment. Embryos were precultured on MS medium for either 2, 4 and 6 days before transfer to colchicine treatment. In each there were two replications of each treatment.

After colchicine treatment, the embryos were rinsed thoroughly with liquid MS medium, and then cultivated on a colchicine-free MS medium to produce plantlets. The plantlets in the 2- to 4- leaf stage were transferred to a soil medium containing field soil and sand (3:1 v/v), and fertilized using a standard 20:20:20 N:P:K solution.

Shoot treatment. Several application techniques were employed. The apical shoots of small hybrid plants (4th to 5th leaf stage) were treated by immersion in aqueous colchicine solution (0.02%) three times in each of three immersion intervals (4 times, 3 hours each for two days, 5 times, 3 hours each for two and half days; 6 times, 3 hours each for three days). Twenty-one shoots in total were treated (seven in each treatment in interval).

A second experiment was conducted to test the effect of DMSO on the chromosome doubling activity of colchicine treatment. In this factorial experiment the colchicine concentration was 0.02 and 0.05%, each in 1% DMSO. Treatment intervals consisted of: 1) one time, for 8 hours for one day; 2) Two times, for 8 hours each, for two days; 3) three times, for 3 hours each, once every another day for six days; 4) six times, for 3 hours each, once every another day for twelve days, and; 5) nine times, for 3 hours each, once every another day for eighteen days. Thirty-five shoots in total were treated (seven in each treatment interval).

A third treatment consisted of the application of 0.5 and 1.0% (wt/wt) colchicine in a lanolin paste (Fougera) on the apical meristems of plants in the 4th to 5th leaf stage. Twenty-six shoots in total were treated.

Evaluation of ploidy level. The ploidy level of colchicine- treated plants were evaluated by chromosome analysis and by flow cytometry. Root tips of selected plants were examined by standard root tip squash preparations and actocarmine staining techniques.

Results and Discussion. *Embryo culture.* A total of 256 embryos (239 colchicine-treated and 17 control) were used in the experiments described above. Seventy-seven plantlets were recovered from the colchicine treated embryos (32.2% regeneration rate). The average regeneration rate was 41.4% (4 of 10 embryos and 3 of 7 embryos) for control embryos. Variation in the initial leaf morphology was observed, but no chromosome doubled plants were obtained.

Results of Experiment 1 suggest that a considerable number of plantlets could be obtained (32 to 47%) from treatment of embryos with 0.01 or 0.05% colchicine (table 1). Thus, the treatment concentrations used in Experiment 2 were increased. It appears that, given the doses used, a concentration of 0.01% colchicine provided for the highest number (42%) of regenerated plantlets. This regeneration rate was similar to control (40%). Apparent colchicine toxicity (13-23% regeneration rate) occurred at concentrations higher than 0.50% colchicine in this experiment. Nevertheless, plantlets with chromosome numbers higher than 2n=19 were not recovered.

Repeated application of colchicine at any concentration caused a reduction of the number of plantlets recovered (25-33%) when compared to the control (40-43%) treatment in Experiments 1 and 2 (Table 1). Repeated application of colchicine at or beyond 10 days resulted in no plantlets recovered.

Preculture of embryos for six days on MS media (Experiment 3) resulted in a higher recovery of plantlets (52%) when compared to controls (40%) (Table 2).

Apical shoot treatments. Because colchicine toxicity was observed in embryo Experiments 1-3 and no higher-ploidy-level plantlets were recovered from the higher colchicine treatments, an experiment (shoot experiment) was designed to determine whether addition of DMSO to the colchicine application solution would result in recovery of plants with higher ploidy levels.

All 21F_1plants treated with 0.02% colchicine survived treatment. All news leaves of the plants after treatment were deformed. However, after continued growth (~10 nodes above treatment node) all plants appeared to revert back to normal morphology. Treated plants did not change ploidy level.

When 35 plants were treated with 0.02 and 0.05% colchicine and 1% DMSO, 20 plants died. The remaining plants showed distortions in leaf and shoo morphology typical of colchicine treatment alone. These plants eventually recovered and appeared normal, but the treatment did not change the ploidy level of any of the plants.

All of the 26 plants treated with colchicine (0.5 and 1.0%) in a lanolin paste died after treatment. Plant growth reduction was observed in control plants (lanolin paste smear without colchicine). Therefore, it appears that lanolin paste under our conditions is somewhat toxic to cucumber plants and that a combination of lanolin paste and colchicine at the doses used inhibits plant growth and development.

It is concluded that colchicine treatment of embryos or shoot tips with colchicine in the concentrations and treatment durations used in our studies does not result in the doubling of *C. sativus* x *C. hystrix* F_1hybrid embryos or plants. The colchicine treatment and culture of single cells from callus should be evaluated for its potential efficacy.

Table 1. Regeneration rates of embryos rescued from a *Cucumis sativus* x *C. hystrix* mating after colchicine treatment.

Effect of concentration			
Conc.(%)	**Treated numbers**	**Regeneration numbersrate**	**Regeneration (%)**
Experiment 1			
0.00	10	4	40.0
0.01	47	22	46.8

0.05	56	18	32.1
Total	113	44	
Experiment 2			
0.00	7	3	42.8
0.10	57	24	42.1
0.50	40	5	12.5
1.00	39	8	22.8
Total	143	40	

Effect of treatment duration			
Days[1]	**Treated numbers**	**Regeneration numbers**	**Regeneration rate (%)**
Experiment 1			
0	10	4	40
2	68	21	30.7
4	70	17	24.7
6	68	22	32.5
Total	216	64	
Experiment 2			
0	7	3	42.8
8	20	5	25.0
10	10	0	0
12	10	0	0
Total	47	8	

[1] Days in solution

Table 2. Results of preculture (before colchicine treatment) of rescued embryos on the regeneration rate of embryos from a *Cucumis sativus x C. hystrix* mating.

Days	Treated numbers	Regeneration numbers	Regeneration rate (%)
0	10	4	40.0
2	47	20	42.5
4	52	19	36.5
6	48	25	52.0
Total	157	68	

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A Genetic Model of Bitter Taste in Young Fruits of Melon*

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Abstract. The bitter taste of young fruits obtained from F_1 and F_2 individuals from crosses among various varieties of melon (*Cucumis melo)* from different regions were analyzed. The results showed that bitter taste in young fruits was determined by two pairs of the genes which were independently inherited and dominantly complementary. Progeny between varieties from the same center of origin did not express dominant complementation, whereas progeny from different centers of origin did.

Introduction. The bitter taste in the young fruits of melon is a significant quality character that is easy to determine. When melon germplasm from all over the world was studied, it was found that ripe fruits did not show the bitter taste, but young fruits were divided into two types: (1) bitter, and (2) non-bitter. The young fruits of wild melon showed a strong bitter taste, whereas the young fruits of local cultivars from all over the world were mostly non-bitter. In the cultivars that were selected by crossing and genetic recombination, some of hem had the bitter taste and others did not. To date, the inheritance of bitter taste in immature fruits has scarcely been studied.

It was documented that bitter taste in young melon fruits is a dominant character (5), which is seen in other cucurbits (2,3,4). The bitter taste in young fruits of melon is from cucurbitacin (1). The production of cucurbitacin is mainly determined by genetic factors; however, environmental conditions can also affect production. Japanese researchers suggested that the inheritance of bitter taste may have epistatic interactions, but there has been no report on how these genes interact.

Materials and Methods. The *C. melo* genotypes used this study were genetically stable after a number of selfing generations. The name, origin and botanical variety (e.g., *inodorus, conomon)* of these materials are presented in Table 1.

The research was performed in an experimental plot of the Agricultural University of Hebei. The materials were strictly selfed for three generations again after previous selfing, then bitter and other genetic traits were recorded. In order to observe the inheritance of characters in progeny of crosses of bitter x bitter (BxB), bitter x non-bitter (BxNB) and non-bitter x non-bitter (NBxNB), the crosses were made with different genotypes. The bitter taste in young fruits was checked 12 days after fruit set.

During crossing, the stamens of the flowers of female-parents were strictly removed the day before flowering, and bags were put on the emasculated flowers. Flowers of the male-parent were bagged on the day of flowering, the flowers were pollinated, bagged, labeled and marked. For selfing, female and male flowers from the same plant were bagged on the day before flowering. At 7:00-8:00 a.m. the next day, flowers were pollinated, bagged and marked. Six hybrid combinations (Africa Wild X S-3, Africa Wild x Sichuan Wild, Sichuan Wild X B-10, B-10 X Honey Dew, S-3 X W-B, and Honey Dew x Nunong) were selected according to the F_1phenotypes, and 200 F_2 individuals were planted for each.

Results. *Bitter x bitter crosses.* The F_1 hybrid of the cross between the two bitter parents (Africa Wild x Sichuan Wild) showed bitter taste (Table 1). Of the 200 F_2 plants grown from this cross, all of them also had the bitter phenotype (Table 2).

Bitter x non-bitter crosses. In all BxNB crosses, the F_1s were bitter. When two of these crosses (Africa Wild x S-3, and Sichuan Wild x B-10) were selfed, the F_2s had B:NB ratios of 73:27 and 74:26, respectively. In the significance test of standard deviation (P=0.4122 and P=0.6241), this segregation followed a 3:1 ratio (P 0.06) and showed Mendelian inheritance (Table 2).

Non-bitter x non-bitter crosses. When both parents were non-bitter, only four of the 10 F_1hybrids were non-bitter (Honey Dew x Nunong, Honey Dew x W-B, Nunong x W-B, S-3 x B-10). For these crosses, all of the young fruits in the F_2 populations showed the non-bitter character (e.g., Honey Dew x Nunong). Surprisingly, six F_1s from NBxNB combinations (S-3 crossed with Honey Dew, Nunong, and W-B; B-10 crosses with Honey Dew, Nunong, and W-B) showed bitter taste.

Complementary expression. In two NBxNB combinations which gave rise to bitter F_1s(Honey Dew X B-10, S-3 X W-B), F_2segregation (B:NB) was 114 to 86 and 116 to 84, respectively, and obviously did not correspond to the ratio (3:1) determined by a single dominant gene. In the test of standard deviation (p=0.8377, p=0.7263), the result corresponded to a ration 9:7 for the F_2segregation (P 0.05), suggesting complementary gene action of two independent genes. When there was a homozygous recessive condition at either locus, the dominant expression at the other locus is prohibited. That is, non-bitter (*AAbb*) x non-bitter (*aaBB*) -- F_1bitter (*AaBb*) -- bitter F_1(*AaBB*[or *AABb*]) -- F_2, 3 *A_BB* (bitter): 1 *aaBB* (non-bitter) [or 3 *AAB_*(bitter): 1 *AABB* (non-bitter)].

Dominant complementation and ecophenotypes of melon. When materials which originated from continental climate regions in Middle Asia and West Asia were crossed, the progeny did not suggest dominant complementation (e.g., *C. melo* var. *cantalupensis* [W-B]). This indicated that there was recessive homogeneity in the two pairs of genes controlling the bitter taste. Similarly, when the material originating from East Asia (*C. melo* var. *makuwa* [S-3], *C. melo* var*. conomon* [B-10]) were hybridized with each other, the F and F populations did not have the bitter taste, which

1 2

suggested that these materials were also homozygous recessive at both loci.

Discussion. The inheritance of the bitter taste in the young fruit of melon is controlled by two independent genes which have a complementary relationship. The bitter taste in young fruits is a primitive character. In the long-period of naturalization and selection, bitter types have been gradually eliminated, but the recessive variance with the non-biter (The bitter *A_B_*--the non-bitter *aaBB* or *AAbb*) has remained. The cultivars with the recessive variable homozygotes from the same secondary center of origin did not express dominant complementation, neither in selfing or in crossing. However, when the different recessive variable cultivars from the different original centers were crossed each other, they did express the dominant complementation. The results from this research may provide important information for the study of the origin, evolution and taxonomy of melon.

Table 1. Species of melon and their F_1performance of bitter taste in young fruits.

Genotype	Honey Dew	Nunong	W-B	S-3	B-10	Africa Wild	Sichuan Wild	Origin	Variety
Honey Dew	X	X	X	0	0	0	0	America	*C. melo* var. *inodorus*
Nunong		X	X	0	0	0	0	Japan	*C. melo* var. *reticulatus*
W-B			X	0	0	0	0	Italy	*C. melo* var. *cantalupensis*
S-3				X	X	0	0	Hebea	*C. melo* var. *makuwa*
B-10					X	0	0	Guangdong	*C. melo* var. *conomon*
Africa Wild						0	0	Africa	*C. melo* var. *agrestis*
Sichuan Wild							0	Sichan	*C. melo* var.*agrestis*

Note: 0 = bitter; X = not bitter.

Table 2. F_2 segregation from crosses between various varieties of melon.

			Number of F_2 Plants		Expected F_2 segregation (3:1)	
Cross	**Type**	**F_1**	**B**	**NB**	**B**	**NB**
Africa Wild x Sichuan Wild	BxB	B	200	0	100	0
Africa Wild x S-3	BxNB	B	145	55	72.5	27.5
Sichuan Wild x B-10	BxNB	B	147	53	73.5	26.5
Honey Dew x Nunong	NBxNB	NB	0	200	0	100
B-10 x Honey Dew	NBxNB	B	114	86	57	43

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Breeding for Resistance to Powdery Mildew in Snake Melon (*Cucumis melo* var. *flexuosus*) in Sudan

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Snake melon (*Cucumis melo* var. *flexuosus*) is a popular vegetable in Sudan, consumed fresh in salad and also in pickles. Powdery mildew is one of the most important limiting production factors, specifically during winter in Sudan (1). This project aims at breeding a resistant snake melon cultivar to powdery mildew, since there are presently no resistant cultivars.

A field study was conducted during Oct 1996 to Jan 1997 at the University Experimental Farm. Material tested included PI 414723 (resistant), local cv. Shendi (susceptible), F_1 ('Shendi' X PI 414723), BC_1 ('Shendi' X F_1) and the F_2 population. Differential hosts shown in Table 2 were planted at the same time with the tested material. The plants were inoculated fifteen days after planting by spraying a spore suspension. A rating scale of 1 to 9 (1 = high susceptibility and 9 = high resistance) was used. The powdery mildew was examined both in the laboratory using conidial structures and germination of spores, and on differential hosts in the filed.

The results (Table 1) indicated that 'Shendi' was highly susceptible (PMR=1), PI 414723 was resistant (PMR=9) and their F_1 was intermediate (PMR=6.2). TheF_2 showed segregation with about 7.6% having the level of resistance of the PI 414723. The BC_1 also showed segregation with 33% having the level of resistance of the F_1. This indicated partial dominance of the resistance. Due to the production of fibrosin bodies in the conidia, arrangement of conidia in chains at the apex of the conidiophores and through the lateral germination of germtubes (2), the causal agent was identified as *Sphaerotheca fuliginea.* This was further confirmed by the known reaction of the differential hosts (Table 2). Since 'Nantais oblong' was not infected, *Erysiphe cichoracearum* was ruled out as a causal agent.

In conclusion, resistance to powdery mildew can be transferred into 'Shendi' through backcrosses with selfing. Seasonality of race prevalence should be considered in the breeding programs as race 1 prevails during the warmer time of the season and race 2 during the cooler part of the season (1).

Table 1. Distribution of rating for powdery mildew resistance (PMR) of the different lines and crosses tested.

	Number of plants in each disease rating class[z]										
Line or Cultivar	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total no. of plants**	**Mean**
Shendi	200	-	-	-	-	-	-	-	-	200	1.0
PI 414723	-	-	-	-	-	-	-	-	25	25	9.0
F_1 (Shendi x PI 414723)	-	-	-	4	8	8	-	-	-	20	6.2
F_2 (Shendi x PI 414723)	22	-	25	-	30	-	22	-	19	118	4.8
BC (Cv. Shendi x F1)	35	-	26	-	19	1	10	-	-	91	3.2

[z] 1 = highly susceptible, 9 = highly resistant

Table 2. Observed reaction of differential hosts to infection of powdery mildew in the filed in 1996-97.

	Differential hosts

	Iran H	Nantais oblong	PMR 45	WMR 29	PMR 1	PMR 5	PI 414723	PI 124112
Reaction type	S[z]	S	S	R	R	R	R	R

[z] R = resistant, S = susceptible

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Wilt Disease of Melon (*Cucumis melo* L.) and Associated Organisms in Sudan

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Muskmelon in the Sudan is traditionally grown in small fields and is consumed locally. As such the crop has received very little attention. However, with the recent introduction of some high-value commercial varieties such as ‘Galia’ and ‘Ananas’ for export purposes, attention has become focused on its safety and productivity. One of the main problems of commercial production of these new varieties is a wilt disease. The present investigation focuses on the possible cause(s) of this wilt-disease complex.

A disease survey was carried out in two muskmelon fields. ‘Galia’ was sown during the first week of October and ‘Ananas’ was sown during the first week of November. Data were taken at 5-day intervals, and only completely wilted plants were counted. Wilted plants were pulled and together with their roots, examined for disease symptoms. Stems were examined for the presence or absence of discoloration of the vascular vessels.

Preliminary field observations have revealed that wilt disease of muskmelon is more severe in the fall crop (July-October) than at other times of the year. Symptoms of the disease in the field were observed mainly after flowering and during fruit-set. Some plants showed symptoms of sudden wilting without any signs of leaf yellowing, while others showed gradual wilting associated with or without leaf yellowing. Others showed yellowing on the old leaves, while the younger leaves were still green. Other symptoms observed included burned leaf margins and wilting, and wilting of individual branches, while the rest of the plant was still healthy in appearance. Foot-rot symptoms were observed on the bases of stems, appearing as soft areas, dark brown in color and sometimes associated with a brown, gummy exudates. Root rotting symptoms were also observed on some wilted plants. The rotted roots appeared brown, shredded and very much reduced in size and number. Also general stunting was observed in wilted plants. When stems of wilted plants were split open lengthwise, brownish discoloration of the water conducting vessels was observed in some plants.

The results from the ‘Galia’ field (Table 1) revealed that 24.4% of the total plant population showed wilt disease symptoms. In the last five readings of Table 1, a very high proportion (71.3%) of wilted plants had typical *Fusarium* wilt symptoms (vascular discoloration), while the rest have shown symptoms of foot rot (16.0%) and root-rot (4.5%).

Observations in the Ananas filed (1804 total plants, Table 2) revealed that 21.18% of these plants had wilt disease symptoms, of which 61.0% have typical *Fusarium* wilt symptoms. Foot-rot and root-rot were found in 16.8% and 4.0% of the total wilted plants, respectively.

Other organisms were associated with wilted plants. Larvae of the red melon beetle (*Aulacophora Africana)* were found in the roots and stems of wilting plants. These yellowish larvae seem to penetrate the roots and stems and feed on them. When they become mature, they enter the pupal stage in the soil and appear as whitish bodies. This presence of the beetle may not indicate a direct relationship between the beetle and wilt, but as a pest, it may indirectly help in aggravating the disease. Earlier, Schmutterer (3) reported the red melon beetle on cultivated melon in an irrigated area of central Sudan.

Towards the end of the season, termites were also observed, resulting in evacuated portions of the roots being filled with soil. Termites, in general, are often suspected to be associated with plants weakened due to some other causes. Field observations of 'Galia' (Table 1) and 'Ananas' (Table 2) showed 8.2% and 17.3%, respectively, of the wilted plants with insect damage. Examination of wilted plants also revealed white galls of varying sizes caused by the root-knot nematode, *Meloidogyne incognita.* The presence of root-knot nematode in association with wilted plants may suggest that it plays a role in lowering the resistance of muskmelon to *Fusarium* wilt.

The present results have confirmed an earlier observation by Mohamed et al. (2) that wilt is a serious disease of muskmelon in central Sudan. Wilt in the Sudan either appears suddenly, while the leaves are still green, or appears gradually, being accompanied by leaf yellowing. Mas and Riser (1) had reported that wilt may either appear suddenly, without any prior symptoms of leaf yellowing or shows slow wilting accompanied by progressive yellowing. However, in Sudan, wilt accompanied by leaf yellowing appears to be the most common form of the disease. Mohamed et al. (2) have added another type of symptom, leaf margin burning, and this again has been observed in the present investigation. Other symptoms, viz. branch wilt, foot-rot and root-rot, are rarely reported elsewhere associated with wilt disease. Mohamed et al. (2) reported that wilt of muskmelon in the Sudan represents typical *Fusarium* wilt caused by *F. oxysporum* f.sp *melonis.*

It appears that organisms other than *Fusarium,* such as red melon beetle, termites and nematodes, may play an important role in aggravating the wilt disease beside their direct effect on the root system of muskmelon in the Sudan.

Table 1. Results of the survey of wilt disease in a 'Galia' field (total plant population-7032).

			No. of plants showing				
Rating No.	**Date**	**Vascular discoloration**	**Foot-rot**	**Root-rot**	**Insect damage**	**Total no. of wilted plants**	**(%)**
1	Nov. 11	-	-	-	-	46	0.65
2	Nov. 28	-	-	-	-	67	0.95
3	Dec. 4	-	-	-	-	86	1.22
4	Dec. 8	50	13	13	20	96	1.37
5	Dec. 13	59	19	11	34	123	1.75
6	Dec. 18	386	89	19	32	526	7.48
7	Dec. 23	267	69	19	19	374	5.32
8	Dec. 28	319	53	6	20	398	5.66
Total		1081	243	68	125	1716	24.40
(%) [y]		71.26	16.02	4.48	8.23		

[z] The first three readings were taken without classification of the symptoms.

[y] The percentages of wilt according to the symptoms were calculated from the total of wilted plants (1517) in the last five readings.

Table 2. Results of the survey of wilt disease in the 'Ananas' field (total plant population-1804).

			No. of plants showing				
Rating No.	**Date**	**Vascular discoloration**	**Foot-rot**	**Root-rot**	**Insect damage**	**Total no. of wilted plants**	**(%) of wilted plants**
1	Jan. 13	30	29	11	26	96	5.32
2	Jan. 18	27	18	4	12	61	3.38
3	Jan. 22	33	11	4	10	58	3.22
4	Jan. 28	143	6	0	18	167	9.26
Total		233	64	19	66	17.28	21.13
(%)		60.99	16.75	4.97	17.28		

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Melon Dieback: Effect of Thermic Stress and Inoculum

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Melon dieback is a serious disease affecting melon, and has been responsible for severe economic losses in many areas of Spain since the early 1980's (1).

With the aim of developing a method that allows the screening of materials with tolerance to melon dieback, we conducted a trial using a field resistant and highly susceptible cultivar. We also tested the hypothesis observed by several farmers that the appearance of melon dieback is linked to low temperatures just after transplant. This is supposed to be independent of the temperature during the other development stages.

The cultivar with field resistance ('Pat 81') and the susceptible control ('BG 13.819') were cultivated in 12 L pots. The pots were filled with soil obtained from plots with high incidence of melon dieback and in which *Acremonium cucurbitacearum* was found in former years. This soil was subjected to the following four treatments before filling the pots:

- Sterile control: autoclaved soil.
- Naturally infested soil: no treatment was given to the soil.
- Artificially infested soil: An isolate of *A. cucurbitacearum* (100,000 propagules per g of soil) were added to the soil sterilizing by autoclaving (2).
- Naturally plus artificially infested soil: An isolate of *A. cucurbitacearum* (100,000 propagules per g of soil) were added to the naturally infested soil.

Each variety x inoculum level was tested under two temperature regimes. One of them consisted of optimum thermic growing conditions. In the second regime, plants were grown during 6 days under a low temperature stress (7-12 C minimum temperature), 6 days after transplanting.

Starting 110 days after transplanting, aerial biomass (g), vine length (cm), and disease severity in the roots (RI) were recorded. RI was scored on a 0 (healthy) to 5 (very lesioned or necrotic) scale. In this scoring system root development, discoloration, corking, rootlet losses and necrosis were considered. A similar system has previously been used by other researchers (3). In some plants of each treatment, fungi associated with the affected areas were studied after isolation.

Results obtained did not show significant differences between the temperature regimes (Table 1), therefore results from the temperature regimes were combined (Table 2). Disease severity in roots is the best criterion for distinguishing among accessions and inoculation treatments. The naturally infested soil treatment caused 34% reduction in biomass in 'Pat 81' and 46% in 'BG 13.819'. Decreases in length of the vine were 5 and 28%, respectively. The resistant cultivar showed less damage than the susceptible one, although these differences were not significant with the experimental design used. However, RI scores were significantly different.

The effect of inoculation with 100,000 propagules of *A. cucurbitacearum* per g of soil on plant development and root system was slight in both cultivars. The effect of natural infestation was more severe. The treatment with both artificial and natural infested soil was not significantly different than the natural infestation only treatment.

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Table 1. AVOVA for disease severity in roots (RI), aerial biomass production and vine length.

		z		

Source of variation	df	RI		Biomass (g)		Vine length (cm)	
		Mean square	F ratio	Mean square	F ratio	Mean square	F ratio
Inoculum (I)	3	8058	765.1**	169077	24.1**	149	6.6**
Cultivar (C)	1	2813	267.1**	111	0	10	4
Temperature (T)	1	1	1	17293	25	10	5
I x C	3	573	54.4**	9531	14	83	37
I x T	3	21	19	6525	9	58	26
C x T	1	8	7	8825	13	16	7
I x C x T	3	45	4.2**	11358	16	34	15

[z] RI=root disease index, 0 (healthy) to 5 (very lesioned or necrotic).
*.** Significant at P 0.05 or 0.01, respectively.

Table 2. RI, aerial biomass production (g) and vine length (cm) for each treatment and cultivar.

	RI [z]		Biomass (g)		Vine length (cm)	
	BG 13.819	Pat 81	BG 13.819	Pat 81	BG 13.819	Pat 81
Control [y]	0.11aA[x]	0.03aA	373.58 a. A	368.58 aA	277.1 aA	233.2 aB
Artificial I.	1.27bA	0.89bB	348.23 aA	305.14 abA	260.9 aA	242.0 aA
Natural I.	3.98cA	2.34cB	200.44 bA	242.58 bA	200.2 bA	221.4 aA
Nat. + Art. I.	3.98cA	2.32cB	223.43 bA	242.00 bA	215.6 bA	237.4 aA

[z] RI = root disease index, 0 (healthy) to 5 (very lesioned or necrotic).

[y] Control = sterile soil, Artificial I. = artificial inoculum (100,000 propagules/g), Natural I. = naturally infested field soil, Nat. + Art.I. = naturally infested soil with 100,000 propagules/g of *A. cucurbitacearum* added.

[x] Numbers in the same column/row followed by the same small/capital letter are not significantly different at the P=0.05 level.

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A Suspected Plasmagene as the Cause of a New Melon Mosaic Disease in China.

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The melon mosaic disease described in this note was first observed in Gansu, China, in 1983. The frequency of the disease was less than 1/60,000 plants in a large melon field, but was found in 66.7% of the plants in one breeding line in our experimental plots. The symptoms were different from those of other mosaic diseases caused by cucumber mosaic virus (CMV), watermelon mosaic virus, and other viruses. In 1986-1988, isolation cultures and filtrates of diseased tissue were screened microscopically, and no fungi, bacteria or nematodes were observed. Neither rubbing the inoculum on plants nor aphids spread the disease. Transmission appears to be only through seeds of diseased plants. Previously, seeds from diseased plants were treated with hot water (60 C, 10 min), AgNO 3 (1%), Na 2PO 4 (10%), mercuric chloride (0.1%), and high temperature (73C, 96 hr), but did not cause remarkable differences in the rate of disease (4). We are using this strain to study the expression characteristics and genetics of the disease.

Materials and Methods. Diseased plants were divided into three types based on expression characteristics: (1) “Mosaic,” the most common type (Figures 1A and 1B), with yellow spots of varying sizes in the green tissue of the leaves, and with a clear dividing line between yellow and green. If there were only a few small spots on the leaves, this plant type would grow regularly. If there were many and large spots, or dense small spots, the plants did not grow regularly, sometimes without producing fruits or blossoms. (2) “Inlay” (Figures 2A and 2B), where half or less of leaves were yellow or white, from the leafstalk along the middle or the lateral leaf vein. Sometimes whole leaves or lateral vines were white. Most of these plants could grow regularly, but some were too weak to grow and blossom. (3) “Albino,” where whole cotyledons in seedlings were white, and died about one week after emergence. Albinos arose from seeds with white lateral vines.

In the experimental field, plants with the different types of mosaic disease expression were self-crossed, as well as crossed to normal (cv. Huanghe Honeydew) plants, reciprocally. Seeds were planted individually the following year.

Results and Discussion. The results are presented in Table 1. There was no transmission of the disease when the male parent alone was affected by the symptoms. Among the progeny, the disease symptoms were more serious and the incidence of diseased plants greater when the female parent was affected by the melon mosaic disease. Diseased plants were not found among progeny when the maternal parent was symptomless. Mosaic progeny were observed when the maternal parent expressed either the mosaic or inlay types of the disease. It is postulated that this melon mosaic disease is caused by a plasmagene.

Table 1. The incidence of melon mosaic disease among progeny from parents with different expressions of the disease.

Crossees, including the expression type in the parents	Number of plants	Number of diseased plants	Incidence of disease (%)	Remarks
Normal x mosaic	103	0	0	
Mosaic (slight) x normal	68	14	20.6	
Mosaic x normal	51	24	47.1	
Mosaic (self-pollinated)	63	31	49.2	
Inlay (self-pollinated)	68	6	8.8	Seeds from green sectors on the vine.
Inlay (self-pollinated)	51	24	47.1	Seeds from inlaid green and yellow sectors of the vine.
Inlay (self-pollinated)	55	55	100	Seeds from white (albino) sectors of the vine.
Normal (self-pollinated)	50	0	0	Seeds from disease free plants of a diseased strain.

Figure 1A. An example of the mosaic pattern, with yellow spots in the green leaf tissue.

Figure 1B. Another example of the mosaic pattern, ranging from slight (plant on left) to serious (plant on right).

Figure 2A. An example of the inlay pattern, where whole leaf sections are yellow or white.

Figure 2B. Another example of the inlay pattern on melon leaf tissue.

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Figure 1A. An example of the mosaic pattern, with yellow spots in the green leaf tissue.

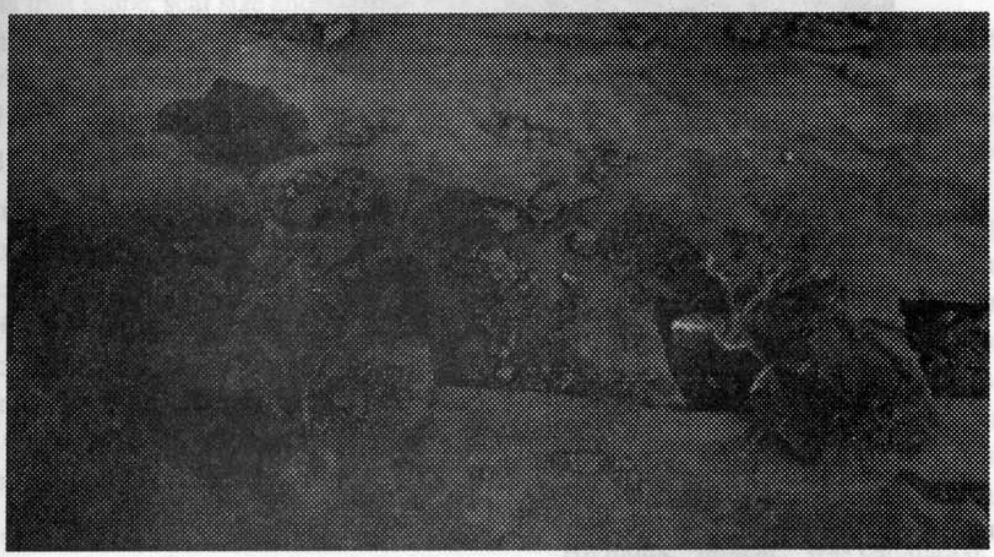

Figure 1B. Another example of the mosaic pattern, ranging from slight (plant on left) to serious (plant on right).

Figure 2A. An example of the inlay pattern, where whole leaf sections are yellow or white.

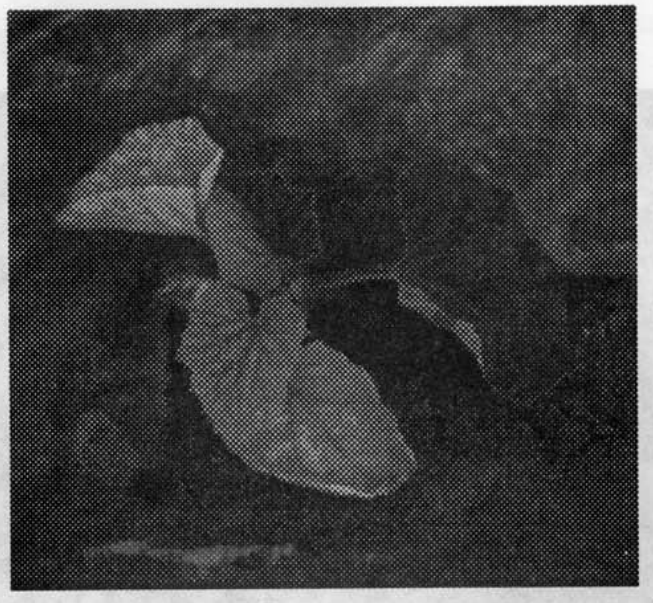

Figure 2B. Another example of the inlay pattern on melon leaf tissue.

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Discriminating Fruit from 3n and 4n Vines in Progeny of an Open Pollinated 4n x 2n Melon

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Triploid melon are not seedless (1,3). Observation that triploid fruit were firmer at full slip indicates there may be post-harvest advantages to working with triploid fruit. There were also observations made that polyploidy melon may have better tolerance to foliar diseases. It is difficult to make seed from hand pollination of tetraploid melons with diploid pollen (Adelberg and Nugent, unpublished data). The following study attempts to lay a foundation for working with mixed 3n and 4n populations in the filed, as a means to identify genotypes pairs to make triploid hybrids and conduct post-harvest evaluation of fruit.

4n x 2n progeny are categorized as tetraploid or triploid by viability of seed in progeny fruit. Fruit with less than 10% viable seed will e classified as triploid, greater than 10% are classified as tetraploid. This classification was applied, retroactively, to more common screening techniques such as fruit shape, scar size and fruit size. Other classification schemes to distinguish ploidy, such as seedling cotyledon shape, pollen morphology, and a new index termed “fatxcar” (scar size/shape) were verified or refuted using seed viability data.

Materials and Methods. Experiments were conducted on an autoploid series (2n, 3n, 4n) of B-line and ‘Planter’s Jumbo’ (P. Nugent, USDA Vegetable Lab, Charleston SC) in a completely randomized design. Experiments for heterosis and ploidy effects between ‘Planter’s Jumbo’ (PJ) and ‘Green Ice’ (GI) were conducted using GI 2n and 4n PJ, diploid hybrid PJ x GI [2n (PJ x GI)], and triploid hybrid PJ x GI [3n (4n PJ x GI)].

Tetraploid melon were bee-pollinated when surrounded by flowering diploid plants (open pollinated [OP] 4n x 2n). This seed, and seed of tetraploid parents, were germinated at 30C in vertical rolls of germination paper. After 4 days, seedlings were transplanted to a Todd 200 planter in the greenhouse. Diploid seed were directly germinated in a Todd 200 planter.

Seedlings of 4n x 2n were screened as tetraploid or triploid at seedling stage based on cotyledon shape. Broad, rounded cotyledons were assumed to be from tetraploid seedlings and narrow, mottled cotyledons were assumed to be from triploid seedlings.

Transplants were placed in the field the first week of May 1996. The field had been bedded, and a subsoil trench was laid with palletized chicken manure (4-2-2), on center, as the only fertilizer application. Transplants were provided with trickle irrigation at 0.76m spacing, by planting at emitter sites. Rows were 1.83m apart, and 3 subplots of 12-20 hills (depending on germination) were repeated in the field design. Field design also placed triploid or hybrids adjacent to their diploid and tetraploid parents.

Pollen was collected on June mornings and fixed in refrigerated 70% ethanol and examined at 100X for determination of ploidy, based on uniformity, shape and size of starch filled grains. Estimates were made of the number of triploid plants in (4n x 2n) populations.

Fruit were harvested at skip twice a week, July 9 through August 9. Fruit were weighed, and their circumference measured lengthwise with string (scar to scar) and equatorially (width). Fruit shape ratio was quantitatively described by dividing longitudinal and equatorial circumference. This was directly compared to an invasive method of slicing fruit and dividing internal diameter dimensions. Blossom scar was measured with a string. Soluble solid (% brix) was measured with a hand-held refractometer. Seed were removed and dried (all fruit had many seed). Fifty dried seed per fruit were imbibed on vertically rolled germination paper and percentage germination was recorded after 4 days at 30C.

An index, “fatxcar,” was calculated, where scar size was divided by fruit shape ratios. The intention was to emphasized the scar size of oblate fruit and shrink scar sized of long fruit, so that triploids and tetraploids can be separated in field evaluations using non-invasive means.

Data were tabulated per fruit. Putative triploids and tetraploids from 3n and 4n seeds were separated based on an arbitrary criterion that tetraploids germinate greater than 10% and triploid germinate less than 10%. This criterion was established prior to the analysis.

Results. *Screening ploidy prior to fruit set.* When 4n x 2n seedlings were separated based on cotyledon shape, 29% of the putative 3x seedlings were triploid from the germination test. This figure was appropriate for both PJ and B. For PJ and B, 19% and 35% respectively, were triploid in progeny that were screened as tetraploids. Cotyledon shape *was not* useful to distinguish 3n and 4n progeny at seedling stage.

Pollen morphology showed triploid plots of B to contain 27% triploid plants, and PJ contained 48% triploid plants, as compared to 29%, from the germination test. Single hill harvests would be necessary to draw a tighter correlation but were not conducted. Pollen morphology as a field screen of a mixed population prior to harvest would be logistically difficult.

Fruit of Autoploid Series (Table 1).

1. Autotriploid fruit is intermediate in size between diploid parent (large) and tetraploids parent (small) for both genotypes.
2. Soluble solids was not improved in either autotriploid. Effects are specific for genotype and should not be generalized for ploidy.
3. Autotriploids take longer to mature than either diploids or tetraploids.
4. Fruit shape ratios can be quantified by non-destructive means (circumference with string) and was used to describe ploidy differences. 3n and 4n were not distinguishable. The invasive method of internal diameters did not give any more precision in separating 3n and 4n (data not shown). Differences between shape determined by circumference and internal diameter, showed fruit was estimated to be longer by circumference. Diploids were estimated 2% longer and polyploids were estimated 8 and 9% longer, respectively. There is a 75% chance that this error is randomly applied to tetraploids and triploids (paired t-test), and therefore using circumference, as opposed to internal diameter, would not bias these distinctions.
5. Blossom end scar is intermediate in autotriploids between small (diploid) and large (tetraploid) scar sizes. Distinction of3n and 4n, made by blossom end scar size, had 5% chance of error (paired t-test). Increasing this difference by fatxcar index, reduces the error in 3n and 4n distinction, to 3% (paired t-test). This small math trick reduced the probability of type I errors by 40% in this data set.
6. Yield was not estimated due to the low percentage of 3n in mixed progeny rows.

Heterosis and Ploidy Effects on Fruit Qualities (Table 2).

1. Diploid PJ were larger than diploid GI. Diploid PJ x GI were the same size as the larger parent. Tetraploid PJ is the same size as GI. The triploid hybrid PJ x GI and the autotriploid PJ were the same size as their parents. Heterosis was not observed for fruit size.
2. Soluble solids in diploid PJ x GI is higher than either parent, a heterotic response. The triploid hybrid were the same as parents, similar to triploid inbred. Heterosis at 3n Ploidy was not observed.
3. Diploid PJ x GI were earlier in maturity than diploid parents, a heterotic response. Triploid hybrid and inbred are likely to mature after their parents. Heterosis was not observed at higher Ploidy.
4. Estimated shape can distinguish diploids from polyploids, regardless of background. 3n and 4n were not distinguished. Internal diameter did not make better distinctions (data not shown).
5. Scar will only distinguish diploids from polyploids. Losing the ability to separate 3n PJ from 4n PJ was an artifact of fewer internal replications in the one dimensional analysis, compared to factorial in Table 1. This casts doubt on utility of scar character in simple field experiments. Heterosis possibly creates larger scars in diploid hybrids compared to diploid parents, which can only become a worse problem for discrimination of triploid and tetraploid.
6. Fatxcar index does not help the situation in 5. Yield was not estimated due to the low percentage of 3n in mixed progeny rows.

Conclusions. June and July 1996 were atypically dry with two brief periods of light rain, and foliar disease was not observed on any plots. Post-harvest evaluations of triploids melon would require separating 3n and 4n fruit in the field at time of harvest. We have not found a satisfactory way to make this distinction. Two options we will follow in future work are: 1) conduct field trials on methods of hand-pollination techniques for tetraploid females with diploid parents, and 2) create new tetraploid populations, with recessive fruit characters to diploid parent (e.g., smooth skinned, white fleshed tetraploids for hybridization with netted orange diploids) for easy field discrimination of 3n and 4n.

Heterosis does not occur in all parental combinations. In this study we had parents which were heterotic as diploids, but were not heterotic at higher ploidy. The fruit of diploid hybrid PJ x GI was sometimes bicolor. Salmon (orange) is generally thought to be dominant to green. We have made previous observations in other triploid hybrids, where an orange fleshed tetraploid from a diploid hybrid of orange and green, when backcrossed to the green parent, produces green triploid progeny (2,3). This poses a dilemma when proposing the easy field discrimination of 3n and 4n by fruit characters.

Table 1. Progeny of OP audoploid 4n x 2n melon, with diploid and tetraploid parents, in Kiwi field at Musser Farm,. Oconee county, SC, 1996. Less than 10% germination on paper in an incubator at 30 C was criterion used to distinguish 4n from 3n.

Ploidy and Genotype[z]	Mean fruit weight (kg)	Soluble solids (% brix)	Days to harvest (post transplant)	Fruit shape[y]	Blossom scar (mm)	Fatxcar[x] (Scar/shape)	Germination (%)
2n PJ	1.72	10.9	86	1.04	31	30	69
3n PJ	1.32	10.2	91	0.97	46	48	4
4n PJ	1.22	9.6	86	0.97	54	55	24
2n B	1.36	12.7	84	1.03	39	38	81
3n B	1.04	12.3	90	0.94	64	68	2
4n B	0.77	12.6	85	0.93	70	75	27
	Probability > F from Analysis of Variance						
Ploidy (P)	0.0000	0.0175	0.0035	0.0000	0.0000	0.0000	
Genotype (G)	0.0001	0.0000	0.0340	0.4360	0.0167	0.0176	
P x G	0.3019	0.0249	0.4651	0.0030	0.1366	0.0188	

[z] PJ='Planter's Jumbo', B=B-line.

[y] longitudinal circumference/equitorial circumference.

[x] an index calculated by scr size/fruit shape ratios

Table 2. Progeny of hybrid and polyploid hybrid melon from 4n x 2n o.p. cross, grown in Kiwifield at Musser Farm, Oconee County, SC, 1996. Less than 10% germination on paper in incubator at 30 C was criterion used to distinguish 4n from 3n.

Ploidy and Genotype[z]	Mean fruit weight (kg)	Soluble solids (% brix)	Days to harvest (post transplant)	Fruit shape[y]	Blossom scar (mm)	Fatxcar[x] (Scar/shape)
2n PJ	1.72a[w]	11.0b	97bc	1.04a	31.7a	30.6a
2n GI	1.22c	11.2b	89bc	1.03a	28.2a	27.8a
2n (PH x GI)	1.63ab	12.9a	82a	1.05a	33.1a	31.8a
3n (PJ x GI)	1.18bc	9.9bc	91bc	0.96b	55.8b	58.2b
3n PJ	1.32bc	10.5bc	92c	0.97b	46.3b	47.5b
4n PJ	1.22c	9.9c	85ab	0.97b	53.6b	55.1b

[z] PJ='Planter's Jumbo', GI='Green Ice'.

[y] longitudinal circumference/equitorial circumference.

[x] an index calculated by scar size/fruit shape ratios.

[w] a,b,c, denote differences between means within columns as determined by Tukey's Honestly Significant Difference test, with slpha = 0.05.

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Cucurbit Genetics Cooperative Report 20:45 (article 19) 1997

Honey Bees Waste Time on Triploid Male Flowers

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Adlerz (1) reported that 8 honey bee visits are necessary to effect fruit set on diploid watermelon. Although a large number of male flowers exist on diploid pollenizer rows in a triploid field, the preferred ratio of diploids: triploids seems to be 1:10. If a ratio of 1:2 or higher could be pollinated effectively, the grower would realize a greater return.

In 1996, we evaluated pollination on triploid plants in an effort to measure how many honey bee visits are necessary to produce fruit set on triploid plants.

Materials and Methods. Alternating row segments of four diploid and three triploid plots, each with 7 plants, were transplanted at the Clemson University Musser Farm. The female flowers of the triploid plants were covered in the evening and uncovered the next morning to count and time bee visits to the female flowers. Adjacent to this small plot was a planting of three diploid, five tetraploid and 15 triploid hybrids from these parents for evaluation. A hive of honey bees was transferred to the middle of an outside row after plants began to bloom.

Four-channel stopwatches were used to measure the duration of bee visits, and paper covers were used to close female flowers the evening before opening. The number of bee visits were controlled by uncovering the flower and allowing 0-16 visits before closing. We measured visits and times for only honey bees on most flowers and visits and times for a small wild bee.

We observed that bees spent a large amount of time on the male flowers of the triploids. These male flowers are normal in appearance even though they are virtually devoid of pollen. Nevertheless, the bees were not only attracted to the functionless males but spent time there. We decided to measure just how much time was being spent on the triploid males as well the triploid females. We also decided to expand our study of male and female flowers to 22 more triploid plants in adjacent plots. By taking 10 min samples of bee activity on each triploid plant, we were able to sample variability among varieties and across the field. We also counted the number of open male and female blooms on each plant each day of observation to estimate total plant activity.

Results and Discussion. It was difficult to to obtain more than 10 honey bee visits in a single morning from 7-11 a.m. because of personnel schedules and the lack of bee activity during the pollination of the small 7 x 7 plot. Consequently, the number of bee visits necessary for fruit set was determined on only a single fruit. The only controlled triploid fruit set was obtained from 10 honey bee visits, but large numbers of abortions at equal or higher numbers of visits suggests that this single figure is low.

A very small wild bee was a very frequent visitor to the female flowers, but large numbers of carefully monitored visits did not result in fruit set. A few bumblebees were pollinators, but their effectiveness was not measured.

Bees made more visits and spent more time on triploid males than on triploid females. Bees spent 161 sec per triploid plant on the male flowers and only 23 sec per triploid plant on the female flowers. On this basis we speculate that an increase in triploid plants in a production field simply increases the amount of time wasted by the *Apis* bees. This wasted time does not appear to be beneficial to either the bees or to triploid production. Our observations suggest that a gynoecious triploid hybrid may prove more productive.

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Cucurbit Genetics Cooperative Report 20:46-47 (article 20) 1997

Bisex Sterility Governed by a Single Recessive Gene in *Cucurbita pepo* L.

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Bisex genetic sterility has been reported for both *Cucurbita pepo* L. (1) and *C. maxima* Dutch. (2). In *C. pepo* male flowers had rudimentary anthers containing no pollen and female flowers appeared normal but aborted a week after anthesis regardless of sib or cross pollination. In *C. maxima*, male flowers had stiff short petals and rudimentary anthers containing no pollen; the female flowers appeared normal but set fruit parthenocarpically by either controlled or natural pollination. In both *C. pepo* and *C. maxima* segregation ratios supported single recessive gene models for bisex sterility, designated s in *C. maxima.* Unfortunately genetic stock for either of these sterilities is no longer available.

During the Fall 1996 pollination season, male sterile plants were observed in a F8 *C. pepo* lines, YSN531PMR. The androecium of the male flowers failed to develop, appearing as a small green nub at anthesis. Five out of 15 plants were male sterile, suggesting a single gene heterozygote had been selfed in the previous F7 generation. Self pollinations were obtained on 9 of the fertile plazNts, and sibling pollinations (sterile x fertile) were made on all 5 male sterile plants. The fertile plants produced fruit and seed as expected. The sterile plants, however, set fruit parthenocarpically with no seed found in sibling or naturally pollinated fruit.

Thirty seed each of the original F8 line and the 9 F9 fertile selfs were sown in the Spring of 1997. The resulting plants were classified at peak bloom based on male flower development. Sterile plants were recovered in 6 of the 9 F9 lines, indicating that 2/3 of the 1996 normal F8 plants were heterozygous as would be expected if the F7 progenitor was a single gene heterozygote (25 plants, P.99 for correct classification of single recessive gene). Using 3:1 expected ratio, chi-square analyses were performed on the pooled (1996-97) F8 segregation data and the 6 segregating F9 lines. All populations fit a single gene recessive model (Table 1).

Phenotypically, sterility in YSN531-PMR resembles the bisex sterilities cited by previous investigators; the androecium is rudimentary, female flowers appear normal, but no viable seed are obtained by controlled or natural pollination. In the absence of available stocks to test allelism, assignment of gene symbol *s-2* is appropriate. The association of parthenocarpy and sterility in YSN531-PMR has yet to be determined. Parthenocarpy has been observed in other fertile UF/CFREC breeding lines; it is likely happenstance in YSN531-PMR rather than a pleiotropic effect of sterility. Stock of YSN531-PMR segregation for sterility will be increased and made available to interested investigators as well as to the gene curators.

Table 1. Sterile segregation in an F8 *Cucurbita pepo* line, YSN531-PMR, and in the F9 lines derived from fertile F8 plants.

Line	Phenotype		Frequency	1:3	
	Sterile	Fertile	Sterile	$X^{2\,z}$	P
F_8^y	9	27	0.25	0.00	>.99
F_9#1	4	20	0.17	0.89	.50-.25
F_9#2	10	19	0.34	1.39	.25-.10
F_9 #3	4	21	0.16	1.08	.50-.25
F_9#4	8	19	0.30	0.31	.75-.50
F_9 #5	5	22	0.19	0.60	.50-.25
F_9#6	9	20	0.31	0.56	.50-.25
F_9 Combined	40	121	0.25	0.00	>.99
Homogeneity				4.83	.50-.25

[z] X^2df: individual; 1:F_9 combined, 1: F_9 homogentity, 5.

[y] F_8 data combined from 1996 (5 sterile, 10 fertile) and 1997 (4 sterile 17 fertile) plantings.

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Cucurbit Genetics Cooperative Report 20:48-49 (article 21) 1997

Cuban Pumpkin Genetic Variability under Low Input Conditions

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Introduction. Genetic improvement of crop yields under marginal conditions suffers from many practical problems. One of them is to find varieties tolerant to the interactions among the different kinds of stresses resulting from temperature, drought, salinity, pests and diseases. Is it possible to select any varieties with these characteristics? How important are landraces in this process?

Cuban pumpkin (*Cucurbita moschata* Duch) is an interesting model. This crop is popular for culinary and medical properties, taste, -carotene content, and is also used in African religious ceremonies. Nonetheless, yields have proportionally declined in Cuba as crop input levels have decreased over the last 10 years. That is why pumpkin has disappeared from virtually every market (Rios et al., 1994, 1996). However, one genotype has been cultivated all over the island, even though it was developed under high-input conditions.

The aim of this paper is to show the role of landraces as an important genetic source for tolerance to marginal conditions.

Materials and Methods. Thirty four landraces of *C. moschata* from different Cuban sources were sown under low input conditions with neither chemical fertilizer nor chemical pest and disease control. Filter cake was used as organic fertilizer at the rate of 12 kg to a pair of plants. The experiment had 21 plants per genotype distributed in 3 replications, using plant spacing of 1m and 8m between rows. The plots were made up in a single row with 8m long and 8m wide.

In order to cluster the landrace collection according to qualitative and quantitative characters, factorial correspondence multivariate analyses were applied. Traits observed were yield and its components, and selected characteristics of fruits and leaves according to Esquinas and Gulick (1983). This experiment was carried out in the Research Institute of Fundamental Tropical Agriculture (Havana).

Results and Discussion. Among the 34 landraces, 25 were able to produce fruit. It is important to note that the majority of these genotypes fruited between 80 and 110 days. Cuban germplasm can therefore be an important genetic source for earliness, since even in tropical areas it is common to find genotypes with a crop cycle longer than 160 days (Lyra, 1992). Such lengthening could be associated with genetically determined adaptative or escape mechanisms relative to marginal conditions (Ceccarelli, 1994).

Among the characters evaluated, primary skin color and yield had the most important contribution to genotype clustering, and six clusters were identified (Table 1).

Table 1. Clustering of 34 Cuban pumpkin landraces according to skin color and yield.

Clusters	Characteristics	Genotype Clusters
1	High yield and green fruits	P-1388, P-828
2	High yield and yellow or brown fruits	P-550, P-130
3	Medium yield and brown,yellow or gray fruits	P-1461, P-1118, P-30
4	Medium yield and green fruits	P-1523, P-1411, P-1043, CRISOSTOMO, P-1029
5	Low yield and yellow or brown fruits	P-909, P-1175, P-900, RG*, P-826, P-1377
6	Low yield and green fruits	P-1188, P711, P-1974, P-1027, P-1189, P2002, P-1442, P-39

*Commercial variety

The predominant fruit types were the piriform and crookneck type. Elongate, globular and flat shapes were scarce. Yield per plant showed a large variability between landraces, ranging from 0.5 kg up to 18 ton/ha. The principal yielding varieties had medium-sized fruits (2.5-3 kg) as well as more than 4-5 fruits per plant.

In general terms, the genetic variability found was within the species' boundary, because no deviation was observed even though *C. moschata* is cross compatible with other species of *Cucurbita.* It may be that other *Cucurbita* species do not tolerate the Cuban climate,, which is characterized by two periods: a high temperature period with some rainfall and a low temperature period with drought. The morphological variability under marginal conditions could be related to different low-input pumpkin genotypes brought to Cuba before Colombus (Perez Guzman, 1993). Probably, they were brought to Cuba by indigenous tribes through The Caribbean Sea from Central and South American, as has been theorized with other traditional crops

such as beans (Castineira, 1992).

In summary, germplasm variability among landraces of Cuban pumpkin could be an essential resource for breeding plants for low-input environments.

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Cucurbit Genetics Cooperative Report 20:50-52 (article 22) 1997

Response of Cuban Pumpkin (*Cucurbita moschata Duch)* to Abiotic and Biotic Stress Interactions

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Maynard (1996) recently reported on the promising potential for developing high-yielding pumpkin hybrids when grown under high-input cropping conditions. He showed that heterosis could be used as a straightforward means to increase pumpkin yield per area. On the contrary, under the low-input cultural conditions common in Cuba, a different breeding strategy must be used and pumpkin cultivars should be developed under conditions of stress and stress interactions interactions. That is why a collection of germplasm resistant or tolerant to marginal environments has been an essential issue for Cuban pumpkin breeders. The aim of this paper is to show the role of landraces as an important source of genetic material for tolerance to marginal growth conditions, and to show how a simple selection method was able to combine genes for a sustainable response to biotic and abiotic stress interactions under Cuban cultural conditions.

Materials and Methods. Nine selected lines were developed from Cuban landraces using recurrent selection with testing of open pollinated sib families. The lines were cultivated on farms providing latosolic soils and different abiotic and biotic stresses. Performance was determinated on the basis of yield as well as the occurrence of silvering leaves (Paris, 1987) and downy mildew infection (Ciba Geigy, 1984).

Taking into consideration Fernandez/s criteria (1993), the genotypes were classified according to their reaction to abiotic stresses as follows:

- Group A: Genotypes performing favorably under high temperature and drought stresses.
- Group B: Genotypes perform favorably under high temperature stress and poorly under drought stress.
- Group C: Genotypes performing poorly under high temperature stress and favorably under drought stress.
- Group D: Genotypes performing poorly under both abiotic stress conditions.

In addition, yield was plotted against genotype infection indexes for silvering leaves and downy mildew symptoms under naturally high disease conditions to characterize their biotic stress performance. Genotypes were classified according to these criteria as follows:

- Degree 1: Genotypes having a high infection index to downy mildew and silvering leaves (GROUP A).
- Degree 2: Genotypes having a high infection index to downy mildew and high infection index to silvering leaves (GROUP B).
- Degree 3: Genotypes having a low infection index to downy mildew and high infection index to silvering leaves (GROUP C).
- Degree 4: Genotypes having a low infection index for both diseases (GROUP D).

Results and Discussion. For abiotic stress (i.e., heat and drought), genotypes G2, G3, and G4 had a high value of stress tolerance and were included in Group A (Figure 1). Group B was represented by G1 and G5; the first genotype had a medium and the second a low stress tolerance index value. There were no genotypes included in the Group C cluster. Genotypes G6, G7, G8, G9, and G10 were included in the D cluster, characterized by low tolerance to heat and drought

stresses. G10 has been marketed by a Cuban seed company nearly everywhere as a unique commercial variety.

Deviating performances were evident for genotypes G1 and G2, selected from landrace P-1523, and for genotypes G3 and G4, selected from landrace P-130. P-1523 was collected in The Isle of Youth and P-130 in San Juan y Martinez, Pinar del Rio. Both places posses dry soils and a rainfall regimen similar to the Cuban average. Thus, presumably, the different allelic series were linked and arose from natural selection to biotic and abiotic stress interactions under marginal conditions. Consequently, when breeding plants for marginal conditions it is important to test not only the landraces coming from there, but also those coming from other marginal environments. Evolution may have proceeded differently in the different locations.

Surprisingly, genotypes G2 and G4 had the highest yield (Figure 2) despite their high infection index to silvering leaves and downy mildew. Previously, both genotypes had performed well under abiotic stress conditions. Thus, it is also important in a breeding program to look for this response to marginal conditions, since a sustainable linkage to biotic and abiotic stresses would be the desired means to increase yields and to reveal responses that might be very difficult to observe under high-input agriculture.

The authors gratefully acknowledge the manuscript suggestions carried by Dr I. Boz from Plant Breeding Department of Wageningen.

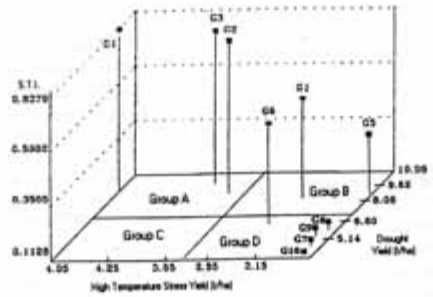

Figure 1. Response of pumpkin lines from Cuban landraces to different abiotic stresses.

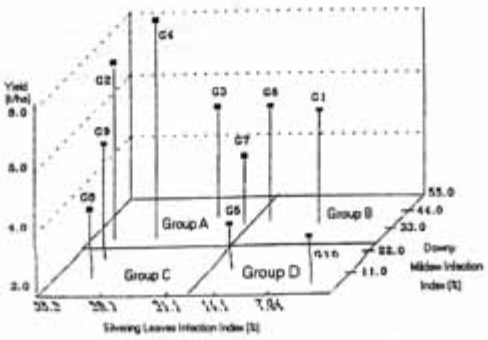

Figure 2. Response of pumpkin lines from Cuban landraces to different biotic stresses.

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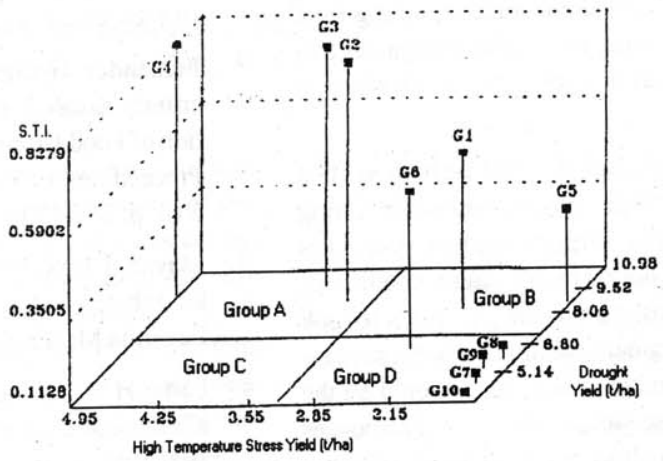

Figure 1. Response of pumpkin lines from Cuban landraces to different abiotic stresses.

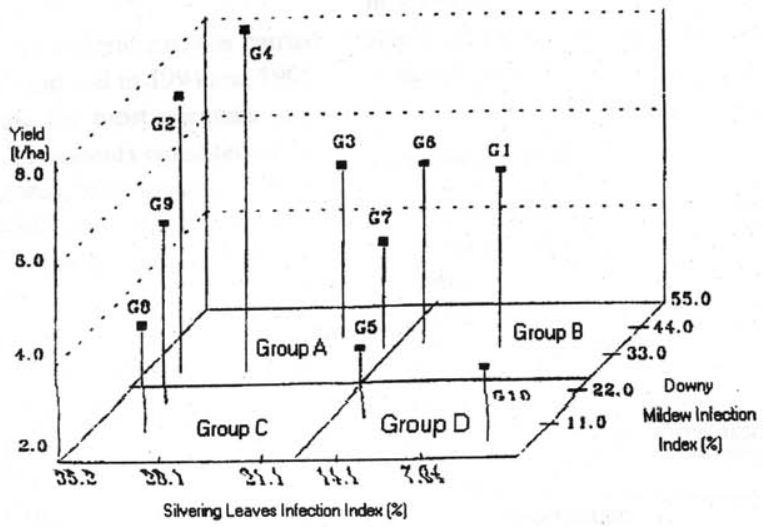

Figure 2. Response of pumpkin lines from Cuban landraces to different biotic stresses.

Cucurbit Genetics Cooperative Report 20:53 (article 23) 1997

Different Crop Association Systems with Pumpkin (Cucurbita moschata Duch.) cv. Mariucha

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In Cuba, pumpkin yields have decreased in recent years to 1.3 t/ha, due to the abiotic stress conditions of this period. This has resulted in a reduced cultivar spectrum in pumpkin, and a decreased in the consumption of ß-carotene (provitamin A) by the people. (Similar yield decreases have been observed in watermelon.) Therefore, pumpkin cultivars such as 'Mariucha' have recently been developed at the National Institute of Agricultural Sciences (NIAS). NIAS is also studying the effects of seed spacing, plant populations, preceding crops and crop cultures, green manures and intercropping, in order to improve the crop technology for pumpkin.

Intercropping is a way of potentially increasing total land use during the pumpkin production season in Cuba. The aim of the current research was to study the effect of different crop associations with pumpkin, as it is feasible to be cultivating in wide planting frames.

Materials and Methods. An experiment was carried out on a compacted Red Ferratic soil in 1994 and 1995, with the objective of finding the most adequate crop association with pumpkin. Treatments consisted of using peanut (*Arachis hypogaea)*, sweetpotato (*Ipomea batata* lin.) cv. CENSA 78-345, and corn (*Zea mays)* in association with pumpkin. These crops were seeded or planted one month after pumpkin in a randomized block design with three replicates. Pumpkins were spaced 1.8 x 3.0 m. Peanut plants were spaced at 0.9 x 0.3 cm, and sweetpotato and corn were spaced at 0.9 x 0.25 cm, on either side of the pumpkin rows.

Results and Discussion. Yields of peanut, sweetpotato and corn, alone and in association with pumpkin, are listed in Table 1. The three association showed a land equivalent index (LEI) greater than 1.0, making it evident that the polycultures surpassed the respective monocultures. In particular, the peanut association was 82% higher than its separate monoculture. There was also a lower occurrence of main pests when pumpkin was grown in association with these crops.

These results illustrate the potential for improving the use of a agricultural lands in Cuba by growing crops in association with pumpkin. It is also an alternative to devoting a large amount of land to potato production, since pumpkin and the other crops do not demand as much in the way of fertilizer. Also, these crops may be able to take advantage of the residual fertilizer remaining in the soil after a potato crop.

Table 1. Effect of intercropping on yield and land equivalent index of pumpkin and three associated crops in 1995.

	Yield (t/ha)			
Treatments	**Pumpkin**	**Peanut**	**Sweetpotato**	**Corn**
Pumpkin-Peanut	5.65	0.38		
Pumpkin-Sweetpotato	6.61		1.04	
Pumpkin-Corn	5.96			0.76
Pumpkin	5.54			
Peanut		0.47		
Sweetpotato			2.65	
Corn				1.95

SE	0.48 ns	0.03 ns	0.86 ns	0.45 ns
CV	16.1	13.3	93.7	65.9

The authors gratefully acknowledge the manuscript suggestions carried by Dr. I. Boz from Plant Breeding Department of Wageningen.

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Cucurbit Genetics Cooperative Report 20:54-56 (article 24) 1997

Screening for Silverleaf Resistance in Cucurbita Accessions

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During the past decade the silverleaf whitefly, *Bemisia argentifolii* Bellows and Perring (= *Bemisia tabaci,* 'B' strain), has become a serious pest of squash and pumpkins in the Caribbean Basin. Populations of this whitefly have increased dramatically in Florida and Puerto Rico since 1987. Whitefly-induced silvering on *Cucurbita* species was first observed in Florida in 1987 (5) and in Puerto Rico in 1989 (4). Since then, the silverleaf whitefly has become a problem in other areas as well.

Cultivars of *C. pepo* show varying levels of resistance to silvering (1,2,3). The purpose of this research was to screen a large number of plant introductions (PIs) from the U.S. National Germplasm System to identify silverleaf resistant is important since silvered plants are less vigorous and silvered fruit are commercially unacceptable. In addition, this germplasm may also be a source of silverleaf whitefly resistance.

Evaluations were done in 1992, 1995 and 1996 in Isabela, Puerto Rico in fields naturally infested by whiteflies. Plots were planted on 60 inch centers and consisted of six plants spaced 30 inches apart. Only the 1992 test was replicated (2 reps). Silverleaf was rated on a plot basis at 6 and 8 weeks post-plant using a 0 (symptomless) to 5 (completely silvered) scale. The tropical pumpkin (*C. m*oschata) cultivar 'Soler' was used as a check.

C. moschata: In 1992, 341 PIs were evaluated. Fifty seven PIs had a rating of 0.5 at 8 weeks. In 1996, 50 of those PIs were retested along with 79 previously untested accessions. In that evaluation 14 PIs remained almost free of silverleaf (Table 1). Six PIs (162889, 211996, 211999, 427214, 483345 and 512153) were highly resistant to silverleaf in both test years. PI 162889 is from Paraguay, PIs 211993, 211996 and 211999 are from Iran, PI 438579 is from Guatemala, PI 483345 is a F_1 hybrid from Korea, and the remaining accessions originated from the United States. PI 512153 is 'Tennessee Sweet Potato'. PIs 550689 to 550694 are a related group of crooknecks and butternuts including 'Canada Crookneck', 'New Hampshire Butternut' and 'Ponca Butternut'. 'Tennessee Sweet Potato' and 'Canada Crookneck' are U.S. varieties introduced in the 1800's (6), but not thought to be closely related.

C. pepo: In 1995, 350 PIs were evaluated but heavy rains kept the number of whiteflies low. As a result 251 (72%) accessions showed no leaf silvering at 8 weeks after planting. Nearly the same group (346 PIs) were again planted in February 1996. Although whitefly levels were very high at 6 weeks after planting, a large group of PIs had silverleaf ratings 1.0 at that date (Table 1). Silverleaf readings were not taken at 8 weeks since many plants had developed severe virus symptoms by the date. Resistant PIs originated mainly from Turkey, Iran, the former Yugoslavia and Mexico (although most of the *C. pepo* collection originated from those same countries). Both PI 234614 and PI 442791 are from South Africa and identified in the GRIN as 'Little Gem'. Paris et al. (2) observed that cocozelle and vegetable marrow summer squash groups, developed primarily in the Old World, were the least susceptible to silvering.

C. maxima: In 1995, 405 PIs were planted ut whitefly numbers were not sufficiently high to cause extensive silvering until January 1996. By then the plants had grown too large to distinguish between plots. In February, 1996 a portion (100 PIs) of the *C. maxima* were replanted. Only seven accessions were found to be resistant to silverleaf (Table 1). NSL 214307 is identified in the GRIN as originating in Florida while the other PIs are from Turkey, Saudi Arabia and Nigeria.

Adult whiteflies were observed on all accessions. Although no counts were take, some accessions with low silverleaf ratings had much fewer whiteflies compared to highly silvered plants which consistently had large numbers of whiteflies. An initial screening for silverleaf resistance allows the breeder to eliminate a large amount of germplasm and concentrate resources on a much more select group in the search for whitefly resistance. Resistant PIs have been selfed for continued silverleaf and whitefly evaluations.

Table 1. *Cucurbita* accessions showing a high level of silverleaf resistance at Isabela, Puerto Rico in 1996.

***C. moschata* (420 PIs tested)**					
162889[y]	211999[y]	483345[y]	550689	550691	550693
211993	427214[y]	512153[y]	550690	550692	550694
211996[y]	438579				
***C. pepo* (350 PIs tested)**					
165047	212214	311103	368603	420328	451853
169430	222786	344358	368605	442294	451854
169450	223354	357928	368609	442297	458730
174188	227298	357936	368615	442299	458731
176961	234614	357937	368616	442304	482593
204693	256063	357952	379309	442307	507888
206957	256064	357963	379310	442311	511982
212000	261610	357967	379311	442318	512188
212001	265560	368592	379314	442321	512189
212013	267664	368594	379316	442791	512192
212014	267756	368595	406679	449350	525181
212060	302418	368602			
***C. maxima* (405 PIs tested)**					
169470	182195	183259	249013	244704	NSL214307
169471					

[z] Mean silverleaf rating of 0 to 1 at six (*C. pepo, C. maxima)* or eight (*C. moschata)* weeks after planting. Silverleaf rated on a scale of 0 (symptomless) to 5 (completely silvered). Check 'Soler' (*C. moschata)* had a mean silverleaf rating of 2.8 at six and 4. at eight weeks after planting.

[y] Tested in 1991-92 and 1995-96.

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New American Summer Squash Cultivars Possessing a High Level of Resistance to a Strain of Zucchini Yellow Mosaic Virus from China

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Different strains of zucchini yellow mosaic virus (ZYMV) have been reported to infect cucurbits in many countries of the world (3,8). Two American strains of this virus are well known, he Florida (ZYMV-FL) and the Connecticut (ZYMV-CT) (6). The first is the most common and causes initially a "light green mosaic," whereas the second incites the typical "yellow mosaic." Both strains also cause a deep foliar serration, blisters, deformations, and plant stunting. There are a few other American strains which appear to be confined to some areas of the country. One from California incites symptoms closely resembling those caused by watermelon mosaic virus (unpublished). However, shape, size, and color of fruits produced by plants infected with the American strains of ZYMV are severely affected, rendering them unmarketable.

Following the assessment of the economic importance of this virus, efforts were made to find sources of resistance in squashes and other cucurbits. All cultivars of *Cucurbita pepo, C. maxima* and *C. moschata* were found to be susceptible, but an intense screening located high levels of resistance in *Cucurbita ecuadorensis* (Equador) and in a landrace of *C. moschata* 'Nigerian Local' (Nigeria) (6). Their resistance is very effective in controlling strains of ZYMV from Africa, the Americas, Asia, Europe, and Oceania. These two *Cucurbita* species also were demonstrated to be resistant to strains of cucumber mosaic virus (CMV), the two types of papaya ringspot virus (PRSV-p and PRSV-W), and watermelon mosaic virus (WMV). The 'Nigerian Local', however, is susceptible to squash mosaic virus (SqMV), whereas *C. ecuadorensis* offers a low level of tolerance to this virus (5).

Except in a few cases (2,7), attempts to transfer the ZYMV resistance from *C. ecuadorensis* into cultivated species were unsuccessful. More promising results were obtained with the resistance located in 'Nigerian Local'. Thus, in recent years, a limited number of summer squash cultivars have been released by a few American seed companies. The Harris Moran Seed Company is the vendor of three zucchini-type cultivars possessing a high level of tolerance to ZYMV-FL: Tigress, Jaguar and Puma (1). Rogers Seed Company has recently released two new cultivars, Dividend and Revenue (9), which are also highly tolerant to ZYMV-FL. Since this strain is the most widespread in the USA, including Hawaii, it was used during the breeding of these five cultivars. Infected plants reacted to the Florida strain with normal growth, but leaves developed mild and sparse chlorotic spots. All fruits were of normal size, shape, and color. Hence, this tolerance has great economic importance in controlling the devastating effects of ZYMV-FL.

Studies had indicated that the resistances to ZYMV-FL in 'Nigerian Local' is rather complex, possibly involving one major factor plus some modifiers (4). However, when plants of 'Dividend', 'Jaguar', 'Puma', 'Revenue', and 'Tigress' were inoculated with a strain of ZYMV from China (ZYMV-CH), they displayed the same high level of resistance possessed by the original resistant parent, 'Nigerian Local'. In September 1991, ZYMV-CH was found to severely infect the Cucurbitaceae growing near the capital, Beijing. In green house and filed tests, with susceptible hosts, this strain incited the characteristic 'yellow mosaic' that is caused by most strains of the virus (3).

The high level of resistance possessed by the new five American cultivars to the ZYMV-CH was unexpected, since it never was used in their breeding. Consequently, the development of valuable cultivars such as 'Dividend', 'Jaguar', 'Puma', 'Revenue' and 'Tigress' can be considered a significant accomplishment. They are very productive cultivars representing a significant step forward in the development of other commercial cultivars resistant to the major cucurbit viruses.

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Differential Response of *Cucurbita pepo* Cultivars to Strains of Zucchini Yellow Mosaic Virus

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Lisa and Lecoq (2) described zucchini yellow mosaic virus (ZYMV) as being remarkably variable. Different strains of ZYMV can be distinguished on the basis of the symptoms on susceptible hosts, and pathotypes have been reported (1) that differ for virulence to a resistant genotype. Two strains ZYMV are known to be present in the USA (4). The Connecticut strain (ZYMV-CT) produces the most severe symptoms but the Florida strain (ZYMV-FL) is the most common. The purpose of this research was to test resistant germplasm of summer squash for reaction to the FL and CT strains of ZYMV.

Three sources of ZYMV resistance were included in these tests. 'Freedom II' and 'Prelude II' from the Asgrow Seed Co. have a genetically engineered coat protein gene for resistance. 'Tigress' and 'Jaguar' (from the Harris Moran Seed Co.) and 'Revenue' and 'Dividend' (from Rogers Seed Co.) all derive their ZYMV resistance from *Cucurbita moschata* 'Nigerian Local'. *Cucurbita ecuadorensis* is the source of resistance to ZYMV for breeding line NY 247.

All resistant cultivars and lines tested had a high level of resistance of ZYMV-FL. Inoculated plants grew vigorously and their fruit were symptomless. NY 247, 'Freedom II', and 'Prelude II' were also highly resistant to ZYMV-CT, but inoculated plants of 'Tigress', 'Jaguar' and 'Dividend', developed foliar mosaic and stunning in greenhouse tests. They were less affected by ZYMV-CT than susceptible *C. pepo* plants, but they lacked the high level of resistance to ZYMV-CT of their 'Nigerian Local' parent.

When 'Tigress' and 'Jaguar' plants were tested in the greenhouse with other strains of ZYMV, they were susceptible to those from Australia, Brazil, Egypt, and Taiwan, but displayed tolerance to a California and a China strain. Under the same growing conditions, 'Nigerian Local' and NY 247 were resistant to all strains.

Resistant cultivars and the susceptible cultivar 'Black Jack' were inoculated with ZYMV-CT in the greenhouse and transplanted to the field. 'Black Jack' was severely stunted and produced very few fruit, all of them very malformed, but all of the resistant cultigens grew vigorously and produced many marketable fruit. The number of fruit and the % marketable fruit produced by six plants of each cultivar are given in Table 1. 'Jaguar', 'Tigress' and 'Dividend' produced a higher percentage of unmarketable fruit than the other resistant cultivars, primarily due to misshapen fruit caused by ZYMV.

Table 1. Fruit Production to 8/25/96 and Grade by Plants Inoculated with ZYMV-CT.

Cultivar or line	No. of fruit	marketable
NY 247	13	100
Freedom II	35	100
Prelude II	35	94
Tigress	29	76
Jaguar	22	68
Revenue	24	96
Dividend	25	76
Black Jack	2	0

'Nigerian Local' has a high level of resistance to both ZYMV-FL and ZYMV-CT, but some cultivars deriving their resistance from this source have high level resistance to one but not the other of these ZYMV strains. 'Nigerian Local' has a single,

incompletely dominant major gene and possibly modifiers for ZYMV resistance (3), and modifying genes may be needed for a high level of resistance to ZYMV-CT. The reaction of some resistant cultivars to ZYMV-CT does not appear to be necessarily due to a different expression in a *C. pepo* gene background of the major gene for ZYMV resistance from Cucurbita moschata 'Nigerian Local'. *C. pepo* breeding lines have been developed with ZYMV resistance from 'Nigerian Local' that are highly resistant to the Connecticut as well as the Florida strain of the virus.

The lower level of resistance to ZYMV-CT of some cultivars should not be a threat to most US growers. The CT strain of the virus is of only limited distribution and these cultivars are highly resistant to the predominant strain of the virus in the country (4). Also, symptoms produced by ZYMV-CT on these cultivars were less severe in the field than in the greenhouse. Despite being inoculated in the seedling stage with a high tire of ZYMV, a more severe test of resistance than commonly occurs with natural infection, they produced many marketable fruit in the field.

There is no source of immunity for summer squash to natural infection with ZYMV. The occurrence of ZYMV in leaves of a resistant cultivar could provide an opportunity for the development of new pathotypes that could multiply in that resistant host and have a selective advantage over strains that the cultivar is resistant to. Pyramiding genes for ZYMV resistance that are derived from different sources could guard against this possibility and make possible cultivars with more stable resistance to ZYMV.

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Evaluation of Gherkin Germplasm

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Introduction. Gherkin, burgherkin or West Indian gherkin is botanically known as *Cucumis anguria* L. and is a diploid species having chromosome number 2n=24. It has descended from a non-bitter variant of an African wild species *C. longipes* Hook, which bears bitter fruits. Fruits of gherkin are small, egg-shaped and are borne on a long peduncle. The fruits can be consumed fresh in salads, processed in pickles or cooked as a vegetable (1). Gherkin is not grown in this part of India, so an effort has been made to evaluate this germplasm under Punjab conditions.

Material and Methods. Forty-eight lines of gherkin were introduced from North Central Regional Plant Introduction Station, Ames during 1994. These genotypes were grown at Vegetable Research Farm, PAU, Ludhiana during summer 1995 under replicated trial. Each replication accommodated five plants. Spacing between rows and plants was maintained at 3 m x 50 cm respectively. Two rows were planted per bed. Data were recorded for only 44 genotypes as 8 lines did not germinate. Quantitative characters studied include cotyledon size (L x B, cm^2), fruit number per plant, fruit shape (E/P), vine length (m) and yield (kg/plant). Based upon the performance in the first year, 18 lines were planted during 1996 for re-evaluation.

Results and Discussion. Number of fruits/ vine ranged from 4 for TGR 898 to 138 for PI 386034 (Table 1). Other prolific fruit bearing lines were PI 386032 (1000), PI 396055 (80), TGR 1253 (78), PI 386052 (75), PI 386085 (75), PI 282442 (65), PI 147065 (65) and Clark No. 156 (63). the highest fruit yield/plant was recorded in PI 282442 (2kg), followed by PI 386052 (1.8kg), PI 386085 (1.4kg), PI 386055 (1.4kg), PI 196477 (1.375kg), and PI 438679 and PI 386034 (1.3kg each). Vine length varied from 1.07 m in PI 386076 to 3.58 m in PI 386052. Other genotypes having vine length greater than 3 m include TGR 539 (3.18m), TGR 1928 (3.13m), PI 386071 (3.10m) and PI 282442 (3m). Fruit shape ratio varied from 2.2 for PI 233646 to 1.1 for TGR 1253.

Correlation coefficients were estimated between yield/plant and fruit number/plant, vine length, cotyledon size and fruit shape. Estimation of correlation (Table1) indicated that yield might be improved by selecting for fruit number and vine length. Fruit shape and cotyledon size had no correlation with yield cannot be used as a selection criterion for improving gherkin yields.

Eighteen lines producing average yield of 0.80 kg/plant or more during 1995 were replanted during 1996. Among these lines, PI 438679, PI 196477, PI 147065 and PI 320052 had yields in 1996 that were similar to the 1995 yields (Table 2). The fruit of these four PIs are egg-shaped, non-bitter and with the exception of PI 147065 have smooth surfaces. PI 438679, PI 196477, PI 147065 and PI 320052 are all commercially acceptable.

Table 1. Evaluation of gherkin germplasm during 1995.

SR No.	Line	Fruit No./Plant	Vine Length (m)	Cotyledon Size (cm^2)	Fruit Shape (E/P)	Yield/Plant (kg)
1	PI-233646	50	1.1660	0.640	2.200	1.100
2	PI-386082	22	2.580	1.440	1.300	0.591
3	PI-482-385	29	1.950	1.200	1.600	0.357
4	PI-386023	100	2.000	0.560	1.400	0.500
5	PI-386075	32	1.750	0.310	1.300	0.450
6	PI-386034	138	2.500	0.830	1.600	1.300
7	PI-386029	58	2.000	0.630	1.700	0.967
8	PI-438679	52	2.400	1.280	1.700	1.375
9	PI-320052	38	2.500	0.580	1.500	0.205
10	PI-196477	62	2.700	0.850	1.800	0.300
11	PI-386044	19	2.500	0.750	1.700	0.629
12	PI-438570	28	2.200	1.250	1.800	0.350
13	Clark No. 156	63	2.000	1.740	1.200	0.300
14	PI-386062	22	2.730	0.970	1.700	0.733
15	PI-386080	35	1.750	0.740	1.600	1.050
16	Gatooma 29	11	2.790	0.530	1.600	0.460
17	Gatooma 26	51	2.760	0.900	2.000	0.700
18	TGR-1928	19	3.130	1.640	2.000	0.483
19	TGR-80	30	3.570	1.090	2.000	0.150
20	TGR-539	17	3.180	0.910	1.500	1.800
21	TGR-289	8	2.000	1.370	1.500	1.100
22	TGR-235	40	2.600	1.470	1.900	0.210
23	TGR-1253	78	3.550	0.830	1.100	0.080
24	TGR-898	4	2.120	1.470	1.700	1.100
25	PI-442176	15	2.140	0.750	1.700	0.150
26	PI-147065	65	2.250	0.820	2.000	1.150
27	PI-386076	40	1.070	0.400	1.600	0.160
28	PI-386071	38	3.100	0.590	1.400	0.125
29	PI-386070	15	1.530	0.400	1.800	0.400

30	PI-386086	8	2.200	0.430	1.800	0.800
31	PI-386085	75	2.000	0.740	1.400	0.350
32	PI-386052	75	3.580	0.670	1.700	1.800
33	PI-386067	24	1.410	0.620	2.000	0.350
34	PI-386036	22	1.550	0.320	1.900	0.255
35	PI-386039	23	1.750	0.590	1.600	0.210
36	PI-386064	14	1.900	0.910	1.200	0.420
37	PI-386037	53	2.500	0.510	1.500	0.900
38	PI-386055	80	0.050	0.550	1.600	1.400
39	PI-386048	56	0.500	0.460	1.700	1.060
40	PI-386066	50	2.300	0.330	1.500	0.700
41	PI-386051	40	1.830	0.370	2.000	0.375
42	PI-386054	60	1.100	0.440	1.600	0.850
43	PI-282442	65	3.000	0.550	1.300	2.000
44	PI-482383	50	2.700	1.190	1.600	0.840
CD at P=0.05		3.45	0.640	0.090	0.130	0.210
Corr. with yield		0.69	0.470	-0.020	-0.130	

Table 2. Yield and fruit characteristics of selected gherkin lines during 1996.

SR	Line	Fruit No/Plant	Yield/plant (kg)	Fruit surface	Fruit shape	Fruit taste
1	PI-438679	42.4	0.920	Smooth	Egg	Non-bitter
2	Pi-196477	60.7	1.360	Smootj	Egg	Non-bitter
3	PI-147065	60.2	1.400	Spined	Egg	Non-bitter
4	PI-320052	40.3	0.820	Smooth	Egg	Non-bitter
CD a P=0.05		5.17	0.250			

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Seed Treatment Effects on Emergence of Luffa Sponge Gourd

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Luffa (or loofa) sponge gourds (*Luffa aegyptiaca* Mill) are increasing in popularity in North America. However, additional research is needed to solve some of the production problems for luffa, especially in the area of seed germination. There is little published information in luffa on the effects of seed treatment on germination, or of growth regulators on sex expression. However, it would be useful to increase the germination rate of luffa seeds, which is often below 75%. It would also be useful to increase the percentage of pistillate flowers on the luffa plants for easier hybridization. Luffa and cucumbers are members of the cucurbitaceae family. Cucumbers respond favorably to growth regulators for increasing the percentage of pistillate flowers (1,2). The objective of this research was to determine the effects of several pre-planting treatments on seed germination and growth regulators on sex expression in luffa sponges gourds.

Six treatments were applied to 'Fletcher' luffa seeds prior to planting. A total of 60 seeds were used per treatment combination. The treatments included water, acetone, gibberellic acid-3 (GA-3), ethephon, scarification, and a control. The control consisted of untreated, dry seeds. In the water treatment, seeds were soaked in distilled, aerated water for 87 hr at 25 C. In the acetone treatment seeds were soaked for 16 hr at 25 C in a solution of 0.1mM GA3 plus 200 ml acetone. In the ethephon treatment seeds were soaked in 3.5 mM ethephon mixed with 200 ml acetone for 16 hr at 25 C. The scarification treatment involved shaking the seeds for 2 minutes in a 762 mm diameter closed PVC tube lined with sandpaper. AFter treatment application, the seeds were planted in a peatlike mix in flats in the greenhouse. Emergence data were taken two weeks after seeding.

After seeding emergence data were taken, the seedlings were transplanted into the field. Ethephon was sprayed on seedlings until runoff 0. 1. or 2 times using a rate of 100 mg/L (+4 drops Tween-20). Seedlings received either one treatment of ethephon at the first leaf stage, two treatments of ethephon at the first and third leaf stages, or no treatment (the control). As the plants were maturing, the number of pistillate nodes out of a total of twenty nodes on five plants was recorded. The data collected were analyzed using the GLM procedure of SAS.

There was a significant increase in the percentage emergence when luffa seeds were soaked in water relative to the acetone, ethephon, GA3, and scarification treatments (Table 1). However, the water treatment was not significantly different from the control. Therefore, none of the seed treatments improved the rate of emergence of the luffa seedlings, and all but the water soaking treatment made the percentage emergence worse.

Based on the tests conducted, spraying seedlings of 'Fletcher' luffa gourds with ethephon did not increase the percentage of pistillate flowers when the seeds had been treated with acetone, GA3, or scarification. Significant differences were found with the ethephon and water seed treatments when ethephon was applied at the first true leaf stage. The control seed treatment showed a significant increase in percentage pistillate flowers when the seedlings were not sprayed with ethephon (Table 2).

We had hoped that luffa would respond to ethephon in the same way that cucumbers do. However, our experiment indicated that ethephon applied at the tested rates had no significant effect on sex expression. Similarly, none of the treatments enhanced seed emergence from the soil. Additional research is needed to identify useful treatments for improvement of seed emergence and pistillate flower production in luffa sponge gourd.

Table 1. Effect of seed treatments on seedling emergence in luffa sponge gourd[z]

Seed Treatment	Percentage emergence
Acetone	47
GA3	56
Ethephon	57
Scarification	63
Water	80
Control	72
LSD (5%)	11
CV (%)	22

[z] Data are means of two replications of 60 seeds each.

Table 2. Effects of seed and seedling treatments on sex expression of luffa gourd.

Seed treatment	Number of ethephon applications[z]	Percentage of pistillate nodes[y]
Acetone	0	17
	1	16

	2	15
GA3	0	17
	1	18
	2	20
Ethephon	0	11
	1	35
	2	14
Scarification	0	19
	1	21
	2	19
Water	0	33
	1	9
	2	20
Control	0	28
	1	23
	2	18
LSD (5%)		6
CV (%)		39

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Regeneration of Plants from Hypocotyl of *Sechium edule* Swartz

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Buddha's Hand (*Sechium edule*) is a perennial root vegetable suitable for cultivation in tropical and sub-tropical regions. It is grown in southern and Southwest China where it has been readily accepted by farmers because of its high tolerance to disease, tolerance to storage and transportation, and high economic value. In recent years the crop has been successfully introduced into Northern China. However, production throughout all of China is limited by low propagation efficiency and high seedling cost.

The purpose of these experiments was to develop methods to overcome the high propagation costs. Experiments were conducted at the Northwest Agricultural University during two seasons: December 1993 - June 1994; and December 1994 - November 1995.

Experiments were conducted to determine optimal media for plantlet regeneration from hypocotyl explants. Experiments were also conducted to determine media for initiation of shoots and roots from hypocotyl calli and from stems with terminal buds and stem segments with axillary buds.

The greatest induction of calli from hypocotyl tissue was obtained from MS medium supplemented with 0.1 mg/L IAA, 1.0 mg/L BA, and 200mg.L LH. Shoots were easily differentiated on MS medium with 0.5 mg/L IAA and 0.5 mg/L BA. The differentiation ratio was 575%. Differences were observed in optimal rooting media for shoots with terminal bud and shoots having axillary buds. Terminal bud segments rooted best in MS medium with 1 mg/L IAA, with rooting occurring in 8 days and at a ratio of 81.3%. Stem segments with axillary buds rooted at a ratio of 83.3%. Stem segments with axillary buds rooted at a ratio of 83.3% in 1/2 MS medium supplemented with 0.3 mg/L IAA. Rooting for these explants occurred in 5 days. Following rooting, plantlets were transferred to pots containing 3 parts soil, 2 parts sand, and 1 part manure. The survival rate for the transferred plantlets was 75%.

Plantlets were acclimated and hardened by initially keeping them in a small arched shed covered with plastic. In early May 1995, after 40 days acclimation, plants with 4 to 5 true leaves were planted in the field. the plants were still tender and required extra care to ensure survival. The plants flowered during the last 10 day period of October. Fruits were harvested on November 7, 1995. The average number of fruit per plant was 88.434 and the average weight was 240.2 g.

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1997 Gene List for Cucumber

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Complete lists and updates of genes for cucumber (*Cucumis sativus* L.) have been published previously (Pierce and Wehner, 1989; Robinson et al., 1982; Wehner, 1993), and this is the latest version. For the first time, this gene list includes marker loci for restriction fragment length polymorphisms (RFLPs) and random amplified DNA (RAPDs). The genes on the 1997 list are of nine categories as follows: seedling markers, stem mutants, leaf mutants, flower mutants, fruit type mutants, fruit color mutants, resistance (mostly to diseases), protein (isozyme) variants, and DNA (RFLPs and RAPDs) markers (Table 1).

> Revisions to the 1997 cucumber gene list include the addition of a flower mutant, *male sterile-2 pollen sterile, ms-2^{PS}* (Zhang et al., 1994), correction of the spelling of the *ginko* mutant to *ginkgo*, modification of the description of the gene for resistance to *Fusarium oxysporum* f. sp. *cucumerinum* races, *Foc* (Vakalounakis, 1993, 1995, 1996), and addition of 7 isozyme mutants, *Ak-2, Ak-3, Fdp-1, Fdp-2, Mpi-1, Pep-gl*, and *Skd* (Meglic and Staub, 1996). the gene list now includes a total of 269 (158 classical genes, 91 RFLPs, and 20 RAPDs) gene mutants.

Isozyme variant nomenclature for this gene list follows the form according to Staub et al. (Staub et al,, 1985), such that loci coding for enzymes (e.g. glutamine dehydrogenase, G2DH) are designated as abbreviations, where the first letter is capitalized (e.g. G2dh). If an enzyme system is conditioned my multiple loci, then those are designated by hyphenated numbers, which are numbered from most cathodal to most anodal and enclosed in parentheses. The most common allele of any particular isozyme is designated, 100, and all other alleles for that enzyme are assigned a value based on their mobility relative to that allele. for example, an allele at locus 1 of FDP (fructose diphosphatase) which has a mobility 4 mm less that of the most common allele would be assigned the designation *Fdp)(1)-96*.

RFLP marker loci were identified as a result of digestion of cucumber DNA with *Dra*I, *Eco*RI, *Eco*RV, or *Hind*III (Kennard et al., 1994). Partial-genomic libraries were constructed using either *Pst*I-digested DNA from the cultivar Sable and from *Eco*RV-digested DNA from the inbred WI 2757. Derived clones were hybridized to genomic DNA and banding patterns were described for mapped and unlinked loci (CsC482/H3, CsP314/E1, and CsP344E1, CsC477/H3, CsP300/E1).

Clones are designated herein as CsC = cDNA, CsP = *Pst*I-gnomic, and CsE = *Eco*RI-genomic. Lower case a or b represent two independently-segregating loci detected with one probe. Lower -case s denotes the slowest fragment digested out of the vector. Restriction enzymes designated as DI, IDRA*I;* EI, *Eco*RI; E5, *Eco*RV; and H3, *Hind*III. Thus, a probe identified as CsC336b/E5 is derived from a cDNA library (from 'Sable') which was restricted using the enzyme *Eco*RV to produce a clone designated as 336 which displayed two independently segregating loci one of which is b. Clones are available in limited supply from Jack E. Staub.

RAPD marker loci were identified using primer sequences from Operon Technologies (OP; Alameda, California, U.S.A.) and the University of British Columbia (Vancouver, BC, Canada). Loci are identified by sequence origin (OP or BC), primer group letter (e.g., A), primer group array number (1-20), and locus (a, b, c, etc.) (Kennard et al., 1994). Information regarding unlinked loci can be obtained from Jack E. Staub.

Because of their abundance, common source (two mapping populations) and the accessibility of published information on

their development (Kennard et al., 1994) DNA marker loci are not included in Table 1, but are listed below.

The 60 RFLP marker loci from mapping cross Gy 14 x PI 183967 (Kennard et al., 1994): CsP129/E1, CsC032a/E1, CsP064/E1, CsP357/H3, CsC386/E1, CsC365/E1, CsP046/E1, CsP347/H3, CsC694/E5, CsC588/H3, CsC230/E1, CsC593/D1, CsP193/H3, CsP193/H3, CsP078s/H3, CsC581/E5, CsE084/E1, CsC341H3, CsPO24/E1, CsP287/H3, CsC629/H3, CsP225s/E1, CsP0501/H3, CsE051/H3, CsC366a/E5, CsC32b/E1, CsP056/H3, CsC378/E1, CsP406/E1, CsP460/E1, CsE060/E1, CsE103/E1, CsP019/E1, CsP168/D1, CsC560/H3, CsP005/E1, CsP440s/E1, CCsP221/H3, CsC625/E1, CsP475s/E1, CsP211/Eq, CsP215/H3, CsC613/E1, Csc029/H3, CsP130/E1, CsC443/H3, CsE120/H3, CsE031/H3, CsC366b/ E5, CsC082/H13, CsP094/H3, CsC362/E1, CsP441/E1, CsP280/H3, CsC558/H3, CsP037a/E1, CsP476/H3, CsP308/E1, CsP105/E1, and CsC166/E1.

The 31 RFLP marker loci from mapping cross Gy 14 x PI 432860 (Kennard et al., 1994): CsC560/D1, CsP024/E5, CsP287/H3, CsC384/E5, CsC366/E5, CsC611/D1, CsP055/D1, CsC482/H3, CsP019/E1, CsP059/D1, CsP471s/H13, CsC332/E5, CsP056/H3CsC308/E5, CsP073/E5, CsP215/H3, CsC613D1, CsP266/D1, CsC443/H3, CsE031/E1, CsE120/H3, CsE063/E1, CsP444/E1, CsC612/D1, Cs362/E1, CsP280/H3, CsC558/H3, CsP008/D1, CsP308/E1, CsC166/E1, and CsP303/H3.

The 20 RAPD marker loci from mapping cross Gy 14 x PI 432860 (Kennard et al., 1994):OPR04, OPW16, OPS17, OPE13a, OPN06, OPN12, OPP18b, BC211b, OPN04, OPA10, OPE09, OPT18, OPA14b, OPU20, BC460a, OPAB06, OPABpo5, OPH12, OPA14a, and BC211a.

Researchers are encouraged to send reports of new genes, as well as seed samples to the cucumber gene curator (Todd C. Wehner), or to the assistant curators (Jack E. Staub, and Richard W. Robinson). Please inform us of omissions or errors in the gene list. Scientists should consult the list as well as the rules of gene nomenclature for the Cucurbitaceae (Robinson et al., 1976; Robinson et al., 1982) before choosing a gene name and symbol. That will avoid duplication of gene names and symbols. The rules of gene nomenclature were adopted in order to provide guidelines for naming and symbolizing genes. Scientists are urged to contact members of the gene list committee regarding rules and gene symbols.

Table 1. the 158 (non-molecular) genes of cucumber.

	Synonym	Character	References[z]	Supplemental references[z]	Available[y]
a	-	*Androecious.* Produces primarily staminate flowers if recessive for *F.* A from MSU 71305 and Gy 14; *a* from An-11 and An-314, two selections from 'E-e-szan' of China.	Kubicki, 1969		P
Ak-2	-	*Adenylate kinase* (E.C. # 2.7.4.3). Isozyme variant found segregating in PI 339247, and 271754; 2 alleles observed.	Meglic and Staub, 1996		P
Ak-3	-	*Adenylate kinase* (E.C.#2.7.4.3). Isozyme variant found segregating in PI 113334, 183967, and 285603; 2 alleles observed.	Meglic and Staub, 1996		P
al	-	*albino cotyledons.*. White cotyledons and slightly light green hypocotyl; dying before the first true leaf stage. Wild type Al+ from 'Nishiki-suyo'; *al* from M_2 line from pollen irradiation.	Iidea and Amano, 1990, 1991		?
ap	-	*apetalous.* Male-sterile. Anthers become sepal-like. *Ap* from 'Butcher's Disease Resisting'; *ap* from 'Butcher's Disease Resisting Mutant'.	Grimbly, 1980		L
Ar	-	*Anthracnose resistance.* One of several genes for resistance to *Colletotrichum lagenarium. Ar* from PI 175111, PI 175120, PI 179676, PI 183308, PI 183445; *ar* from 'Palmetto' and	Barnes and Epps. 1952.		P

		'Santee'.			
B	-	*Black or brown spines.* Dominant to white spines on fruit.	Strong, 1931; Tkachenko, 1935; Wellington, 1913.	Cochran, 1938; Fujieda and Akiya, 1962; Hutchins, 1940; Jenkins, 1946; Youngner, 1952.	W
B-2	-	*Black spine-2.* Interacts with *B* to produce F_2 of 15 black: 1 white spine. *B-02* from Wis. 9362; *b-2* from PI 212233 and 'Pixie'.	Shanmugasundarum et al., 1971a		?
B-3	-	*Black spine-3.* Interacts with *B-4* to produce an F_2 of nine black: 7 white spine. *B-3 from LJ90430;* b-3 *from MSU 41.*	Cowen and Helsel, 1983.		W
B-4	-	*Black spine-4.* Interacts conversely with *B-3. B-4* from LJ90430; *b-4* from MSU 41.	Cowan and Helsel 1983		W
bi	-	*bitterfree.* All plant parts lacking cucurbitacins. Plants with *bi* less preferred by cucumber beetles. Plants with *Bi* resistant to spider mites in most American cultivars; *bi* in most Dutch cultivars.	Andeweg and De Bruyn, 1959	Cantliffe, 1972; Da Costa and Jones, 1971a, 1971b; Sons et al., 1973.	W
bl	*t*	*blind.* Terminal bud lacking after temperature. Carlsson, 1961. shock. *bl* from 'Hunderup' nd inbred HP3.			L
bla	-	*blunt* leaf. Leaves have obtuse spices and reduced lobing and serration. *bla* from a mutant of 'Wis. SMR 18'.	Robinson, 1987a		W
Bt	-	*Bitter fruit.* Fruit with extreme bitter flavor. *Bt* from PI 173889 (Wild Hanzil Medicinal Cucumber).	Barham, 1953		W
bu	-	*bush.* Shortened internodes. *bu* from 'KapAhk 1'.	Pyzenkov and Kosareva, 1981		L
Bw	-	*Bacterial wilt resistance.* Resistance to *Erwinia tracheiphila. Bw* from PI200818; *bw* from 'Marketer'.	Nutall and Jasmin, 1958	Robinson and Whitaker, 1974	W
by	*bu*	*bushy*. Short internodes; normal seed viability. Wild type *By* from induced mutation of 'Borszczagowski'. . Linked with *F* and *gy*, not with *B* or *bi.*	Kubiki et al., 1986a		?
c	-	*cream mature fruit color,* interaction with *R* is evident in the F_2 ratio of 9 red (*RC*) : 3 orange (*Rc) : 3 yellow* (rC) *:* 1 cream (*rc).*	Hutchins, 1940		L
Cca	-	*Corynespora cassicola resistance.* Resistance to target leaf spot; dominant to susceptibility. *Cca* from Royal Sluis Hybrid 72502; *cca* from Gy 3.	Abul-Hayja et al., 1975		W
Ccu	-	*Cladosporium cucumerinum resistance.* Resistance to scab. *Ccu* from line 127.31, a selfed progeny of 'Longfellow'; *ccu* from	Bailey and Burgess, 1934	Abul-Hayja and Williams, 1976; Abul-Hayja et al., 1975, Andeweg,	W

		'Davis Perfect'.		1956.	
cd	-	*chlorophyll deficient.* Seedling normal at first, later becoming a light green; lethal unless grafted. *cd* from a mutant selection of backcross of MSU 713-5 x 'Midget' F1 to 'Midget'.	Burnham, et al., 196		L
chp	-	*choripetalous*. Small first true leaf;' choripetalous flowers; glosssy ovary; small fruits; few seeds. Wild type *Chp+* from 'Borszczagowski'; *chp* from chemically induced mutation.	Kubicki and Korzeniewska, 1984		?
cl	-	*closed flower.* Staminate and pistillate flowers do not open; male-sterile (nonfertile pollen).	Groff and Odland, 1963		W
cla	-	*Colletotrichum lagenarium resistance.* Resistance to race 1 of anthracnose; recessive to susceptibility. *Cla* from Wis. SMR 18; *cla* from SC 19B.	Abul-Hayja et al., 1978		W
Cm	-	*Cornyespora melonis resistance.* Resistance to *C. melonis* dominant to susceptibility. *Cm* from 'Spotvrie'; *cm* from 'Esvier'.			?
Cmv	-	*Cucumber mosaic virus resistance.* One of several genes for resistance to CMV. *Cmv* from 'Wis. SMR 12', 'Wis. SMR 15'; and 'Wis. SMR 18'; *cmv* gtom 'National Pickling' and 'Wis. SR 6'.	Wasuwat and Walker, 1961	Shifriss et al., 1942	W
co	-	*green corolla,* Green petals that turn white with age and enlarged reproductive organs; female-sterile. *co* from a selection of 'Extra Early Prolific'.	Hutchins, 1935	Currence, 1954	L
cor-1	-	*cordate leaves-1*. Leaves are cordate. *cor-1* from Nezhinskii'.	Gornitskaya, 1967		L
cor-2	*cor*	*cordate leaves-2*. Leaves re nearly round with revolute margins and no serration. Insect pollination is hindered by short calyx segments that tightly clasp the corolla, preventing full opening. *cor-2* from an induced mutant of 'Lemon'.	Robinson, 1987c		?
cp	-	*compact.* Reduced internode length, poorly developed tendrils, small flowers. *cp* from PI 308916.	Kauffman and Lower, 1976		W
cp-2	-	*compact*-2. Short internodes; small seeds, similar to *cp*, but allelism not checked. Wild type *Cp-2* from 'Borszczagowski'; *cp-2* from induced mutation of 'Borszczagowski' called W97. Not linked with *B* or *F*; interacts with *by* to produce super dwarf.	Kubicki et al, 1986b		W
cr	-	*crinkled leaf.* Leaves and seed are crinkled.	Odland and Groff, 1963a		?
cs	-	*carpel splitting.* Fruits develop deep	Caruth, 1975; Pike		?

		longitudinal splits. *cs* from TAMU 1043 and TAMU 72210, which are second and fifth generation selections of MSU3249 x SC 25.	and Caruth, 1977		
D	*g*	*Dull fruit skin.* Dull skin of American cultivars, dominant to glossy skin of most European cultivars.	Poole, 1944; Strong, 1931; Tkachenko, 1935		W
de	*I*	*determinate habit.* Short vine with stem terminating in flowers; modified by *IN-de* and other genes; degree of dominance depends on gene background. *de* from Penn 76.60G*, Minn 158.60*, 'Hardin's PG57', Hardin's Tree Cucumber', and S_2 -1 (and inbred selection from Line 541)**.	Denna, 1971*; George, Nutall and 1970**; Hutchins, 1940, Jasmin, 1958		W
de-2	-	*determinate-2.* Main stem growth ceases after 3 to 10 nodes, producing flowers at the apex; smooth, fragile, dark-green leaves; similar to *de*, but not checked for allelism. Wild type *De-2* from 'Borszczgowski'; *de-2* from W-sk mutant induced by ethylene-imine from 'Borszczagowski'.	Soltysiak et al. 1986		?
df	-	*delayed flowering.* Flowering delayed by long photoperiod; associated with dormancy. Idf *from 'Baroda' (PI 212896)* and PI 215589 (*hardwickii)**.	Della Vecchia et al., 1982*; Shifriss and George, 1965**.		W
dl	-	*delayed growth.* Reduced growth rate; shortening of hypocotyl and first internodes. *dl* from 'Dwarf Marketmore' and 'Dwarf Tablegreen', both deriving dwarfness from 'Hardin's PG-57'.	Miller and George, 1979		W
dm	*P*	*downy mildew resistance.* One of several genes for resistance to *Pseudoperonospora cubensis. Dm* from Sluis & Groot Line 4285; *dm* from 'Poinsett'.	van Vliet and Meysing, 1977	Jenkins, 1946; Shimizu, 1963.	W
dm-1	*dm*	*downy mildew resistance-1*. One of three genes for resistance to downy mildew caused by *Pseudoperonospora cubensis* (Berk & Curt). Wild type *Dm-1* from Wisconsin SMR 19; *dm-1* from WI 4783. Not checked for allelism with *dm.*	Doruchowski and Lakowska-Ryk, 1992.		?
dm-2	-	*downy mildew resistance-2*. One of three genes for resistance to downy mildew caused by *Pseudoperonospsora cubensis* (Berk & Curt). Wild type *Dm-2* from Wisconsin SMR 18; *dm-2* from WI 4783. Not checked for allelism with *dm.*	Doruchowski and Lakowska-Ryk, 1992		?
dm-3	-	*downy mildew resistance-3.* One of three genes for resistance to downy mildew caused by *Pseudoperonospora cubensis* (Berk & Curt). Wild type *Dm-3* from Wisconsin SMR 18; *dm-3* from WI 4783. Not checked for allelism with *dm.*	Doruchowski and Lakowska-Ryk, 1992		?
dvl	*dl*	*divided leaf-2*. True leaves are partly or fully divided, often resulting in compound leaves	den Nijs and Mackiewicz, 1980		W

		with two to five leaflets and having incised corollas.			
dvl-2	*dl-2*	*divided leaf-2*. Divided leaves after the 2nd true leaf; flower petals free; similar to *dvl*, but allelism not checked. Wild type *Dvl-2* from 'Borszczagowski'; *dvl-2* from mutant induced by ethylene-imine from 'Borszczagowski".	Rucinska et al., 1992b		?
dw	-	*dwarf*. Short internodes. *dw* from an induced mutant of 'Lemon'.	Robinson and Mishanec, 1965		?
dwc-1	-	*dwarf cotyledons-1.* Small cotyledons; late germination; small first true leaf; died after 3rd true leaf. Wild type *Dwc-1* from 'Nishiki-suyo'; *dwc-1* from M_2 line from pollen irradiation.	Iida and Amano, 1990, 1991.		?
dwc-2	-	*dwarf cotyledons-2.* Small cotyledons, late germination; small first true leaf. Wild type *Dwc-2* from 'Nishiki-suyo'; *dwc-2* from M_2 line from pollen irradiation.	Iida and Amano, 1990, 1991.		?
Es-1	-	*Empty chambers-1*. Carpels of fruits separated from each other, leaving a small to large cavity in the seed cell. *Es-1* from PP2-75; *es-1* from Gy-30-75.	Kubicki and Korzeniewska, 1983		?
Es-2	-	*Empty chambers-2*. Carpels of fruits separated from each other, leaving a small to large cavity in the seed cell. *Es-2* from PP-2-75; *es-2* from Gy-30-75.	Kubicki and Korzeniewsika, 1983.		?
F	*Acr, acr^F, D, st*	*Female.* High degree of pistillate sex expression; interacts with *a* and *M*; strongly modified by environment and gene background. *F* and *f* are from 'Japanese'.	Galun, 1961; Tkachenko, 1935.	Kubicki, 1965, 1969a; Poole, 1944; Shifriss, 1961	W
fa	-	*fasciated.* Plants have flat stems, short internodes, and rugose leaves.*fa* was from a selection of 'White Lemon'.	Robinson, 1987b*; Shifriss, 1950		?
Fba	-	*Flower bud abortion.* Preanthesis abortion of floral buds, ranging from 10% to 100%. *fba* from MSU 0612.	Miller and Quisenberry, 1978		?
Fdp-1	-	*Fructose diphosphatase* (E.C. # 3.1.3.11). Isozyme variant found segregating in PI 137851, 164952, 113334 and 192940; 2 alleles observed.	Meglic and Staub, 1996.		P
Fdp-2	-	*Fructose diphosphatase* (E.C. # 3.1.3.11). Isozyme variant found segregating in PI 137851, 164952, 113334 and 192940; 2 alleles observed.	Meglic and Staub 1996		P
Fl	-	*Fruit length.* Expressed in additive fashion, fruit length decreases incrementally with each copy of *fl* (H. Munger, personal communication).	Wilson, 1968		W
Foc	*Fcu-1*	*Fusarium oxysporum f. sp. cucumerinum resistance*. Resistance to fusarium wilt races 1	Netzer et al., 1977; Vakalounakis,		W

		and 2; dominant to susceptibility. *Foc* from WIS 248; *Foc* from 'Shimshon'.	1993, 1995, 1996		
G2dh	-	*Glutamine dehydrogenase* (E.C.# 1.1.1.29). Isozyme variant found segregating in PI 285606; 5 alleles observed.	Knerr and Staub, 1992		P
g	-	*golden leaves.* Golden color of lower leaves. *G* and *g* are both from different selections of 'Nezhin'.	Tkachenko, 1935		?
gb	*n*	*gooseberry fruit.* Small, oval-shaped fruit. *gb* from the 'Klin mutant'.	Tkachenko, 1935		?
gc	-	*golden cotyledon.* Butter-colored cotyledons; seedlings die after 6 to 7 days. *gc* from a mutant of 'Burpless Hybrid'.	Whelan, 1971		W
gi	-	*ginkgo.* Leaves reduced and distorted, resembling leaves of Ginkgo; male- and female-sterile. Complicated background: It was in a segregating population whose immediate ancestors were offspring of crosses and backcrosses involving 'National Pickling', 'Chinese Long', 'Tokyo Long Green', 'Vickery', 'Early Russian', 'Ohio 31' and an unnamed white spine slicer.	John and Wilson, 1952		L
gi-2	-	*ginkgo-2.*Spatulate leaf blade with reduced lobing and altered veins; recognizable at the 2nd true leaf stage; similar to gi, fertile instead of sterile. Wild type *Gi-2* from 'Borszczagowski'; *gi-2* from mutant in the Kubicki collection.	Rucinska et al., 1992b		?
gig	-	*gigantism.* First leaf larger than normal. Wild type *Gig* from 'Borszczagowski'; *gig* from chemically induced mutation.	Kubicki et al., 1992b		?
gl	-	*glabrous.* foliage lacking trichomes; fruit without spines. Iron-deficiency symptoms (chlorosis) induced by high temperature. *gl* from NCSU 75* and M834-6**.	Robinson and Mishanec, 1964*	Inggamer and De Ponti, 1980**; Robinson, 1987b	W
glb	-	*glabrate.* Stem and petioles glabrous, laminae Whelan, 1973 slightly pubescent. *glb* from 'Burpless Hybrid'.			W
gn	-	*green mature fruit.* Green mature fruits when *rr GnGn;* cream colored when *rr GnGn;* orange when *R_ _*. Wild type *Gn* from 'Chipper', SMR 58 and PI 165509; *gn* from TAMU 830397.			W
Gpi-1	-	*Glucose phosphate isomerase.* (E.C. # 5.3.1.9). Isozyme variant found segregating (1 and 2) in PI 176524, 200815, 249561, 422192, 432854, 436608; 3 alleles observed.	Knerr and Staub, 1992		P
Gr-1	-	*Glutathione reductase-1* (E.C. # 1.6.4.2). Isozyme variant found segregating in PI 109275; 5 alleles observed.	Knerr and Staub, 1992		P
gy	-	*gynoecious.* Recessive gene for high degree of pistillate sex expression.	Kubicki,1974		W

H	-	*Heavy netting of fruit.* Dominant to no netting and completely linked or pleiotropic with black spines (*B*) and red mature fruit color (*R*).	Hutchins, 1940; Tklaachenko, 1935		W
hl	-	*heart leaf.* Heart shaped leaves. Wild type *Hl* from Wisconsin SMR 18; *hl* from WI 2757. Linked with *ns* and *ss* in the linkage group with *Tu-u-D-pm.*	Vakalounakis, 1992		W
hn	-	*horn like cotyledons.* Cotyledons shaped like bull horns; true leaves with round shape rather than normal lobes; circular rather than ribbed stem cross section; divided petals; spineless fruits; pollen fertile, but seed sterile. Wild type *Hn* from 'Nishiki-suyo'; *hn* from M_2 line from pollen irradiation.	Iida and Amano, 1990. 1991		?
hsl	-	*heart shaped leaves.* Leaves heart shaped rather than lobed; tendrils branched. Wild type *Hsl* from Nishiki-suyo' hsl from M_2 line from pollen irradiation.	Iida and Amano, 1990, 1991		?
I	-	*Intensifier of P*. Modifies effect of *P* on fruit warts in *Cucumis sativus* var. *tuberculatus.*	Tkachenko, 1935		?
Idh	-	*Isocitrate dehydrogenase* (E.C. # 1.1.1.42). Isozyme variant found segregating in PI 183967, 21589; 2 alleles observed.	Knerr and Staub, 1992		P
In-de	*In (de)*	*Intensifier of* de. Reduces internode length and branching of *de* plants. *In-de* and *in-de* are from different selections(S_5-1 and S_5 -6, respectively) from a determinant inbred S_2-1, which is a selection of line 541.			
In-F	*F*	*Intensifier of female sex expression.* Increases degree of pistillate sex expression of *F* plants. *In-F* from monoecious line 18-1; *in-F* from MSU 713-5.	Kubicki, 1969b		?
l	-	*locule number*. Many fruit locules and pentamerous androecium; five locules recessive to the normal number of three.	Youngner, 1952.		W
lg-1	-	*light green cotyledons-1*. Light green cotyledons, turning dark green; light green true leaves, turning dark green; poorly developed stamens. Wild type *Lg-1* from 'Nishiki-suyo'; *lg-1* from M_2 line from pollen irradiation.	Iida and Amano, 1990, 1991		?
1g-2		*light green cotyledons-2.* Light green cotyledons,turning dark green (faster than lg-1; light green true leaves, turning dark green; normal stamens. Wild type *Lg-2* from 'Nishiki-suyo'; *lg-2* from M_2 line from pollen irradiation.	Iida and Amano, 1990, 1991		?
lh	-	*long hypocotyl.* As much as a 3-fold increase in hypocotyl length. *lh* from a 'Lemon' mutant.	Robinson and Shail, 1981		W

ll	-	*little leaf*. Normal-s9zed fruits on plants with miniature leaves and smaller stems. *ll* from Ark. 79-75.	Goode et al., 1980; Wehner et al. 1987		W
ls	-	*light sensitive*. Pale and smaller cotyledons, lethal in high light. Abstract gave *cg* as symbol; article that followed gave *ls* as symbol. Mutant *ls* from a selection of 'Burpless Hybrid'.	Whelan, 1972b		L
m	*a,g*	*andromonoecious.* Plants are andromonoecious if (*mf*); monoecious if (*Mf*); gynoecious if (*Mf*) and hermaphroditic if (*mF*). *m* from 'Lemon'.	Rosa, 1928*; Tkachenko, 1935	Shifriss, 1961; Wall, 1967; Youngner, 1952	W
m-2	*h*	*andromonoecious-2.* Bisexual flowers with normal ovaries.	Iezzoni, 1982; Kubicki, 1974.		?
Mdh-1	-	*Malate dehydrogenase-1* (E.C. # 1.1.1.37.). Isozyme variant found segregating in PI 171613, 209064, 326594; 3 alleles observed.	Knerr and Staub, 1992		P
Mdh-2	-	*Malate dehydrogenase-2* (E.C.# 1.1.1.37). Isozyme variant found segregating in PI 174164, 185690, 357835, 419214; 2 alleles observed.	Knerr and Staub, 1992		P
Mdh-3	-	*Maleate dehydrogenase-3* (E.C.# 1.1.1.27). Isozyme variant found segregating in PI 255236, 267942, 432854, 432887; 2 alleles observed.	Knerr et al., 1995		P
Mdh-4	*Mdh-3*	*Maleate dehydrogenase-4* (E.C. # 1.1.1.37). Isozyme variant found segregating in PI 255236, 267942, 432854, 432887; 2 alleles observed.	Knerr and Staub, 1992		P
mp	*pf*+ *pf*^{1} pf^{p}	*multi-pistillate.* Several pistillate flowers per node,recessive to single pistillate flower per node. *mp* from MSU 604G and MSU 598G.	Nandgaonkar and Baker, 1981	Fujieda et al., 1982	W
Mp-2	-	*Multi-pistillate-2.* Several pistillate flowers per node. Single dominant gene with several minor modifiers. Iida and Amano, 1990, 1991	Thaxon, 1974.		?
Mpi-1	-	*Mannose phosphate isomerase* E.C. # 5.3.1.8). Isozyme variant found segregating in PI 176954, and 249562; 2 alleles observed.	Meglic and Staub, 1996.		P
Mpi-2	-	*Mannose phosphate isomerase (E.C.#5.3.1.8).* Isozyme variant found segregating in PI 109275, 175692, 200815, 209064, 263049, 354952; 2 alleles observed.	Knerr and Staub, 1992		P
mpy	*mpi*	*male pygmy.* Dwarf plant with only staminate flowers. Wild type *Mpy* from Wisconsin SMR 12; *mpy* from Gnome 1, a selection of 'Rochford's Improved'.	Pyzhenkov and Kosareva, 1981		?
ms-1	-	*male sterile-1.* Staminate flowers abort before anthesis; partially female-sterile. *ms-1* from selections of 'Black Diamond' and 'A & C'.	Shifriss, 1950	Robinson and Mishanec, 1967	L

ms-2	-	*male sterile-2.* Male-sterile; pollen abortion occurs after first mitotic division of the pollengrain nucleus. *Ms-2* from a mutant of 'Burpless Hybrid'.	Whelan, 1973		?
ms-2^{PS}	-	*male sterile-2 pollen sterile.* Male-sterile; allelic to *ms-2, but not to* ap. *Ms-2^{PS}* from a mutant of SunSeeds 23B-X26.	Whelan, 1973		?
n	-	*negative geotropic peduncle response.* Pistillate flowers grow upright; *n* from 'Lemon'; *N* produces the pendant flower position of most cultivars.	Odland, 1963b		W
ns	-	*numerous spines.* Few spines on the fruit is dominant to many. *Ns* from Wis. 2757.	Fanourakis, 1984; Fanourakis and Simon, 1987		W
O	*y*	*Orange-yellow corolla.* Orange-yellow dominant to light yellow. *O* and *o* are both from 'Nezhin'.	Tkachenko, 1935		?
opp	-	*opposite leaf arrangement.* Opposite leaf arrangement is recessive to alternate and has incomplete penetrance. *Opp* from 'Lemon'.	Robinson, 1987e		W
P	-	*Prominent tubercles.* Prominent on yellow rind of *Cucumis sativus* var. *tuberculatus*, incompletely dominant to brown rind without tubercles. *P* from 'Klin'; *p* from 'Nezhin'.	Tkachenko, 1935		W
Pc	*P*	*Parthenocarpy.* Sets fruit without pollination. *Pc* from 'Spotvrie'; *pc* from MSU 713-205*.	Pike and Peterson, 1969*; Wellington and Hawthorn, 1928; Whelan, 1973	de Ponti and Garretsen, 1976	?
Pe	-	*Palisade epidermis.* Epidermal cells arranged perpendicular to the fruit surface. Wild type *Pe* from 'Wisconsin SMR 18', 'Spartan Salad' and Gy 2 compact; *pe* from WI 2757.	Fanourakis and Simon, 1987		W
Pep-gl-1	-	*Peptidase with glycyl-leucine* (E.C.# 3.4.13.11). Isozyme variant found segregating in PI 113334, 212896; 2 alleles observed.	Meglic and Staub 1996		P
Pep-gl-2	-	*Peptidase with glycyl-leucine* (E.C. # 3.4.13.11). Isozyme variant found segregating in PI 137851, 212896; 2 alleles observed.	Meglic and Staub 1996		P
Pep-la	-	*Peptidase with leucyl-leucine* (E.C. # 3.4.13.11). Isozyme variant found segregating in PI 169380,175692, 263049, 289698, 354952, 5 alleles observed.	Knerr and Staub, 1992		P
Pep-pap	-	*Peptidase with phenylalanyl-L-proline* (E.C. # 3.4.13.11). Isozyme variant found segregating in PI 163213, 188749, 432861; 2 alleles observed.	Knerr and Staub, 1992		P
Per-4	-	*Peroxidase* (E.C. # 1.11.1.7). Isozyme variant found segregating in PI 215589; 2 alleles observed.	Knerr and Staub, 1992		P
Pgd-	-	*Phosphogluconate dehydrogenase-1* (E.C. #	Knerr and Staub,		P

1		1.1.1.43). Isozyme variant found segregating in PI 169380, 175692, 222782; 2 alleles observed.	1992		
Pgd-2	-	*Phosphogluconate dehydrogenase-2* (E.C. # 1.1.1.43). Isozyme variant found segregating in PI 171613,177364, 188749, 263049, 285606, 289698, 354952, 419214, 432858; 2 alleles observed.	Knerr and Staub, 1992		P
Pgm-1	-	*Phosphoglucomutase* (E.C. # 5.4.2.2.). Isozyme variant found segregating in PI 171613, 177364, 188749, 263049, 264229, 285606, 289698, 354952; 2 alleles observed.	Knerr and Staub, 1992		P
pl	-	*pale lethal.* Slightly smaller pale-green cotyledons; lethal after 6 to 7 days. *Pl* from 'Burpless Hybrid'; *pl* from a mutant of 'Burpless Hybrid'.	Whelan, 1973		L
pm-1	-	*powdery mildew resistance-1.* Resistance to *Sphaerotheca fuliginea. Pm-1* from 'Natsufushinari'.	Fujieda and Akiya, 1962; Kooistra, 1971	Shanmugasundarum et al., 1972	?
pm-2	-	*powdery mildew resistance-2.* Resistance to *Sphaerotheca fuliginea. Pm-2* from 'Natsufushinari'.	Fujieda and Akiya, 1962; Kooistra, 1971	Shanmugasundarum et al., 1972	?
pm-3	-	*Powdery mildew resistance-3.* Resistance to *Sphaerotheca fuliginea. Pm-3* found in PI 200815 and PI 200818.	Kookiest, 1971	Shanmugasundarum et al., 1972	W
pm-h	*s, pm*	*powdery mildew resistance expressed by the hypocotyl.* resistance to powdery mildew as noted by no fungal symptoms appearing on seedling cotyledons is recessive to susceptibility. *Pm-h* from 'Wis. SMR 18'; *pm-h* from 'Gy 2 *cp cp*', 'Spartan Salad' and Wis. 2757.	Fanourakis, 1984; Shanmugasundarum et al., 1971b		W
pr	-	*protruding ovary.* Extended carpels. *Pr* from 'Lemon'.	Youngner, 1952		W
prsv	*wmv-1-1*	*watermelon mosaic virus 1 resistance.* Resistance to papaya ringspot virus (formerly watermelon mosaic virus 1). Wild type *prsv+* from WI2757; *prsv* from 'Surinam'.	Wang et al., 1984		W
psl	*pl*	Pseudomonas lachrymans *resistance.* Resistance to *Pseudomonas lachrymans* is recessive. *Psi* from 'National Pickling' and 'Wis. SMR 18'; *psl* from MSU 9402 and Gy 14.	Dessert et al., 1982		W
R	-	*Red mature fruit.* Interacts with *c*; linked or pleitropic with *B* and *H.*	Hutchins, 1940		W
rc	-	*revolute cotyledon.* Cotyledons are short, narrow, and cupped downwards; enlarged perianth. *Rc* from 'Burpless Hybrid' mutant.	Whelan et al. 1975		L
ro	-	*rosetts.* Short internodes,muskmelon-like leaves. *Ro* from 'Megurk', the result of a cross	De Ruiter et al., 1980.		W

		involving a mix of cucumber and muskmelon pollen.			
s	*f, a*	*spine size and frequency.* Many small fruit spines, characteristic of European cultivars is recessive to the few large spines of most American cultivars.	Strong, 1931; Tkachenko, 1935	Caruth, 1975; Poole, 1944	W
s-2	-	*spine-2.* Acts in duplicate recessive epistatic fashion with*s-3* to produce many small spines on the fruit. *S-2* from Gy 14; *s-2* from TAMU 72210.	Caruth, 1975		?
s-3	-	*spine-3.* Acts in duplicate recessive epistatic fashion with *s-2* to produce many small spines on the fruit. *S-3* from Gy 14; *s-3* from TAMU 72210.	Caruth, 1975		?
sa	-	*salt tolerance.* Tolerance to high salt levels is attributable to a major gene in the homozygous recessive state and may be modified by several minor genes. *Sa* from PI 177362; *sa* from PI 19240.			P
sc	cm	*stunted cotyledons.* Small, concavely curved cotyledons; stunted plants with cupped leaves; abnormal flowers. *Sc sc* from Wis. 9594 and 9597.	Shanmugasundarum and Williams, 1971; Shanmugasundarum et al., 1972		W
Sd	-	*Sulfur dioxide resistance.* Less than 20% leaf damage in growth chamber. *Sd* from 'National Pickling'; *sd* from 'Chipper'.	Bressan et al., 1981		W
sh	-	*short hypocotyl.* Hypocotyl of seedlings 2/3 the length of normal. Wild type *Sh* from 'Borszczagowski'; *sh* from khp, an induced mutant from 'Borszczagowski'.	Soltysiak and Kubicki 1988		?
shl	-	*shrunken leaves.* First and 2nd true leaves smaller than normal; later leaves becoming normal; slow growth; often dying before fruit set. Wild type S*hl* from 'Nishiki-suyo'; *shl* from M_2 line from pollen irradiation.	Iida and Amano, 19990, 1991		?
Skdh	-	Shikimate dehydrogenase (E.C. #1.1.1.25). Isozyme variant found segregating in PI 302443, 390952, 487424; 2 alleles observed.	Meglic and Staub, 1996		P
sp	-	*short petiole.* Leaf petioles of first nodes 20% the length of normal. *Sp* from Russian mutant line 1753.	Den Nijs and de Ponti, 1983		W
sp-2	-	*short petiole-2.* Leaf petioles shorter, darker green than normal at 2-leaf stage; crinkled leaves with slow development; short hypocotyl and stem; little branching. Not tested for allelism with *sp.* Wild type *Sp-2* from 'Borszczagowski'; *sp-2* from chemically induced mutation.	Rucinska et al., 1992a		?
ss	-	*small spines.* Large, coarse fruit spines is dominant to small, fine fruit spines. *Ss* from	Fanourakis, 1984; Fanourakis and		W

		'Spartan Salad', 'Wis. SMR 18' and 'GY 2 *cp cp';* ss from Wis. 2757.	Simon, 1987		
T	-	*Tall plant.* Tall incompletely dominant to short.	Hutchins, 1940		?
td	-	*tendrilless.* Tendrils lacking; associated with misshapen ovaries and brittle leaves. Td from 'Southern Pickler'; *td* from a mutant of 'Southern Pickler'.	Rowe and Bowers, 1965.		W
te	-	*tender skin of fruit.* Thin, tender skin of some European cultivars; recessive to thick tough skin of most American cultivars.	Poole, 1944; Strong, 1931		W
Tr	-	*Trimonoecious.* Producing staminate, perfect, and pistillate flowers in this sequence during plant development. *Tr* from Tr-12, a selection of a Japanese cultivar belonging to the Fushinari group; *tr* from H-7-25. MOA-309, MOA-303, and AH-311-3.	Kubicki, 1969d		P
Tu	-	*Tuberculate fruit.* Warty fruit characteristic of American cultivars is dominant to smooth, non-warty fruits characteristic of European cultivars.	Strong, 1931; Wellington, 1913	Andeweg, 1956; Poole, 1944	W
u	*M*	*uniform immature fruit color.* Uniform color of European cultivars recessive to mottled or stippled color of most American cultivars.	Strong, 1931	Andeweg, 1956	W
ul	-	*umbrella leaf.* Leaf margins turn down at low relative humidity making leaves look cupped. *ul* source unknown.	den Nijs *and de Ponti, 1983*		W
v	-	*virescent.* Yellow leaves becoming green.	Strong, 1931; Tkachenko, 1931		L
vvi	-	*variegated virescent.* Yellow cotyledons, becoming green; variegated leaves.	Abul-Hayja and Williams, 1976		L
w	-	*white immature fruit color.* White is recessive to green.*W* from 'Vaughn', 'Clark's Special;', 'Florida Pickle' and 'National Pickling'; *w* from 'Bangalore'.	Cochran, 1938		W
wf	-	*White flesh.* Intense white flesh color is recessive to dingy white; acts with *yf* to produce F_2 of 12 white (*Wf Yf* and *wf Yf*) : 3 yellow (*Wf yf*) : 1 orange (*wf yf*). *Wf* from EG and G6, each being dingy white (*Wf* from EG and G6, each being dingy white (*Wd Yf*) : *wf* from 'NPI' which is orange (*wf yf*).	Kooistra, 1971		?
wi	-	*wilty leaves.* Leaves wilting in the field, but not in shaded greenhouse; weak growth; no fruiting. Wild type *Wi* from 'Nishiki-suyo'; *wi* from M_2 line from pollen irradiation.	Iida and Amano, 1990, 1991		?
Wmv	-	*Watermelon mosaic virus resistance.* Resistance to strain 2 of watermelon mosaic virus. *Wmv* from 'Kyoto 3 Feet'; *wmv* from	Cohen et al., 1971		P

		'Beit Alpha'.			
wmv-1-1	-	*watermelon mosaic virus-1 resistance.* Resistance to strain 1 of watermelon mosaic virus by limited systematic translocation; lower leaves may show severe symptoms. *Wmv-1-1* from Wis. 2757; *wmv-1-1* from 'Surinam'.	Wang et al., 1984		?
wy	-	*wavy rimed cotyledons.* Wavy rimed cotyledons, with white centers; true leaves normal. Wild type *Wy* from 'Nishiki-suyo'; *wy* from M_2 line from pollen irradiation.	Iida and Amano, 1990, 1991		?
yc-1	-	*yellow cotyledons-1.* Cotyledons yellow at first, later turning green. *yc-1* from a mutant of Ohio MR 25.	Aalders, 1959		W
yc-2	-	*yellow cotyledons-2.* Virescent cotyledons. Virescent cotyledons. *yc-2* from a mutant of 'Burpless Hybrid'.	Whelan and Chubey, 1973; Whelan et al., 1975.		W
yf	*v*	*yellow flesh.* Interacts with wf to produce F_2 of 12 white (*Wf Yf* and *wf Yf*) : 3 yellow (*Wf yf*) : 1 orange (*wf yf*). *Yf* from 'Natsufushinari', which has an intense white flesh (*Yf wf*); *yf* from PI 200815 which has a yellow flesh (*yf Wf*).	Kooistra,1971		P
yg	*gr*	*yellow-green immature fruit color.* Recessive to dark green and epistatic to light green. *yg* from 'Lemon'.	Youngner, 1952		W
yp	-	*yellow plant.* Light yellow-green foliage; slow growth.	Abul-Hayja and Williams, 1976		?
ys	-	*yellow stem.* Yellow cotyledons, becoming cream-colored; cream-colored stem, petiole and leaf veins; short petiole; short internode. Wild type *Ys* from 'Borszczagowski'; *ys* from chemically induced mutation.	Rucinska et al., 1991		?
zymv	-	*zucchini yellow mosaic virus resistance.* Inheritance is incomplete. Believed to be inherited in a recessive fashion with the source of resistance being 'TMG-1'.	Provvidenti, 1985		W

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Gene Nomenclature for the Cucurbitaceae

From: Robinson, R. W., H.M. Munger, T.W. Whitaker and G.W. Bohn 1976.

Genes of the Cucurbitaceae, HortScience 11:554-568.

1. Names of genes should describe a characteristic feature of the mutant type in a minimum of adjectives and/or nouns in English or Latin.
2. Genes are symbolized by italicized Roman letters, the first letter of the symbol being the same as that for the name. A minimum number of additional letters are added to distinguish each symbol.
3. The first letter of the symbol and name is capitalized if the mutant gene is dominant, and all letters of the symbol and name are in lower case if the mutant gene is recessive to the normal type. The normal allele of a mutant gene is represented by the symbol "+", or where it is needed for clarity, the symbol of the mutant gene followed by the superscript "+". The primitive form of each species shall represent the + allele for each gene, except where long usage has established a symbol named for the allele possessed by the normal type rather than the mutant.
4. A gene symbol shall not be assigned to a character unless supported by statistically valid segregation data for the gene.
5. Mimics, i.e. different mutants having similar phenotypes, may either have distinctive names and symbols or be assigned the same gene symbol, followed by a hyphen and distinguishing Arabic numeral or Roman letter printed at the same level as the symbol. The suffix-1 is used, or may be understood and not used, for the original gene in a mimic series. It is recommended that allelism tests be made with a mimic before a new gene symbol is assigned to it.
6. Multiple alleles have the same symbol, followed by a Roman letter or Arabic number superscript. Similarities in phenotype are insufficient to establish multiple alleles; the allelism test must be made.
7. Indistinguishable alleles, i.e., alleles at the same locus with identical phenotypes, preferably should be given the same symbol. If distinctive symbols are assigned to alleles that are apparent reoccurrences of the same mutation, however, they shall have the same symbol with distinguishing numbers or letters in parentheses as superscripts.
8. Modifying genes may have a symbol for an appropriate name, such as intensifier, suppressor, or inhibitor, followed by a hyphen and the symbol of the allele affected. Alternatively, they may be given a distinctive name unaccompanied by the symbol of the gene modified.
9. In cases of the same symbol being assigned to different genes, or more than one symbol designated for the same gene, priority in publication will be the primary criterion for establishing the preferred symbol. Incorrectly assigned symbols will be enclosed in parentheses on the gene lists.

From: **CGC Gene List Committee, 1982. Update of cucurbit gene list and nomenclature rules. CGC 5:62-66.**

The same symbol shall not be used for nonallelic genes of different *Cucurbita* species. Allelic genes of compatible species are designated with the same symbol for the locus.

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25. **Cohen, Yigal** Department of Life Sciences, Bar-Ilan University, Ramat-Gan 52 100, Israel. Ph: + 9723-5318251. Fax: + 9723-6771088. Melon.
26. **Cook, Kevin L.** Rogers Seed Co., Research Station, 10290 Greenway Road, Naples, FL 33961. Ph: (813) 774-6852. Fax: (813) 774-6852. Breeding of summer squash.

27. **Corella, Pilar** Asgrow Seed Co. Apdo. 175, 04700 El Ejido (Almeria), Spain. Ph: 34-51-580012, Fax: 34-51-581162.
28. **Coyne, Dermot P.** Department of Horticulture, University of Nebraska, Lincoln, NE 68583-0724 Ph: (402) 472-1126. Fax: (402) 472-2853. Email: *dcoyne@unlinfo.unl.edu.* Breeding, genetics, physiology, plant development and disease resistance of squash.
29. **Cramer, Chris** North Carolina St. Univ., Box 7609, Raleigh,NC 27695-7609. Ph.: (919) 515-1220. EmIl:*chris_cramer@ncsu.edu* Cucumber yield, yield components, combining ability, heterosis and recurrent selection.
30. **Cui, Hongwen** Department of Horticulture, Northwestern Agricultural Univ., Yangling, Shaanxi 712100, P.R. China. Cucumber breeding.
31. **Dane, Fenny** Dept. Horticulture, Auburn University, Auburn, AL 36849. Ph: (205) 844-3047. Email: *fdane@ag.auburn.edu.*
32. **Danin-Poleg, Yael** A.R.O., Newe Ya-ar Expt. Station, P.O. Box 1021, Ramat Yishay 30095, Israel. Ph.: 972-4-9539553/4. Fax: 972-4-9836936. Email: *geneweya@netvision.net.il.*
33. **de Groot Erik** Breeding, Sementi Nunhems S.R.L., Via Ghiarone, 2, 40019 S. Agata Bolognese, Italy.
34. **de Ruiter, A.C.** de Ruiter Zonen CV, Postbus 1050, 2660 BB Bergeschenhoek, The Netherlands. Ph: 010-5292204. Fax: 010-5216125. Breeding and seed production of cucumbers.
35. **Decker-Walters, Deena** The Cucurbit Network, 11901 Old Cutler Road, Miami, FL 33156-4242. Ph: (305) 667-3800. Fax: (305) 661-5984. Email: *walters@fiu.edu.* Communication via The Cucurbit Network; the whole family Cucurbitaceae.
36. **Della, Vecchia Paulo T.** Agroflora S/A, Caixa Postal 427, 12.900-000 Braganca, Paulista - SP, Brazil. Ph: 011-7871-0855. Fax: (011) 7843-6572. Breeding & genetics, seed production and disease resistance of melon and squash..
37. **Denlinger, Phil** Mt. Olive Pickle Co., Inc., P.O. Box 609, Mount Olive, NC 28365. Ph: (919) 296-1996..
38. **Dhaliwal, Major Singh** Dept. of Vegetable Crops, L.S. & F. Punjab Agriculture University, Ludhiana-141001, Punjab, India
39. **DiNitto, Louis** Sunseeds, 8850 59th Ave., N.E., Brooks, OR, 97305. Ph.: (503) 393-3243, Fax: (503) 390-0982. Melon (Cucumis melo)
40. **Dogimont, C.**,INRA, St. Maurice, BP 94, 84143 Montavet, France.
41. **Drowns, Glenn** Sand Hill Preservation Center, 1878 230th Street, Calamus, IA 52729. Ph: (319) 246-2299. Genetic preservation of all cucurbits. Taxonomy of Cucurbita moschata and Cucurbita argyrosperma.
42. **Dunlap, James** Texas Agric. Expt. Ststion, 2415 E. Highway 83, Weslaco, TX 78596. Ph: (210) 968-5585, Fax:: (210) 968-0641. E-mail: *j-dunlap@tamu.edu* Melon physiology - fruit development and ripening.
43. **Duangsong, Usa** Peto Thailand, P.O. Box 171, 99 Moo 2, Wiang-Y, Mae Gorn, A Muang Chiang Rai 57000, Thailand.
44. **Eigsti, Orie J.**. 1602 Winsted, College Green, Goshen, ID 46526. Ph.: (219) 533-4632. Polyploid Citrullus lanatus.
45. **El, Jack Ali Elamin** Dept. Horticulture, Fac. Agric. Sciences, University of Gezira, Wad-Medani, P.O. Box 20, Sudan.
46. **Elmstrom, Gary.** Pioneer Vegetable Genetics. 18285 County Road 96, Woodland, CA 95695. Ph: (916) 666-6136. Triploid watermelon breeding.
47. **Everts, Kate** LESREC, Univ. Maryland, 27664 Nanticoke Road, Salisbury, MD 21801-1648. Ph.: (410) 742-8780. Fax: (410) 749-1922. Email: *ke@umail.umd.edu* Diseases of cucurbit vine crops.
48. **Ezura, Hiroshi** Plant Biotech Inst., Ibaraki Aric Ctr, Ago, Iwama, Nishi-ibaraki, 319-02, Ibaraki, Japan. Ph.: 0299-45-8330. Fax: 0299-45-8351.
49. **Fanourakis, Nikolaos E.** Technological Educational Institute, Heraklion Crete 71500, Greece.
50. **Funakushi, Hisashi** Mikado Seed Growers Co., Ltd., 1203 Hoshikuki, Chuo-Ku, Chiba City 260, Japan. Ph: 81-43-265-4847, Fax: 81-43-266-6444.
51. **Gaba, Victor** Dept. Virology, Inst. Plant Protection, A.R.O.,Volcani Center, P.O.B. 6, Bet Dagan 50250, Israel. Ph: 972-3-9683568/9, Fax: 972-3-9604180. E-mail:*vpgaba@volcani*.Tissue Culture & transformation..
52. **Gabert, August C.** Sunseeds Genetics, Inc. 8850 59th Avenue NE, Brooks, OR 97305-9625. Ph: (503) 393-3243, Fax: (503) 390-0982. Cucumber and summer squash breeding and genetics.
53. **Gaggero, James M.** 8276 Canyon Oak Drive, Citrus Heights CA 95610. Ph: (916) 722-5519, Fax: (916) 753-1912. Cucurbitacins.
54. **Garrett, J.T.** Pee Dee Res. & Educ. Center. 500 West Pocket Road, Florence, SC 29501.Ph.: (803) 66203526. Fax: (803) 661-5676. Email: *jtgrrt@ prism.clemson.edu.* Production systems, especialy stand establishment.
55. **Gatto, Gianni** Esasem Spa, Via San Biagio 25, 37052, Casaleone (VR) Italy. Ph.: 0442/331633. Fax: 0442/330834. Email: *GGatto@esasem.it.*
56. **Gautier, Granes** Boite Postale No. 1, 13630, Eyragues, France. Ph: 90.94.13.44, Fax: 90.92.83.96.
57. **Gomez, Humberto** IRTA, Centre de Cabrils, 08348 Cabrils (Barcelona), Spain. Ph.: (93) 750 75 11. Fax: (03) 753 39 54.
58. **Gomez-Guillamon, M. Luisa** Estacion Experimental "La Mayora". 29750 Algarrobo-Costa, Malaga, Spain. Ph: (952)

51 10 00. Fax: (952) 51 12 52. Email: *guillamon@mayora.csic.es*

59. **Green, C.Ed** Seminis Vegetable SEeds, Inc. 37437 State Highway 16, Woodland, CA 95695. Ph: (916) 666-09031, Fax: (916) 668-0219.
60. **Groff, David.** Asgrow Seed Company, Rt. #1, Box 1907, Omega TyTy Road, Tifton, GA, 31794. Ph: (912) 386-8701, Fax: (912) 386-8805. Breeding of squash, cuucumber, melon and watermelon.
61. **Grumet, Rebecca** Dept. Hort., Plant & Soils Building, Michigan State University, East Lansing, MI 48824-1325. Ph: (517) 353-5568, Fax: (517) 353-0890. Email: *grumet@pilot.msu.edu*. Disease resistance, gene flow, tissue culture and genetic engineering.
62. **Hagihara, Toshitsugu** Hagihara-Farm-Cp., Ltd., Hokigi, Tawaramoto-cho, Siki-gun, Nara-ken, 636-03, Japan. Ph.: 07443-3233. Fax: 07443-4332.
63. **Haim, Davidi** Hazera Ltd., Mivhor Farm Doar, Sede Gat 79570, Israel.
64. **Han, Sang Joo** Seoul Seed Intl Co.Ltd., Chongill B/D, 736-17 Yeoksam-Dong, Kangnam-gu, Seoul, Korea. Ph: (2) 569-7147, Fax: (2) 552-9439. Email: *seedexsj@hitel.kol.co.kr.* Disease resistance.
65. **Hassan, Ahmed Abdel-Moneim** Department of Vegetable Crops, Fac. Agriculture, Cairo University, Giza, Egypt. Ph: 724107 & 724966. Cucumber, melon, squash & watermelon germplasm evaluation and breeding for disease resistance, incl. viruses.
66. **Havey, Michael J.** USDA/ARS, Department of Horticulture, University of Wisconsin, Madison, WI, 53706. Ph: (608) 262-1830, Fax: (608) 262-4743. E-mail: *mjhavey@macc.wisc.edu.*
67. **Herman, Ran** "Zeraim" Seed Growers Company Ltd., Department of Breeding, Gedera 70 700, Israel. Ph: 08-59 27 60, Fax: 08-59 43 76.
68. **Herrington, Mark Edward**. 21 Warner Street, Welling Point, Queensland 4160, Australia. Ph: 07 2861488.
69. **Hertogh, K.** Nickerson-Zwaan b.v., Postbus 19, 2990 AA Barendrecht, The Netherlands.
70. **Heuvelmans, Paul** Leen de Mos, groentezaden BV, Noordlandseweg 54, P.O. Box 54, 2690 AB's-Gravenzande, The Netherlands. Ph.: + 31 174 41 20 31. Fax: + 31 174 41 73 57.
71. **Himmel, Phyllis** Asgrow Seed Company, 500 Lucy Brown Lane, San Juan Bautista, CA 95045.
72. **Hirabayashi, Tetsuo** Nihon Horticultural Production Inst., 207 Kamishki, Matsudo-shi, Chiba-ken, 271, Japan. Ph: 0473-87-3827, Fax: 0473-86-1455. Varietal improvement of cucurbit crops, especially melon, cucumber and pumpkin.
73. **Hollar, Larry A.** Hollar & Co., Inc., P. O. Bos 106, Rocky Ford, CO 81067. Ph: (719) 254-7411, Fax: (719) 254-3539. Email: *lahollar@iguana.rural-net.net.* Cucurbit breeding and seed production.
74. **Holle, Miguel** CALCE 2, #183 Urb. El Rancho, Miraflores-Lima 18, Peru. Ph.: 51-14-383749. Fax: 51-14-351570. Email: *mholle@cipa.org.pe.* Plant genetic resources.
75. **Hong, Kue-Hyon** Vegetable Breeding Div, NHRI, 540 Tap-Dong, Suwon 441-440. Republic of Korea. Ph.: 82-331-290-6181. Fax: 81-331-295-9548.
76. **Humaydan, Hasib** Ag Consulting International. 317 Red Maple Drive, Danville, CA 94506. Ph.: (510) 736-1241. Fax: (510) 736-1241.
77. **Hutton, Mark** Sunseeds Genetics, Inc., 8850 59th Ave NE, Brooks, OR 97305-0982. Ph.: (503) 463-7670, Fax: (503) 390-0982. Email: *sunseeds/brooks/mhutton%sunseeds@mcimail.* Squash breeding and cultivar development.
78. **Ibrahim, Aly M.** USDA-ARS, 1636 E. Alisal St., Salinas, CA 93905. Cucumber, melon, watermelon.
79. **Ignart, Frederic** Centre de Recherche TEZIER, Route de Beaumont, Domaine de Maninet, 26000 Valence, France. Ph: (33) 75575757, Fax: (33) 75552681. Squash and melon breeding.
80. **Iida, Akira** Minowa Noen, 63-1 Ichieda-cho, Yamato-Kohriyama City, Nara Pref., Japan, T639-11.
81. **Ikeda, Satoru** Sakata Seed America, Inc., P.O. Box 1118, Lehigh, FL 33970-1118. Ph.: (941) 369-0032. Fax: (941) 369-7528.
82. **Ito, Kimio** Vegetable Breeding Laboratory, Hokkaido Natl. Agric. Expt. Sta. Hitsujigaoka. Sapporo 062. Japan. Ph: 011(851)9141. Fax: 011(859)2174.
83. **Jain, Jaagrati** B-149, M.P. Enclave, Pitampura, Delhi - 110034, India. Ph.: 7183099. Muskmelon genetics and tissue culture.
84. **Ji, Jiabin** Institute of Vegetable Crops, Jiangsu Acad. Agr. Sciences, Nanjing 210014, P.R. China.
85. **Jiang, Jiping** Seminis Vegetable Seeds, 37437 State Highway 16, Woodland, CA 95695. Ph.: (916) 666-0931. Fax: 916) 668-0219. Developing disease screens for fungal diseases of cucurbits.
86. **Johnston, Rob.** Johnny's Selected Seeds. Foss Hill Road, Albion, ME 04910-9731. Ph: (207) 437-9294. Fax: (207) 437-2603.
87. **Kaminimura, Shoji** 421-19 Furuichi-machi, Macbashi City, Gunma-ken 371, Japan.
88. **Kampmann, Hans Henrick** Breeding Station Danefield, Odensevej 82, 5290, Marslev, Denmark. Ph.: 65 95 17 00. Fax: 65 95 12 93.
89. **Kanno, Tsuguo** Dept Upland Farming, Tohoku Natl. AES, 50, Arai, Fukushima, Fukushima Prefecture, Japan 960-21.
90. **Karchi, Zvi** 74 Hashkedim St., Kiryat-Tivon 36501, Israel. Ph.: 04-9830107. Fax: 972-4-9836936. Cucurbit breeding,

cucurbit physiology.

91. **Kato, Kenji** Fac. Agriculture, Okayama Univ., 1-1-1 Tsushima Naka, Okayama, 700 Japan. Ph.: 81-86-251-8323. Fax: 81-86-254-0714. Email: *kenkato@ccews2.cc.oklayama-u.ac.jp.* Use of molecular markers for QTL mapping and cultivar identification in melon.
92. **Katzir, Nurit** A.R.O. Newe Ya-ar Expt. Station, P.O. Box 9000. Haifa 31900, Israel.
93. **Kee, Ed** University of Delaware, RD 2, Box 48, Georgetown, DE 19947. Ph.: (302) 856-7303. Cucurbit crop production and protection.
94. **King, Joseph J.** Seminis Vegetable Seeds, Inc. 37437 State Highway 16, Woodland, CA 95695. Ph.: (916) 666-0931. Fax: (916) 666-5759. Email: *joe.king@svseeds.com/* Genetics and breeding of melon, cucumber and squash.
95. **King, Stephen R.** Seminis Vegetable Seeds, Inc. 37437 State Hwy, 16, Woodland, CA 95695. Ph.: (916) 666-0931. Fax: (916) 668-0219. Emaiol: *srking2570@aol.com.* Melon breeding.
96. **Kirkbride, Joseph H, Jr.** USDA-ARS. Systematic Bot. & Mycol. Lab, Rm 304, . Bldg. 011A, BARC-West, Beltsville, MD 20705-2350. Ph: (301) 504-9447. Fax: (301) 504-5810. E-mail:*jkirkbri@asrr.arsusda.gov.* Systematic taxonomy of the Cucurbitaceae.
97. **Klapwijk, Ad** de Ruiter Zonen CV. Postbus 1050, 2660 BB Bergschenhoek, The Netherlands. Ph: 010-5292253. Fax: 010-5292410.
98. **Knerr, Larry D.** Shamrock Seed Company. 3 Harris Place, Salinas, CA 93901-4586. Ph: (408) 771-1500. Fax: (408) 771-1517. E-mail: *ldknerr@aol.com* Varietal development of honeydew.
99. **Konno, Yoshihiro** Asahi Ind., Biol. Engin. Lab., 222 Wataruse, Kamikawa-machi, Kodama-gun, Saitama 367-03, Japan. Ph.: 0274-52-6339. Fax: 0274-52-4534. Watermelon breeding.
100. **Kown, Young-Seok** Alpine Agriculture expt. Sta., Heong-kye=Ri, doam-Myun, Pyeongchang-gun, Kangwon-Do, Rep. Korea 232-950. Email: *kwong@chollian.dacom.co.kr*. Watermelon germplasm evaluation and breeding for disease resistance.
101. **Kraakman, Peter** Ctra. de Malaga N 340 s/n, El Parador - Hortiheuhas, Almeria, Spain. Ph.: 00-34-50343787**07. Fax: 00-34-50-343710.
102. **Kuginuki, Yashuhisa** National Res. Institute Veg/Orn/Tea, Crop Research Station, Ano, Mie 514-23, Japan. Ph.: 0592-68-1331, Fax: 0592-68-1339. Breeding for resistance to disease.
103. **Kuhlmann, Hubert** Fink GmbH, Benzstrasse 25, D-71083 Herrenberg, Germany. Ph.: (07032) 922-122. Fax: (07032) 922-202.
104. **Kuti, Joseph O.** Dept. Agron & Res Sci, Hort Crops Lab, Taxas A&M University- Kingsville, Kingsville, , TX, 78363. Ph: (512) 595-3711, Fax: (512) 595-3713. Email: *kgjok00@taiu.edu.* Breeding and genetics; host-parasite interrelationships; postharvest physiology.
105. **Kwack, Soo-Nyeon** Dept Hort Breeding, Mokpo Natl Univ., Dorimri, Chonggyemyun, Muangun, Chonnam 534-729, Korea.
106. **Kwon, Young-Seok** Horticultural Experiment Station, 20 Kangdongdong, Kangseoku, Pusan, Rep. Korea 618-300.
107. **Kyle, Molly** Cornell Univ., Dept. Plant Brding & Biom, 312 Bradfield Hall, Ithica, NY, 14853-1902. Ph.: (607) 255-8147, Fax: (607) 255-6683, E-mail: *mmk9@cornell.edu.* Melon and squash breeding and genetics.
108. **Lecouvior, Michel** Clause Semences Professionelles, 24, boulevard P. Brossolette, 91221 Bretigny-sur-Orge, France.
109. **Lehmann, Louis Carl** Dept. Plant Breeding Reesearch. Swedish Univ. Agricultural Sci., S-268 31 Svaloev, Sweden.. Ph.: 46-418-67200, Fax: 46-418-67081. E-mail: *louis.lehmann@vf.slu.se.*
110. **Lester, Gene** USDA/ARS, Subtropical Agric Res Lab. 2301 S. International Blvd. Weslaco, TX 78596. Ph.: (210) 565-2647. Fax: (210) 565-6133. Email: *glester@pop.tamu.edu.* Stress and pre/postharvest physiology of melons.
111. **Lim, Hak-Tae** Kangwon National Univ., Div. Applied Plant Sciences, Chuncheon, 20-701, Korea. Ph.: +82-361-50-6425. Fax: + 82-361-54-3835. Email: *limhakta@cc.kangwon.ac.kr.*
112. **Lin, Depei** Sichuan Academic Agric. Science, Hortseed Cener, Chengdu 61006, People's Rep. China. Ph.: (028) 491732. Fax: (028) 4442025. Watermelon,melon and Cucurbita breeding.
113. **Love, Stephen Loyd.** Aberdeen R&E Center, P.O. Box AA, Aberdeen ID, 83210. Ph.: (208) 397-4181, Fax: (208) 397-4311. Email: *slove@uidaho.edu.* Small scale private watermelon breeding with emphasis on adaptation to cold climates.
114. **Lower, Richard. L.** Coll. Agriculture, Univ. Wisconsin, 1450 Linden Drive, Room 136, Madison, WI 53706. Ph.: (608) 262-2349, Fax: (608) 262-6434. E-mail: *richard.lower@ccmail.adp.wisc.edu.* Effects of plant type genes on yield, sex-expression, growth parameters, pest resistance & adaptability.
115. **Loy, J, Brent** Plant Biology Dept, Nesmith Hall, University of New Hampshire, Durham NH 03824. Ph.: (603) 862-3216, Fax: (603) 862-4757. Email: *jbloy@christa.unh.edu.* Squash, melon, pumpkin. Genetics, breeding, plasticulture, mulch, rowcovers.
116. **Lydon, Lewis R.B.** Arthur Yates & Co., Pty. Limited, Research Farm, Borroway Road, Narromine, N.S.W. 2821.

Australia. Ph.: (068) 89-1144.

117. **Ma, Dewei** Department of Horticulture, Herbei Agricultural University, Baoding, Hebei 071000, P.R. China.
118. **Maggs, Gillian** National Herbarium (WIND), NBRI, Private Bag 13184, Windhoek, Namibia.
119. **Maluf, Wilson Roberto** Dept. de Agricultura/UFLA, Caixa Postal 37, 37200-000 Lavrs-MG, Brazil. Ph.: (035) 829-1326. Fax: (035) 829-1301. Email: *esal@eu.ansp.br.* Cucumbers, melons, squashe
120. **Maneesinthu Likhit** Thep Watana Seeds Co., Ltd. 293-293/1-2, Surwongese Road, Bankok, 10500, Thailand. Ph.: 66-2376540. Fax: 66-2-2376543. Breeding and seed production of cucumber, watermelon, melon and pumpkin.
121. **Markiewicz-Ladd, Krystina** Polonica International, P.O. Box 2305, Gilroy, CA 95021. Ph.: (408) 842-1022. Fax: (408) 675-0103. Melons - breeding, new germplasm, postharvest physiology, biotechnology, cultural practices, new diseases.
122. **Martyn, Ray D.** Dept. Botany & Plant Pathology, PurdueUniversity, West Lafayette, IN 47907-1155. Ph.: (765) 494-4615. Fax: (765) 494-0363. Email: *Martyn@btny.purdue.edu.* Soilborne diseases of watermelon and melon, particularly the fusarium wilts and vine declines.
123. **Matsuura, Seiji** Kiyohara Breeding Sta. Tohoku Seed Co. 1625, Nishihara, Himuro, Utsunomiya, Japan. Ph.: 0286-34-5428. Fax: 0286-35-6544.
124. **Maynard, Donald N.** Univ. Florida, 5007 60th Street East, bradentoj, FL 34203. Ph.: (941) 751-7636, Fax: (941) 751-7639. Email: *bra@gnv.ifas.ufl.edu.* Tropical moschata improvement; watermelon variety evaluation and production practices.
125. **McClurg. Charles A.** University of Maryland, Department of Horticulture, College Park, MD 20742-5611. Ph.: (301) 405-4342. Fax: (301) 314-9308. E-mail: *cm19@umail.umd.edu* Production and culture of cucurbit crops.
126. **McCreight, J. D.** USDA-ARS, 1636 E. Alisal St., Salinas, CA 93915. Ph.: (408) 755-2864, Fax: (408) 753-2866. E-mail: *jmcreig@asrr.arsusda.gov.* Melon breeding and genetics.
127. **McGrath, Desmond John.** Dept. Primary Ind., Hortic. Res. Sta., P.O. Box 538, Bowen. 4805. Queensland, Australia. Ph.: + 61-77-852255, Fax: + 61-77-852427. Disease resistance in Cucumis melo, particularly gummy stem blight..
128. **Meadows, Mike** Rogers NK Seed Co., 10290 Greensway Road, Naples, FL 34114. Ph.: (941) 775-4090. Fax: (941) 774-6852. Email: *Mike.Meadows@GWA.Sandoz.com.* Vegetable diseases.
129. **Merrick, Laura C.** Dept. Appl. Ecology & Environ. Sci., 5722 Deering Hall, Univ. Maine, Orono, ME 04469-5722. Ph.: (207) 581-2950, Fax: (207) 581-2199.Email: *merrick@maine.maine.edu* Cucurbita evolution, cucurbit germplasm evaluation and conservation, ethnobotany and evolution.
130. **Milerue, Sompong** Peto Thailand, P.O. Box 171, 99 Moo 2, Wiang-Y, Mae Gorn, A Muang Chiang Rai 57000, Thailand.
131. **Mochizuki, Tatsuya** Kurume Br, Natl Res Inst Veg/Orn/Tea, 1823 Mii-machi, Kurume, Fukuoka 830, Japan. Ph.: 0942-43-8271. Fax: 0942-43-7014.
132. **Mohamed, Yousisf Fadlalla** Dept. Plant Pathology, Fac. Agric. Sci., Univ. Gezira, Wad Medani, P.O. Box 20, Sudan.
133. **Moraghan, Brian J.** Asgrow Seed Co. P.O. Box 667, Arvin, CA 93203. Ph.: (805) 854-2390, Fax: (805) 854-4379. Melon and watermelon breeding and disease resistance.
134. **Morelock, Ted** Dept. Horticulture & Forestry, University of Arkansa, Fayetteville, AR, 72701. Ph.: (501) 575-2603. Fax: (501) 575-8619. Email: *mmorelock@comp.uark.edu.* Cucumber breeding.
135. **Munger, H.M.** Cornell University, 252 Emerson Hall, Ithica NY 14853. Ph.: (607) 255-1661, Fax: (607) 255-6683. Cucurbit breeding and disease resistance.
136. **Navazio, John** Chriseed, P.O. Box 1788, Mount Vernon, WA 98273. Ph.: (360) 336-9727 Fax: (360) 424-9520. Breeding for increased pigments in cucurbits, carrots and beets.
137. **Nea, Larry** Seminis Vegetable Seeds, 37437 State Highway 16, Woodland, CA 95695. Ph.: (916) 666-0931. Fax: (916) 668-0219. Cucumbers, melons, squash, watermelon.
138. **Nechama Shulamit** Breeding Department, Mivhor Farm, Post Sde Gat 79570, Israel .
139. **Ng, Timothy J.** Department of Horticulture, University of Maryland, College Park, MD 20742-5611. Ph.: (301) 405-4345. Fax: (301) 314-9308. E-mail: tng@umail.umd.edu. Melon breeding and genetics; postharvest physiology; seed germination.
140. **Niemirowicz-Szczytt, Katarzyna** Warsaw Ag. Univ. Dept. Gen & Plt Brdmg, ul. Nowoursynowska 166, 02-766 Warsw, Poland. Ph.: 43 09 82. Fax: (48022) 471562 Cucumber, melon, winter and summer squash, watermelon - genetics, breeding, tissue culture, biotechnology.
141. **Norton, J.D.** Department of Horticulture, Auburn University, Auburn, AL, 36849. Ph.: (205) 844-3031, Fax: (205) 844-3131. Breeding and genetics of melon and watermelon.
142. **Nuez, Fernando** Cat. de Genetica, ETS Ingen. Agron., Univ. Politenica, Camino de Vera, 14, 4620 Valencia, Spain.
143. **Nugent, Perry** USDA-ARS, U.S. Vegetable Laboratory, 2875 Savannah Highway, Charleston, SC, 29414. Ph.: (803) 556-0840. Melon and watermelon inheritance studies, pest resistance, stress resistance, and fruit quality.
144. **Oliveria de Paiva, Waldelice** Centro Nacional de Pesquisa de Agroindustria Tropical, EM-BRAPA/CNPAT - Caixa

Postal 3761, Rua Dra. Sara Mesquita 2270, 60511-110, Fortaleza, Ceara, Brazil. Ph.: (085) 299.18.01. Fax: (085) 299.18.03. Email: *Walde@cnpat.embrapa.br.*

145. **Om, Young-Hyuan** Alpine Agriculture Exp. Station,Heongkya-Ri, Doam-Myun, Pyeongchang-Gun, Kangwon-Do 232-950, Republic of Korea. Ph.: 82-374-35-0461, Fax: 82-374-36-5316. Email: *omy@chollian.dacom.co.kr.*
146. **Omara, Sadig Khidir** Dept. Horticulture, Fac. Agric. Sci., University of Gezira, Wad-Medani, P.O. Box 20, Sudan.
147. **Ortea, Sergio Garza** Univ. Sonora, Dept. Agric. y Ganad., A.P. Postal 305, Hermosillo, Sonora, Mexico. Breeding of Cucurbita spp.; testing of new muskmelon lines.
148. **Ouyang, Wei** Seminis Vegetable Seeds, 37437 State Highway 16, Woodland, CA, 95695. Ph.: (916) 666-0931, Fax: (916) 668-0219. Squash & cucumber breeding.
149. **Owens, Ken**. Seminis Vegetable Seeds, Inc. 37437 State Highway 16, Woodland, CA 95695. Ph.: (916) 666-0931, Fax: (916) 668-0219. Cucumber breeding.
150. **Palmer, Louis** Pioneer Vegetable Genetics, 4331 Cochroach Bay Road, Ruskin, FL 33570-2612. Ph.: (813) 645-3946. Fax: (813) 645-4900. Breeding and genetics.
151. **Palomares, Gloria**. Dept Biotechnologia, Univ Politecnia, Camino de Vera, s/n., E-46022 Valencia, Spain. Ph.: 34 (6) 387 74 20. Fax: 34 (6) 387 74 29. E-mail: *secret@btc.upv.es.*
152. **Paris, Harry** Division of Vegetable Crops, A.R.O., Newe Ya'ar Expt. Station, P. O. Haifa, Israel . Ph.: 972-4-894516. Fax: 972-4-836936. Breeding and genetics of squash, melon and watermelon.
153. **Piero, Abril Jose Luis** Apartado de Correos no. 2, 04720 Agudulce, Almeria, Spain. Fax: 34 50 32 32 01.
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160. **Pootstchi, Iraj** 97 St. Marks Road, Henley-on-Thames RG9 1LP, England.
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162. **Provvidenti, Rosario** Cornell Univ., Dept. Plant Pathology, NY State Agric. Experiment Sta., Geneva, NY, 14456-0462. Ph.: (315) 787-2316, Fax: (315) 787-2389. Email: *rp13@cornell.edu.* Breeding & genetics of resistance to viral diseases of cucumber, squash, melon, watermelon & other cucurbits.
163. **Punja, Zamir K.** Dept. Biological Sciences, Simon Fraser University, Burnaby, B.C. V5A 1S6, Canada. Emaiol: *punja@sfu.ca*
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165. **Ray, Dennis** Department of Plant Sciences, University of Arizona, Tucson, AZ 85721. Ph.: (520) 621-7612, Fax: (520) 621-7186. E-mail: *dtray@ccit.arizona.edu.* Genetics and cytogenetics of Cucumis melo and Citrullus spp.
166. **Reuling, G.** Nunhens Zaden B.V., P.O. Box 4005, 6080 AA Haelen, The Netherlands, Ph.: 04759-9222, Fax: 04759-9223/5104.
167. **Rhodes, Billy B.** Clemson Univ./Horticulture, Poole Agricultural Center, Clemson, SC 29634-0375. Ph.: (803) 656-0410, Fax: (803) 656-04960. Email: *bill_rhodes@quickmail.clemson.edu*. Watermelon genetics, breeding, micropropagation, disease resistance, male sterility, triploids.
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170. **Roig, Luis A.** Departamental Biotechnology, ETS.Ingen. Politec., Camino de Vera 14, 46022-Valencia, Spain. Ph.: 34(6) 3877424, Fax: 34(6) 3877429.
171. **Rumsey, Anthony E.** New World Seeds Pty Ltd., P.O. Box 18, Dural 2158, 22-24 Crosslands Road, Galston, N.S.W., Australia.
172. **Sarfatti, Matti** Hazera Ltd. , Research Dept., Mihvor, M.P., Lakhish Daram 79354, Israel.
173. **Schroeder, Robert Harold** Harris Moran Seed Co., R.R. 1, Box 1243, Davis, CA. 95616. Ph.: (916) 756-1382, Fax: (916) 756-1016. Incorporating disease resistance into useful commercial cultivars.
174. **Schultheis, Jonathan R.** Dept. Hortioculture, 264 Kilgore Hall, North Carolina St. University, Raleigh, NC 27695-7609. Ph.: (919) 515-3131, Fax: (919) 515-7747.Email: *johathan_schultheis@ncsu.edu.*
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177. **Shiffris, Oved** 21 Walter Avenue, Highland Park, NJ 08904. Ph.: (908) 246-0028. Regulation of the B genes in Cucurbita.
178. **Shiga, Toshio** Plant Biotech. Ctr., Sakata Seed Corp., 358 Uchikoshi, Sodegaura, Chiba, 299-02 Japan. Ph.: 0438-75-7276, Fax: 0438-75-2594. Cell biology.
179. **Simon, Philipp W.** USDA/ARS-Veg Crops, Dept. Hort, Univ. Wisconsin, 1575 Linden Dr., Madison, WI 53705. Ph.: (608) 262-1248, Fax: (608) 262-4743. E-mail:*psimon@facstaff.wisc.edu.* Breeding and genetics.
180. **Sipeyre, Bruno** Mas de Rouzel, Chemin des Canaux, 30900 Nimes, France. Ph.: 66.84.21.32, Fax: 66.38.09.42.
181. **Skirvin, Robert M.** Univ. Illinois, Dept. Horticulture, 258 PABL, 1201 Gregory Dr., Urbana, IL 61801. Ph.: (217) 333-1530. Fax: (217) 333-4777. E-mail: *skirvin@uxl.eso.uiuc.edu.* Micropropagation, somaclonal variation.
182. **Snyder, James W.** 1231 Kirkwood Drive, Vineland, NJ 08360. Ph.: (609) 794-3880. Fax: (609) 794-3881.
183. **Staub, Jack E.** USDA, ARS, Dept. Horticulture, Univ. Wisconsin, Madison, WI 53706-1590. Ph.: (608) 262-0028, Fax: (608) 262-4743. Email: *jestaub@facstaff.wisc.edu*. Cucumber breeding & genetics, physiology, biochemical genetic markers, evolution, environmental stress.
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186. **Stevens, M. Allen** Seminis Vegetable SEeds, Inc., 37437 State Highway 16, Woodland, CA, 95695. Ph.: (916) 666-0931, Fax: (916) 668-0219. Direction of research.
187. **Suh, Hyoung** c/o Nath Sluis Ltd., Nath House, Nath Road, Aurangabad, 431005, India.
188. **Summers, William S.** Iowa State University, 106 Horticulture, Ames, IA 50011-1100. Ph.: (515) 294-1978. Fax: (515) 294-0730. Email: *summers@iastate.edu*. Genetic improvement of watermelon.
189. **Tatlioglu, Turan** Institut of Applied Genetics, Univ. Hannover, Herrenhauser Str. 2, 3000 Hannover, Germany.
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191. **Teppner, Herwig** Institute of Botany, Univ. Graz, Holteigasse 6, A-8010 Graz, Austria. Ph.: 316-380-5656, Fax: 316-38-12-21. Systemastics, morphology, ecology, crops & medicinal plants (teaching) and small scale breeding.
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200. **Walters, Terrence** The Cucurbit Network, 11901 Old Cutler Road, Miami, FL 33156-4242. Ph.: (305) 667-3800. Fax: (305) 661-5984. email: *walters@flu.edu*. Communication via The Cucurbit Network, the whole family Cucurbitaceae.
201. **Wang, Ming** Department of Horticulture, Northwestern Agricultural University, Yangling, Shaanxi 712100, P.R. China.
202. **Warid, Warid A.** 11 Cairo University Street, Apartment #4, Giza - 12211, Egypt. Breeding of cucurbits.
203. **Wasilwa, Lusike** Dept. Horticulture & Forestry, University of Arkansas, Fayetteville, AR, 72701. Ph.: (501) 575-2603. Fax: (501) 575-8619. Email: *lwasilwa@comp.uark.edu.* Disease screening, fungal genetics, evaluation of fungal diversity of Colletotrichum spp.
204. **Wehner, Todd C.** Dept. Horticultural Science, Box 7609, North Carolina St. Univ., Raleigh, NC 27695-7609. Ph.: (919) 515-5363, Fax: (919) 515-2505. E-mail: *todd_wehner@ncsu.edu* Pickling/slicing cucumber, watermelon, luffa gourd; selection, disease resistance, yield, genetics & chilling.
205. **Wessel-Beaver, Linda** Department of Agronomy & Soils, Coll. Agriculture, Univ. Puerto Rico, Mayaguez, PR, 00681. Ph.: (809) 832-4040, Fax: (809) 265-0220. Email: *l_beaver@rum.ac.upr.clu.edu.* Pumpkin & squash breeding; disease resistance; insect resistance.
206. **Wiebe, Wayne** Seminis Vegetable Seeds, Inc., 37437 State Highway 16, Woodland, CA 95695. Ph.: (916) 666-0391. Fax: (916) 668-0219. Cucurbit diseases and disease resistance.
207. **Williams, Tom V.** Rogers NK Seed Co., 10290 Greenway Road, Naples, FL 33961. Ph: (813) 775-4090. Fax: (831) 774-6852. Watermelon breeding.
208. **Winkler, Johanna** Saatzucht Gleisdorf GesmbH, A-8200 Gleisdorf, A, Tieberhof 33, Austria.

209. **Wolff, David W.** Texas A&M Experiment Station, 2415 East Hwy. 83, Weslaco, TX 78596-8399. Ph.: (210) 968-5585, Fax: (210) 968-0641, E-mail: *d-wolff@tamu.edu.* Melon breeding and genetics, molecular markers. QTLs.
210. **Wu, Mingzhu** Hort. Inst. Xinjiang Acad. Agric. Sci.. Nanchang Road NO. 38, Urumqi, Xinjiang, People's Rep. China. Ph.: 0991-4840311-2094.
211. **Wu, Wendy Y.** Know-You Seed Co., Ltd., 330 Kao Tan Village, Jen Wu Hsing, Kaosiung, 814, Taiwan, R.O.C., Ph.: 886-7-3719725. Fax: 886-7-3718510. Breeding and growing cucurbits (all).
212. **Wyatt, Colen** Seminis Vegetable Seeds, Inc. 37437 State Highway16, Woodland, CA 95695. Ph.: (916) 666-0931, Fax: (916) 668-0219.
213. **Yamanaka, Hisako** Yamato-Noen Co., Ltd. 100, Byodobo-cho, Tenri-City NARA, Japan 632. Ph.: 07436-2-1182. Fax: 07436-3-3445.
214. **Yorty, Paul** Rogers Seed Co., P.O. Box 104, Twin Falls, ID, 83303-0104. Ph.: (208) 733-0077. Fax: (208) 733-8205. Cucurbit breeding.
215. **Yukura, Yasou** 46-7, 3-Chome, Miyasaka, Setagaya-Ku, Tokyo, Japan.
216. **Zhang, Jiannong** Melon Research Institute, Gansu University of Agriculture, Lanzhou, Gansu, 730070, P.R. China.
217. **Zhang, Xingping** Hollar Seeds, P.O.Box 106, Rocky Ford, CO. Ph.: (719) 254-7411. Fax: (719) 254-3539. Email: *hollarw@iguana.rural-net.net.* Watermelon and melon genetics & breeding.
218. **Zhao, Yanru** 2018 SW 143rd STreet, Newberry, FL 32669. Breeding of resistance to WMV and ZYMV in watermelon (Citrullus lanatus L.).
219. **Zitter, Thomas** Cornell Univ., Dept. Plant Pathology, 334 Plant Science Building, Ithica, NY 14853-5908. Ph.: (607) 255-7857, Fax: (697) 255-4471, E-mail: *tazl@cornell.edu.* Fungal and viral diseases disease resistance.

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- Walters, Terrance W.
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- Zhao, Yanru

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  - Taurick, Gary

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  - Milerue, Sompong
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- **United Arab Emirates**
  - Al Masoum, Ahmed A.

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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 cucurbits, 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 Coordination 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 spokesman of the CGC, as well as its Secretary and Treasurer.

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* spp., muskmelon, watermelon, and other genera and species.

3. Other committees may be selected by the Coordinating Committee as the need or 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.

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 a 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 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:

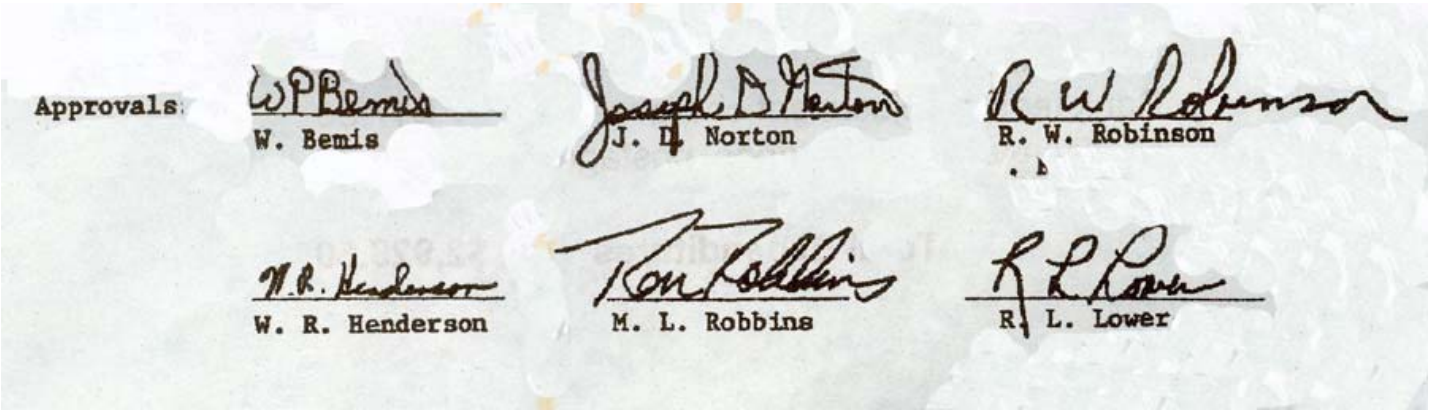
1. The CGC shall be organized and operated exclusively for scientific and educational purpose.
2. No part of the net earnings of the CGC shall or may under any circumstances inure to the benefit of any individual.
3. No part of the activities of the CGC shall consist of carrying on propaganda or otherwise attempting to influence legislation of any political unit.
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; or
   (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 substantial diversion of income or corpus to any officer, member of the Coordinating Committee, or substantial contributor to the CGC.

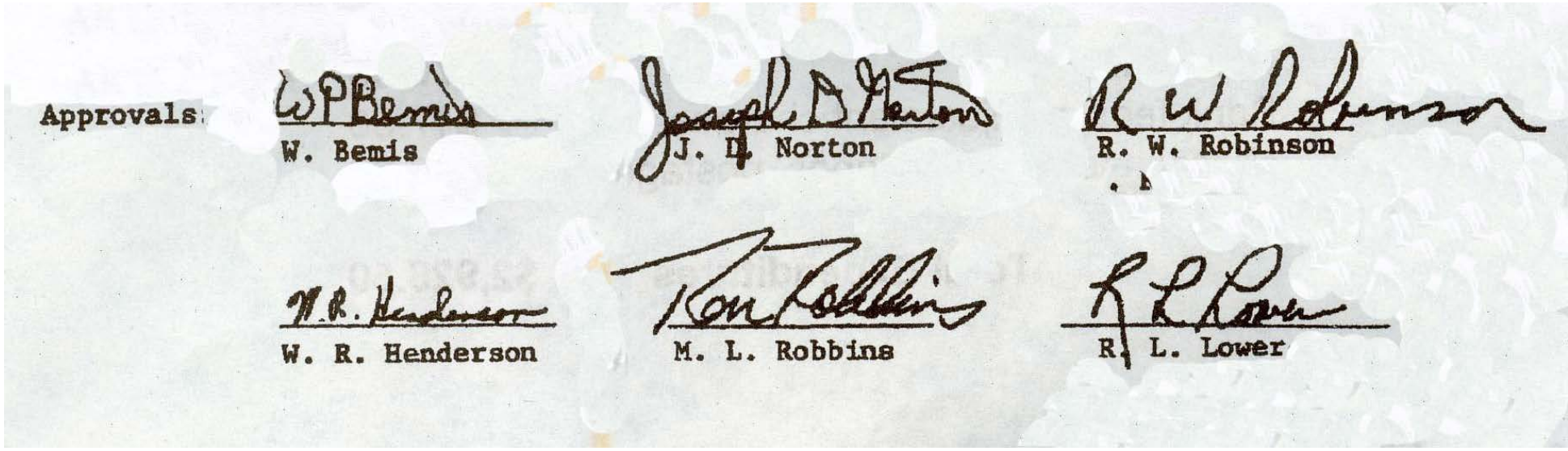
The prohibitions contained in this subsection (6) do not mean to imply that the CGC may make such loans, payments, sales, or purchases to anyone else, unless authority be given or implied by other provisions of the By-Laws.

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.



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


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

Cucurbit Genetics Cooperative Report 19:104 (article 36) 1997

Cucurbit Genetics Cooperative

Financial Statement

31 December 1996

Balance (31 December 1995)		**$2,9259.38**
Receipts		
Dues and CGC back issue orders	$3,277.00	
Interest on savings	$100.73	
Total receipts	**$3,377.73**	
Expenditures		
CGC Report No. 19 (1996)		
Printing	$1,193.32	
Mailing	$596.76	
Call for papers (Report No. 20)	$108.00	
Renewal notices	70.00	
Bank fees & adjustment charges	$17.50	
Miscellaneous (envelopes, postage, etc.)	$152.92	
Total Expeditures	**$2,298.50**	
Balance (31 December 1996)		**$3,408.61**