Cucurbit Genetics Cooperative

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The **Cucurbit Genetics Cooperative** (CGC) was organized in 1977 to develop and advance the genetics of economically important cucurbits. Membership to CGC is voluntary and open to workers who have an interest in cucurbit genetics. Membership is on a biennial basis.

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

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18th Annual CGC Business Meeting (1994)

The 1994 CGC Annual Business Meeting was held at Oregon State University on 9 August 1994 in conjunction with the 91st Annual Meeting of the American Society for Horticultural Science. There were twenty CGC members and other interested individuals in attendance.

Tim Ng began the meeting by giving an update on the CGC Reports. CGC Report No. 17 (1994) was the largest Report ever, and approached the size limit for the binding process currently used. In addition, Report No. 17 was the first to be issued in a multi-column format. The CGC Report is currently indexed by CAB (Plant Breeding Abstracts) and AGRICOLA.

The "Call for Papers" for CGC Report No. 18 (1995) was discussed, and it was generally agreed that "camera-ready" restrictions would be eased on submissions since virtually all reports are edited and word-processed by the Coordinating Committee currently.

In a related vein, the digitization of CGC back issues was discussed for possible inclusion on a CD-ROM. This issue is being pursued with the National Agricultural Library as a possible project for their electronic information effort. Meanwhile, it was suggested that digitization of CGC back issues could be initiated by apportioning it to current CGC members, in particular J. McCreight, T.C. Wehner, J. Staub and T. Ng.

Costs are increasing for the CGC Report, and Tim indicated that while CGC finances were okay for the moment, increased publication costs and the postal increases scheduled for 1995 may mandate an increase in membership fees. CGC membership fees were last raised in 1988.

The rotation of the Coordinating Committee was discussed. In accordance with CGC By-Laws, the ten-year term of the current members will expire for Gary Elmstrom (melon) in 1995, J. Brent Loy (*Cucurbita* spp.) in 1997, Dennis Ray (watermelon) in 1999, Mark Hutton (other genera) in 2001, and Jack Staub (cucumber) in 2003.

The membership vote on By-Law changes was reported. The proposal to allow more than five members to serve on the CGC Gene List Committee was approved with a vote of 52 positive, two negative and three abstentions. The proposal to limit the required back issue availability to the most recent five issues was approved with a vote of 54 positive, no negative and three abstentions. One member had written to suggest that the rotating color format for CGC Report covers be abandoned in favor of the same color every year; however, in attendance at the business meeting were unanimous in their desire to retain the current format. There was also a motion by Todd Wehner (seconded by Linda Wessel-Beaver) to donate back issues of the CGC Report to libraries if they were willing to subscribe to CGC in the future.

An announcement of the current status for Cucurbitaceae '94 (South Padre Island, Texas) was made.

Under new business, Jack Staub raised the issue of establishing core collections for cucurbit crops. He briefly summarized his recent CGC papers on the cucumber core and opined that the current core for cucumber (with 800 accessions) was too large. Norm Weeden provided his observations on the core collections for apple and pea, and a lively discussion followed.

Comments . . . .

From the CGC Coordinating Committee: The Call for Papers for the 1996 Report (CGC Report No. 19) will be mailed in August 1995. Papers should be submitted to the respective Coordinating Committee members by 31 December 1995, although late submissions may be considered if received prior to our processing deadline. The Report will be published by June/July 1996. 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 know 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 know marker genes. CGC members are requested to forward samples of currently held gene stocks to the respective Curator.

19th Annual CGC Business Meeting (1995)

The 1995 CGC Annual Business Meeting will be held on Monday, 31 July 1995, in conjunction with the 92nd Annual Meeting of the American Society for Horticultural Science (ASHS). The meeting will be from 8:00 to 9:00 a.m. in room 409 C of the Montreal Convention Center. (The meeting will immediately follow the ASHS Genetics and Germplasm WG meeting, which begins at 7:00 a.m.) We hope to see you there.

U.S. Cucurbit Crop Germplasm Committee (CCGC) Update

J.D. McCreight, USDA, ARS, Salinas, California USA

CCGC (formerly the U.S. Cucurbit Crop Advisory Committee) held its 11th meeting in South Padre Island, Texas, in conjunction with *Cucurbitaceae '94*. Kent Elsey's retirement and Jon Watterson's transfer to Europe created two vacancies on the Committee. They will be replaced with persons of similar research disciplines (entomology and plant pathology).

GRIN completed its move to a new database (Oracle) for better data entry. PC GRIN is available for DOS; a Macintosh version will be available in 1995. GRIN will soon be accessible via Internet and a CD-ROM version is being developed. A PC GRIN version is being produced for underdeveloped countries. Approximately 800 copies of PC Grin have been distributed. The Core Concept is continuing to develop for germplasm collections, and CCGC is continuing its development of the concept on cucumber.

The De-Accession sub-committee continues to review the National Seed Storage Laboratory cucurbit collection for duplicates. Old cultivars should be included as PI accessions in NSSL. Henry Munger will publish a list in CGC of those to be grown-out for increase/determination of similarity. Cultivar names are being added to GRIN.

Recent activities at the four Regional Plant Introduction Stations with cucurbit accessions were reviewed. Geneva: There is concern for maintenance of *C. maxima*; much work needs to be done to improve the infrastructure (greenhouses, irrigation system); increases are being delayed until such improvements are made. CCGC was requested to help determine the most important/critical accessions for increase. Ames: More accessions were being backed-up at NSSL. More PIs were sufficiently increased in 1994 and are again available for distribution. Laura Merrick reviewed *Cucurbita* accessions and will be helping to correct some species identifications. Pullman: Ray Clark requested support for grow-out station at Parlier, California near the UC station, for *Cucurbita* accessions. In addition, Laura Merrick is finishing the report on her project to increase cucurbit accessions.

Four proposals were received and forwarded to the National Plant Germplasm System:

1) Evaluation of the U.S. Plant Germplasm Collection of Watermelon (*Citrullus lanatus*) for Resistance to Bacterial Fruit Blotch (*Acidovorax avenae* subsp. *citrulli*). Investigator: D. L. Hopkins.
2) Genetic Diversity in Cucumber (*Cucumis sativus* L.) and Melon (*Cucumis melo* L.) Accessions. Investigators: J. Staub and J. McCreight.
3) Evaluation of *Cucumis* Germplasm for Resistance to Zucchini Yellow Mosaic Virus, Papaya Ringspot Virus-W, and Watermelon Mosaic Virus. Investigators: J. D. Norton, J. M. Dangler and G. E. Boyhan.
4) Evaluation of the U.S. Plant Introduction Collection of *Luffa* (*Luffa aegyptiaca* Mill.) for Sponge Yield, Earliness and Quality. Investigators: T.C. Wehner, J. M. Davis and T.L. Ellington.

Larry Hollar successfully lobbied the USDA Agricultural Marketing Service, Seed Regulatory and Testing Branch, Livestock and Seed Division, for interchangeable use of "melon," "muskmelon" and "cantaloupe," resulting in proposed amendments to the Federal Seed Act regulations.

15th Annual Meeting of the Watermelon Research Group (WRG)

Ray D. Martyn, Texas A&M University, College Station, TX

The Watermelon Research Group met in New Orleans on Sunday, January 29, 1995, in conjunction with the Southern Association of Agricultural Scientists (SAAS) and the Southern Region of the American Society for Horticultural Science (SR:ASHS). Twenty five people were in attendance.

Don Maynard (UF-AREC, Bradenton, FL) presented an account of his and Gary Elmstrom's trip to Japan for the International Watermelon Summit in July, 1994. He indicated that a world library has been established and there was a world collection of watermelon germplasm on display. The price of melons in Japan was astounding. Watermelons were as much as $1.40/lb or $40-50 apiece. Cantaloupes ranged from $50-75 apiece.

Don Hopkins (UF-AREC, Leesburg, FL) presented an update on the watermelon fruit blotch (FB) disease. He indicated that there was a cooperative effort between seed corporations, research personnel, and transplant operations to solve this problem. Recommendations for growing melons for seed production are to grow in dry climates and where FB does not occur. Seed infection can be as high as 50% in some cases. The fruit does not have to show symptoms in order for the seed to be infected. The best seed treatment was 24-72 hr fermentation in 1% HCl, but this

reduced the germination slightly to 85-90%. Greenhouse spread in transplants is favored by overhead irrigation and high humidity (70%). Spread is very much limited below 50% RH. Spread of FB in the field is enhanced by rain events and overhead irrigation and is higher in spring crops than in fall crops. The wild citron was susceptible to FB in the laboratory; however, infected citrons have not found in the field. Don also reported that copper resistance has been detected in some isolates of the FB bacterium. Southern states with confirmed reports of fruit blotch include Florida, Louisiana, Georgia, South Carolina, and Texas.

Tom Garrett (Pee Dee-REC, Florence, SC) reported on FB trials in 24 triploid lines. The diploid pollinator had 90% fruit infection while the triploid fruit range from 10-30%. He indicated that the FB bacterium can persist in seed for at least 5 years. Marty Baker (TAES, Overton, TX) reported on a 4- year seedless watermelon variety trial in which over 25 varieties were evaluated. He reported that FB was not seen in any of the lines. He recommended a reduced spacing (6-8') for triploids with one row of pollinator for three rows of triploids with two active bee hives per acre. The size of the fruit continued to increase with most averaging 18-20 lbs currently. He is trying to develop a 22-28 lb triploid melon.

Frank Dainello (TAES, College Station, TX) reported on the progress of the fusarium wilt screening nursery being established in east Texas (Overton). They are still in the process of building up uniform inoculum of FON race 1 and race 2 throughout the fields. Commercial testing of lines is still 1-2 years away.

Charlie Johnson (LSU, Calhoun, LA) reported on his progress in developing a watermelon with resistance to FON race 2. Several lines look very promising. Joe Norton (Auburn, AL) reported on his screening program for ZYMV and the fusarium wilt resistance in Au-Producer. Dan Egel (American Sun Melon) gave an update on the gummy stem (*Didymella bryoniae*) research grant. Research is concentrating on the epidemiology and infection process and the development of a PCR seed detection method.

16th Annual Watermelon Research Group Meeting

The next meeting of the Watermelon Research Group will be in Greensboro, NC on Sunday (1:00 PM - 4:00 PM), February 4, 1996, in conjunction with SAAS and SR:ASHS. For more information, contact Ray Martyn at 409-845-7311 (voice), 409-845-6483 (fax), or *martyn@ppserver.tamu.edu* (e-mail).

Cucurbitaceae '94

Cucurbitaceae '94: Evaluation and Enhancement of Cucurbit Germplasm was held in November 1994 at the Radisson Resort on South Padre Island, Texas. It was hosted by the Texas Agricultural Experiment Station and Extension Service and the USDA-ARS Subtropical Agricultural Research Laboratory. Nearly 200 people were in attendance, representing a multitude of countries and disciplines.

Cucurbitaceae '94 provided a forum for the presentation and exchange of scientific information about germplasm evaluation and enhancement research activities on cucurbit crops. The program consisted of poster presentations, invited talks, and panel discussions on diseases, host-pest interactions, and genetics related to the enhancement of cucurbit germplasm. Molecular and genetic aspects of diseases, germplasm resources, breeding strategies, and the physiology of fruit quality were covered. Meetings of a number of commodity- specific cucurbit groups also took place in conjunction with the conference.

The Proceedings for *Cucurbitaceae '94* is currently being assembled and should be available by Summer 1995. All participants will receive a copy of the Proceedings, and a limited number of extra copies will be available for purchase. For more information on the Proceedings, contact Jim Dunlap, Texas Agricultural Experiment Station, 2415 East Highway 83, Weslaco, TX 78596 USA (Phone: 210-968-0641; Fax: 210-968-5585; E-mail: *j-dunlap@tamu.edu*).

Cucurbitaceae '96

Cucurbitaceae '96 - the Sixth EUCARPIA Meeting on Cucurbit Genetics and Breeding, will be held in Malaga, Spain, on 28-30 May 1996. The preliminary agenda looks quite interesting, and preliminary registration forms have been distributed to interested individuals. If you have not received one and are interested in attending, you can contact the conference organizers at "EUCARPIA CUCURBITACEAE 96, Experimental Station "La Mayora", 29750 Algarrobo, Malaga, Spain." (The fax number is 34-52552677.) The last meeting of this group was in Poland in 1992.

Production and Introduction of Cucurbit Crops in the Basin of the "Three Rivers" in Tibet, China

Meng Zhang, Hongwen Cui and Jianguo Li
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The basin of the "Three Rivers" (the Yaluzangbu, Lhasa and Nyanchu rivers) is situated in the mid-south region of Tibet. It is the center of politics, economics, culture and commerce in Tibet. Eighteen cities and counties of the Lhase, Xigaze and Shannan districts belong to this area, which rises to elevations of 3600 to 4100 meters. The authors participated in the "Three Rivers Project" for comprehensive agricultural harnessing in 1994. The conditions of production, introduction of cucurbit crops and climate in this area are documented here.

The climatic characteristics of agricultural lands are governed by the terrain (a plateau) and geographical position (Table 1).

- The air is thin and the oxygen content is between 62.0-65.4% of that found in the plain area. The atmospheric pressure is 600 mbar, and CO_2 content is less than half that found at sea level.
- The solar radiation is intense, the annual light period is about 3000 hr.
- The ultraviolet rays are abundant, the absolute quantity of the UV rays whose wavelengths are less than 400 mum is 2.3 times that of sea level. Some pathogens survive in these environments, but only with difficulty.
- The temperature is much lower than that found in Yangtze River valley which is at the same latitude. The effective accumulate temperature of the most regions is less than 800 C.
- The line of demarcation between dry and moist seasons is very clear. This transition zone is often the site of high winds, low temperatures and low rainfall from October to April. About 90% of the precipitation falls between May and September. Rains usually occur at night.

Because of such climatic conditions, the cucurbit crops cannot grow outdoors except custard squash (*Cucurbita pepo* L) which survives at some lower elevations. In the lower basin regions of this area, cucumber canopies can mature but fruit formation is difficult. However, environments which are adequately protected can take advantage of the short growing season, large range in day temperatures, and abundant sunshine. Most cucurbit crops can be cultured under protective environments in this basin. Due to naturally occurring strong winds, the primary plant protection in this region is provided by glasshouse structures.

The production of cucurbit crops started in the late 1950's and expanded gradually in the 1980's. Because great efforts were given by the central authorities and local governments to develop the vegetable-basket-project, several millions Yuan Reminbi were put into developing the vegetable protective ground in the Lhasa, Xigaze and Zedong provinces in recent years. There are about 25-30 ha of cucurbit production in these regions. Cultured cucurbits include cucumber (*Cucumis sativus* L.), custard squash (*Cucurbita pepo* L.), pumpkin (*Cucurbita moschata* L.), water melon (*Citrullus lanatus* L.), wax gourd (*Benincasa hispida* Cogn.), balsam pear (*Momordica charantia* L.), sponge gourd (*Luffa aegyptica* Roem), and bottle gourd (*Lagenaria siceraria* Standle). The areas devoted to cucumber (50%) and squash (30%) production play an important role during the entire year.

Double covered plastic is used in the production of cucumber and squash during the winter. Large plastic shelters can be used during April to October. If a harvest is desired earlier than spring, then small, covered shelters under large shelters can be employed. Squash can be cultured outdoors in the Zedong and Lhasa regions. Crops are usually sown in the middle of May and harvested from July to September. Later maturing fruits can be stored and sold during winter and subsequent spring. The areas of watermelon culture in the Lhasa region are smaller by comparison. Watermelons are mainly planted under large plastic shelters in spring (the last ten days of April). Small shelters can be used to increase growing temperatures. The production of other cucurbit crops in this region is comparatively small.

Table 1. Sunlight heat energy and water resources in the basin of the "Three Rivers" of China.

Regions	Annual free-frost period (days)	Annual average temp (C)	Cumulative temp (C)	10C soil average temp	Average rainfall (mm)	Annual sunshine time (hrs)	Annual solar radiation (kcal/cm2)
Lhasa	138	7.5	2116.9	10.3	444.8	3007.7	191
Mezhugongka	91	5.4	1547.7	8.9	542.1	2813.1	—
Nimu	91	6.8	1801.6	10.7	324.2	2947.2	180.8
Zedong	143	8.2	2262.8	12.0	408.2	2938.0	178.9
Xigaze	122	6.3	1821.4	10.5	431.2	3240.3	192.4
Gyangze	113	4.8	1098.4	8.6	304.2	3189.8	188.4

The cucurbit breeding programs are confined to introducing varieties from other districts. The varieties of cucumber cultured in this area include: 'Changchun Mici', 'Beijing Daci', 'Nongda No.14', 'Zongnong No.19', 'Nongcheng No.3', 'Jinyan No.6' and 'Jinza No.2'. Yield averages between 6.0 x 10^4 kg to 9.0 x 10^4 kg per ha. The varieties of squash include: 'Yiwohou', 'Beijing Duanman' and 'Zaoqing Yidai'. Yield averages between 4.5 x 104 kg to 6.0 x 104 kg per ha. The varieties of watermelon include: 'Sumi No.1', 'Zhongyu No.1', 'Zhongyu No.4', 'Jiali', 'Taiwan Xinhongbao' and 'Xinliubao'. Yield averages are about 3.75 x 104 kg per ha. However, yields of 5.7 x 104 kg per ha have been recorded.

Since the history of cucurbit cultivation in Tibet is short, technologies for crop cultivation have not been popularized and thus production has been low. No agricultural chemicals have been used because of the low incidence of disease. Thus, fruits do not contain agricultural residues. As more varieties are introduced and pathogen inoculum load increases, more diseases will occur. Diseases which are predictable include: Sclerotinia rot (Sclerotinia sclerotorum (Lib) de Bary), angular leaf spot (Pseudomonas lachrymans Carsn), powdery mildew (Sphaerotheca fuliginea Poll), and leaf spot (Cercospora citrullina Cooke). Fusarium wilt (Fusarium oxysporum f. sp. niveum Snyder) and anthracnose (Colletotrichum orbiculare Arx) have been found to reduce watermelon production. Attention is not paid to all of these diseases.

The low numbers of butterflies and bees necessitates hand- pollination which significantly increases production costs. This is true of most crops except cucumber.

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1. Shunkai Li. 1992. Vegetable cultural technology of Tibet, Chinese agricultural science and technology publishing house.
2. Agricultural bureau of Tibet autonomous region. 1987. Practical agricultural technology of Tibet. Tibet people's publishing house.
3. Huaxin Xu. 1992. Tibet autonomous region geography Tibet people's publishing house.

North Carolina State University Cucumber Germplasm and Cultivar Releases, 1957 to 1988

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Richard L. Lower
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North Carolina State University has had a breeding program on cucumber (*Cucumis sativus* L.) for four decades. After the initial work on slicing cucumbers in the 1950s, there was a lull in the program until R.L. Lower was hired in 1968, working mainly on pickling cucumbers. The main objectives have been to expand our knowledge of cucumber genetics and breeding, educate graduate students interested in vegetable breeding, do research on problems affecting the cucumber industry, and develop improved cultivars and breeding lines of pickling and slicing types for use in North Carolina and the U.S.

The cucumbers released through the North Carolina Agricultural Research Service have generally been accompanied by germplasm release notices, and the more recent ones have also been published in scientific journals (1,2). However, some releases have not been documented in journals, so our intent was to describe the releases here.

The cultivars and breeding lines were developed using backcross and pedigree breeding methods. Of the 22 releases, 11 were open-pollinated or inbred lines and 11 were hybrids (Table 1). Since 1957, there have been 3 cultivars of slicing cucumbers, and 7 breeding lines and 12 cultivars of pickling cucumbers released to the industry. Significant progress has been made for yield, earliness, fruit quality and disease resistance, and some releases combine all of those with general adaptation ('Calypso' and 'Sampson'). Inbreds have been released with useful combinations of traits: 'Addis' combined high performance with long, dark-green fruits; 'Clinton' added blocky fruit shape, small seedcell and slow seed development; Gy 4 added high yield and high anthracnose resistance; and M 21 had long fruits, high yield, high anthracnose resistance, and determinate plant type.

Literature cited:

1. Lower, R.L., T.C. Wehner and S.F. Jenkins, Jr. 1991. Gy 4 cucumber inbred and 'Raleigh' hybrid pickling cucumber. HortScience 26: 77-78.
2. Wehner, T.C., S.F. Jenkins, Jr., and R.L. Lower. 1991. Gy 5 cucumber inbred and 'Johnston' hybrid pickling cucumber. HortScience 26: 78-79.

Table 1. North Carolina State University cucumber cultivars and breeding lines[z].

Cultigen name	Release date	Developer name	Important traits	Parents or pedigree
Slicer cultivars (open-pollinated)				
Smoothie	1957	Jenkins	General adaptation	Cubit x PR 39
Ashe	1959	Barham, Winstead	DM, scab	Highmoor, Palmetto, SC 14, Ashley
Fletcher	1959	Barham, Winstead	DM, scab	Highmoor, Stono
Pickling inbreds				
M 41	1974	Lower	AL, An, DM, PM	SC 601, SC 604, NCARS lines
Addis (M 11)	1974	Lower	AL, An, DM, PM high yield, long fruit	SC 19B x Pixie x NCARS lines
Clinton (M 24)	1978	Lower	AL, An, DM, PM, scab, CMV, blocky fruit shape	SCAES lines x NCARS lines
Gy 2	1978	Lower	Blocky fruit shape	Gy 3 x Chipper x NCARS lines
M 21	1978	Lower	AL, An, DM, PM, de, high yield	(Poinsett x Pixie) x (SC 19B x NH Tiny Dill)
M 27	1978	Lower	AL, An, DM, PM, de	SCAES x NH x MSU x NCARS lines
Gy 4	1987	Wehner, Lower	AL, An, DM, PM, scab, CMV, high yield	Double Yield, SC 22, SC 19B, Gy 14A
Gy 5	1987	Wehner, Lower	AL, An, DM, PM, scab, CMV, high yield	Gy 3, P 59, SC 791
Pickling hybrids				
Sampson*	1975	Lower	Long-harvest season	Addis x M 41
Calypso	1976	Lower	General adaptation	Gy 14A x Addis
Liberty*	1977	Lower	Home garden	Wisconsin SMR 18 x M 41
Calico	1978	Lower	Blocky, dark green fruits w/ small seedcell	Gy 2 x Clinton
G 29 (Regal)	1978	Lower	High yield, long fruit	Gy 14A x M 21
G 30	1978	Lower	High yield, long fruit	Gy 2 x M 21
Southern Belle	1978	Lower	Early yield	Gy 2 x M 27
Fremont	1984	Wehner, Staub	TLS	WI 1983G x Clinton
Raleigh	1987	Wehner, Lower	High yield	Gy 4 x M 21
Johnston	1987	Wehner, Lower	High yield, long fruit	Gy 5 x M 21
Endeavor	1988	Wehner, Staub	TLS	WI 2870G x Clinton

[z]AL = angular leafspot resistant; An = anthracnose resistant; DM = downy mildew resistant; PM = powdery mildew resistant; TLS = target leafspot resistant; de = determinate plant type; AES = Agricultural Experiment Station; MSU = Michigan State University; NC = North Carolina; NH = New Hampshire; SC = South Carolina.
*Monoecious hybrid.

Selection for Multiple Lateral Determinate Cucumber Genotypes

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Introduction. Manipulation of plant architecture with concomitant adjustments in plant population density can be utilized to increase the yield potential of cucumber. Determinate plants are homozygous recessive for a gene, *de*, which causes the premature termination of plant growth as a consequence of the conversion of the sympodial bud into floral tissue (2). This plant type has a more concentrated fruit set than indeterminate types and so allows for easy determination of optimal harvest time (1,3). We are using the determinate, G421 (provided by R.L. Lower, University of Wisconsin) in our breeding program to increase once-over harvest yield potential in the U.S. processing cucumber.

A little leaf, multiple branching mutant genotype (H-19) has been recovered at the University of Arkansas. It possesses a sequential fruiting habit, and thus may also be a potential source for increasing the yield in cucumber (4). We have used G421 and H-19 in an inbred backcrossing program (recurrent parent = G421) to develop multiple lateral, sequential fruiting determinate lines for once-over machine harvest. We now report the progress in the development of this plant type.

Materials and Methods. The initial G421 x H-19 cross has been carried to the F_2, BC_1S_2 and BC_2S_2. F_2 progeny were evaluated [randomized complete block design (RCBD) with 4 replications] in 1991 for several economically important characteristics on 1.5 m row centers and 0.76 m between plants (Table 1). Measurements of plant traits were also taken on BC_1 plants in a greenhouse and these data were compared to BC_1S_1 progeny in a field nursery (Table 2). Data from these evaluations indicated that adequate variation was present in the progeny for continued selection to be imposed. Therefore, BC_1S_2 and BC_2S_2 progeny were evaluated in a 1994 field nursery at Hancock, WI for determinate habit, multilateral character, and sex expression. Approximately 194 families were examined in a RCBD with four replications. Approximately 25 to 50 plants of each family derived from each of 194 families were evaluated in 25 plant family plot rows at 0.76 m plant spacing (1.5 m row centers) at Hancock, WI.

Results and discussion. Multiple lateral plants were identified which possessed 2 to 7 laterals depending on the cross (data not presented). Plants of UW G421 in the same field had between 0 and 2 laterals. The average number of laterals ranged between 2 and 4 depending upon the family examined. The determinate nature of many multiple lateral plants could not be confirmed because the branch length of determinate plants can vary greatly (12 to 48"; Table 2). Plants were selected, self-pollinated and these progeny will be re- evaluated in subsequent generations to confirm their genotype.

Approximately 144 selections were made from the approximately 4,800 BC_1S_2 and BC_2S_2 plants examined (3% selection intensity). Attempts were made to self pollinate these selected plants. About 66 (47%) of the pollinations produced fruit. The low pollination percentage of selected plants was in large part due to the time of pollination. Final selections were made late in the season after several harvests had been made and plants were senescing.

Several potential determinate, multilateral, gynoecious and monoecious plants were identified in the various families. Depending upon family, the fruit length (L): diameter (D) ratio of fruit harvested from these plants ranged between 2.8 to 3.4. Therefore, it is likely that the determinate, multiple lateral types resulting from this project will have adequate L/D ratios for commercial production. These BC_1S_3 and BC_2S_3 families will be evaluated at replicated close spacing (~ 7 cm between plants on 1.5 m row centers) in 1995 to confirm their genotype and determine their yield potential.

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Table 1. Plant and fruit characteristics of parental germplasm (*dede* and *DeDe*), F1 and F2 generations in cucumber (*Cucumis sativus* L.).

Parent/ generation	Mean days to flower	Mean lateral number[z]	Mean node length (cm)[y]	Mean yield (fruits/plant) Harvest[x] 1	Mean yield (fruits/plant) Harvest[x] 3	Mean length: diameter ratio (L/D)[w]
UW G421 (*dede*)	45.8	1.9	5.0	2.3	7.4	3.0
H-19 (*DeDe*)	48.8	10.2	4.3	3.1	15.2	3.1
F1	46.0	3.0	5.3	2.1	10.5	2.9
F2	46.6	3.8	5.2	2.3	9.0	3.0
LDS (0.05)	5.7	3.9	2.5	2.9	8.7	0.2

[z]Laterals on the main stem.
[y]Length between nodes on the main stem.
[x]Cumulative average yield over 3 harvests.
[w]20 randomly sampled fruit.

Table 2. A comparison of plant and fruit characteristics of BC1 parents and their BC1S1 progeny derived from an initial *dede* x *DeDe* mating in cucumber (*Cucumis sativus* L.).

BC1 parents Main stem cm	BC1 parents Main stem inch	BC1S1 progeny Main stem Mean	BC1S1 progeny Main stem SD	Lateral number Mean	Lateral number SD	Lateral length Mean	Lateral length SD
29	12	65	15	1.8	1.2	11	12
58	24	78	23	1.3	1.0	21	15
87	36	100	42	3.9	3.3	44	39
101	42	115	61	4.7	3.0	54	48
116	48	117	40	4.4	2.7	44	41
130	54	177	27	6.9	4.5	44	36

Problems Associated with the Selection of Determinate Cucumber (*Cucumis sativus* L.) Plant Types in a Multiple Lateral Background

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Introduction. To respond to the need for cultivars suitable for mechanical harvesting our breeding project is manipulating cucumber plant architecture to develop high yielding genotypes. Standard cucumber varieties (gynoecious x monoecious or gynoecious x gynoecious hybrids) possess an indeterminate plant habit (*DeDe*) and few lateral branches (~ 1 to 2). We are developing all female genotypes which are short in stature (determinate, *de*) and possess a multiple lateral branching habit (~ 3 to 5). This plant type can be sown at relatively high densities (compared to standard indeterminate types) and will allow for early, concentrated fruit set on more lateral branches (Staub et al., 1992).

There are two problems inherent to such a breeding project. First, vegetative propagation of determinate types is extremely difficult. Tissue culture has proven ineffective because of recurrent problems with field contamination of selections; rooting of cuttings has not succeeded in producing flowering plants because juvenility can not be restored in determinate plants; and senescing determinate plants rooted by stem layering techniques do not survive transplantation. Controlled self-pollination of all selected plants in a field is impractical early in the season and late season chemically induced sex conversion of mature gynoecious determinate plants to a monoecious flowering habit is impossible.

The second problem is the potential misclassification of mature plants (indeterminate versus determinate types) because of difficulty in identifying the determinate character in a multilateral background. Differences in vine length are mitigated by the removal of apical dominance resulting in plants which are difficult to distinguish. Although *de* conditions termination of growing points at the terminal whorl, the length of lateral branches of determinate plants is quantitatively inherited and can vary dramatically. Size variation observed in segregating progeny derived from determinate x indeterminate crosses is presented here to demonstrate the difficulty in selecting multiple lateral determinate phenotypes.

Materials and Methods. The determinate unilateral line G421 (R.L. Lower, University of Wisconsin) was mated with the indeterminate multiple lateral line H-19 (University of Arkansas) to produce F_2, F_3, BC_1S_1 and BC_1S_2 progeny. F_3 progeny were produced from random F_2's chosen from the middle of the progeny distribution, and G421 was used as the recurrent parent during backcrossing. Measurements of the mainstem of F_2 and F_3 greenhouse grown plants were taken about six weeks after transplanting (two-leaf stage). Mainstem measurements of field grown (Hancock, WI) plants sown on 1.5 m row centers with a within row spacing of 0.76 m were taken approximately eight weeks after sowing. F_3 plants classified as determinate and indeterminate were self-pollinated to produce F_4 lines which were measured in a greenhouse. F_4 and BC_1S_1 plants were classified for determinate character during the same period.

Results and discussion. Progeny segregation in the F_2 generation formed a continuous normal distribution (Figure 1, panel a). Mainstem length varied from ~ 100 to 230 cm and having a mean length of 167 cm. Determinate phenotypes were classified as being between ~ 100 to 140 cm and indeterminates were classified as measuring between ~ 200 to 230 cm. The length of the mainstem was normally distributed in the F_3 generation ranging between ~ 40 to 170 cm and having a mean length of 114 cm (Figure 1, panel b). Determinate phenotypes were classified as being between ~ 40 to 80 cm and indeterminates were classified as measuring ~ 140 to 170. Plants in the middle of all distributions, regardless of the generation, could not be classified with precision. The growing environment can greatly affect the ultimate length of the mainstem.

The distribution of indeterminate and determinate F_4 plants is presented in Figure 1, panel c (far left). A region ("overlapping region") where plants could not be classified was characterized. Segregating BC_1S_1 progeny var-

ied in mainstem length [Figure 1, panel c (far right)] and four were self- pollinated. Measurements of BC_1S_2 progeny indicate that BC_1S1 selections made in the overlap region (Lines 7 & 71) were difficult to classify in BC_1S_2. In contrast, BC_1S_2 progeny resulting from BC_1S_1 lines selected beyond the overlapping region (Lines 8 & 63) were comparatively easier to classify. Nevertheless, in each case the mainstem length of some BC_1S_2 progeny fell into the overlapping region indicating that stabilization of moderately large determinate lines (~ 90 cm mainstem length) will require judicial selection in advanced generations.

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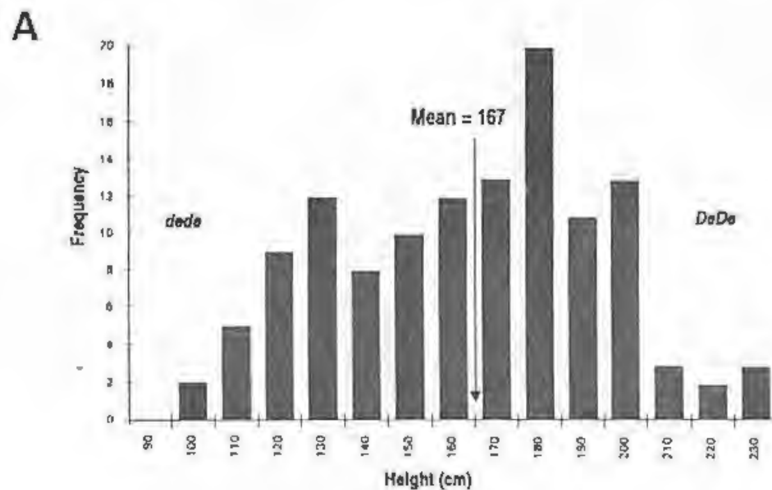
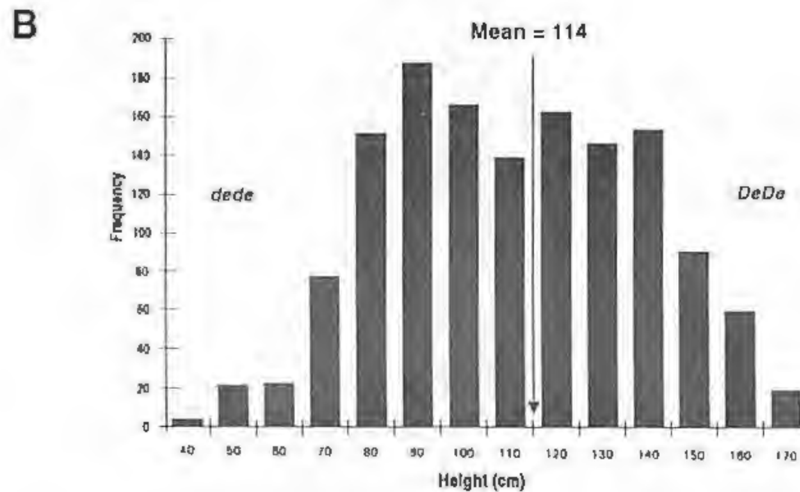
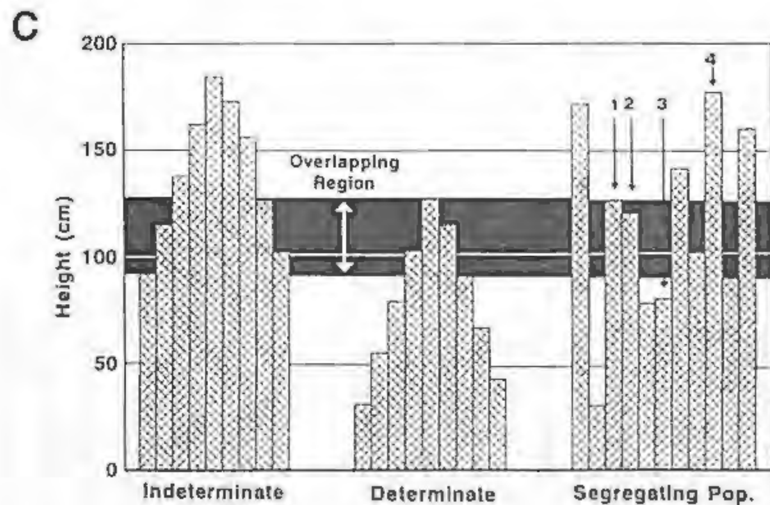
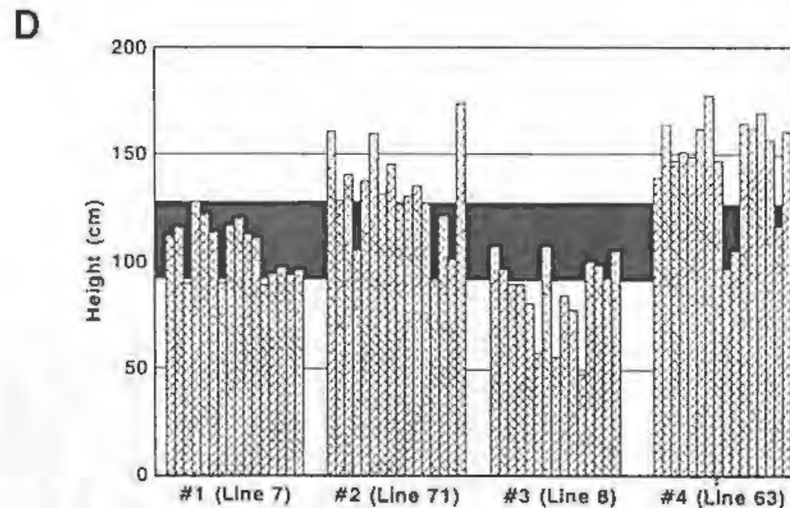
Figure 1. Distribution in plant height (cm) of progeny derived from initial matings of determinate (dede) x indeterminate (DeDe) cucumber (Cucumis sativus L.) inbreds. Plant heights in an F_2 population (panel a), an F_2 derived F_3 population (panel b), segregating plants in an BC_1S_1 population showing a range in determinate and indeterminate individuals classified in a BC_1S_1 population (panel c), and in BC_1S_2 plants derived from self pollination of BC_1S_1 plants (panel d).









Principal Component Analysis for Traits Selection in Cucumber Breeding

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It is not easy to select for numerous traits during crop improvement (3). Principal component analysis (PCA) is a statistical method by which many traits can be scaled into a few comprehensive indices (1). These indices are not subject to trait correlations and can provide information on the relative importance of each trait based on specific principal components. PCA, when integrated with quantitative genetics, can increase selection efficiency. Therefore, a study was designed to examine 12 traits using PCA as a tool for enhancing cucumber improvement strategies.

Methods. Ten inbreds with different genetic backgrounds were selected for intercrossing using an incomplete diallel mating design. The F_1 hybrids were planted in a two-way randomized block design with 3 replications in order to decrease experimental error (2). Ten plants of each cultigen were randomly chosen to evaluate 19 traits during the growth period. Twelve of these traits were selected for analysis based on previous studies. The traits included: 1) total yield per plant (X_1); 2) early yield per plant (X_2); 3) number of harvested fruits in the early stage (X_3); 4) average fruit weight in the early stage (X_4); 5) leaf number at first harvest (X_5); 6) the node position of the first pistillate flower (X_6); 7) leaf number in the last stage (X_7); 8) number of effective branches (X_8); 9) the days from sowing to pistillate flowering of 50% of the plants (X_9); 10) fruit length (X_{10}); 11) downy mildew disease index (X_{11}); and 12) fruit developing average rate (X_{12}).

Results. PCA was conducted using 12 traits by generating a genetic correlation matrix (Tables 1 and 2). The results indicate that the first five components explained 98.6 % of the total phenotypic variation of the 12 traits, while the first three components explained 42.5%, 31.0% and 18.7% of the observed variation, respectively. The vectors indicate the weight of each eigenvector, and do not describe the effect of individual component traits. A factor loading matrix was constructed to more accurately describe the components of each trait using three eigen vectors (Table 3). The first three components were analyzed as follows according to trait properties and the relative importance of components.

The traits X_2, X_3, X_6, X_8 and X_9 produced large loading values for the first component and all were significant. This component array of traits accounted for 84.4% of the total variance of the phenotypic variation. This trait array represents the early maturity and early yield, and therefore this component was designated the "early-maturity component."

The traits X_1, X_5, X_7, X_{10}, and X_{11} produced large loading values for the second component and were also significant in their contribution to the observed phenotypic variance. This trait array explained 76.6% of the total phenotype variance. This array described total yield and its composition, and was designated the "yield component."

Traits X_4, X_6 and X_{12} produced large loading values for the third component which were significant in their contribution to the size and rate of fruit development. These three traits made up 68.9% of the total phenotypic variance for this component which was designated the "fruit weight component."

Conclusion. The traits which had large loading values in the first three principal vectoring components should be made selection criteria in cucumber breeding programs which emphasize improvement for early maturing, high yielding (number and weigh of fruit) lines and hybrids. The relative importance of each trait can be characterized by the rank order of their contribution (%) to explaining the observed phenotypic variation.

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Table 1. The eigenvalues and percentage of genetic correlation matrix describing the effect of 12 traits in cucumber (*Cucumis sativus* L.).

Component	1	2	3	4	5
Eigenvalue	5.1	3.7	2.2	0.6	0.3
Percent (PCI)	42.5	31.0	18.7	4.7	2.7
CPCT[2]	42.5	73.5	91.2	95.9	98.6

[z]Cumulative percentage.

Table 2. The eigenvectors resulting from the principal component analysis in cucumber (*Cucumis sativus L.*).

Traits	Vector 1	Vector 2	Vector 3
X_1	0.2197	0.4218	0.1270
X_2	-0.4105	-0.0007	0.2369
X_3	-0.4364	0.0646	0.0287
X_4	0.2178	-0.1983	0.4648
X_5	0.1148	-0.3620	-0.3181
X_6	0.4021	-0.1792	-0.1311
X_7	0.2151	0.4503	0.0786
X_8	0.4124	0.0758	0.0786
X_9	0.3909	-0.1275	0.2331
X_{10}	-0.0008	0.3454	0.4359
X_{11}	-0.0355	-0.4357	0.2291
X_{12}	-0.0050	-0.2857	0.5324

Table 3. The factor loading matrix constructed from eigenvalues of 12 traits in cucumber (Cucumis sativus L.).

Traits	Vector 1	Vector 2	Vector 3
X_1	0.4936	0.8133	0.1852
X_2	-0.9272	-0.1406	0.3455
X_3	-0.9859	0.1245	0.0418
X_4	0.4920	-0.3824	0.6777
X_5	0.2593	-0.6978	-0.4638
X_6	0.9082	-0.3455	-0.1911
X_7	0.4859	0.8682	0.1146
X_8	0.9317	0.1461	-0.1145
X_9	0.8831	-0.2458	0.3399
X_{10}	0.0018	0.6659	0.6356
X_{11}	0.0800	-0.8400	0.3340
X_{12}	-0.0114	-0.5509	0.7763

Note: $|r_{0.05}| = 0.514$; $|r_{0.01}| = 0.641$.

Cucumber (*Cucumis sativus* L.) Induced Mutations: A Female Sterile Mutant and An Independent Long Hypocotyl Mutant

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As with previously described mutants (2-5), the two mutants reported here belong to our collection developed by Kubicki. Mutants were obtained by ethyleneimine seed treatment of the inbred Borszczagowski (B) line .

The female sterile mutant could be distinguished in the seedling stage (Figure 1) by a long hypocotyl and two true leaves which arose from the first internode. Mature mutant plants were less robust, with shorter main stems but longer internodes and petioles than controls (Table 1). In general, plants produced fewer lateral branches (Figure 2); their leaves were smaller, generally because they were more narrow.

The mutant was monoecious with normally developed male and female flowers. Pollen stainability was up to 98% and viable seeds could be obtained after backcrosses to inbred line (B) or crosses with heterozygous plants. In contrast, female flowers self-pollinated or cross-pollinated with genotypically different lines occasionally developed deformed fruits but never set seeds (Figure 3). Cytoembryological analysis of young ovules indicated early degeneration of the embryo sac. Genetic analysis (Table 2) indicated that a single recessive gene (*fs* - female sterile) regulates the phenotype described above.

A long hypocotyl mutation was previously described by Robinson and Shail (1), as a result of neutron radiation of "Lemon" seed. Our independent mutation was a result of chemical seed treatment of the Borszczagowski line. Phenotypically, our long hypocotyl mutation was similar to that described earlier (1). Mutation was evident in the seedling stage due to the long hypocotyl. The main stem and leaf petioles were longer than that of control and leaf blades were larger (Table 3). Other traits were not changed in comparison to inbred "B" line. Genetic analysis indicates (Table 4) that a single recessive gene also regulates this phenotype; we have designated this gene (*lh2*).

Plants of similar phenotype were obtained as a result of somaclonal variation. Crosses between these two long hypocotyl plants gave long hypocotyl progeny. This suggests that the locus was easy to mutate and that our chemically induced mutation is probably allelic to that obtained in course of tissue culture.

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Figure 1. Long hypocotyl (right) and female sterile (middle) mutant seedlings, compared to the wild type seedling (left).

Figure 2. Female sterile cucumber plant with one deformed fruit.

Figure 3. A deformed fruit with no evidence of seeds from a female sterile mutant plant.

Table 1. Measurements (cm) for five characters of twenty mutant (*fs*) and twenty normal (*B*) cucumber plants.

Plant type	Hypocotyl length	Plant height	5th Leaf: Lamina Length	5th Leaf: Lamina Max. width	5th Leaf: Petiole Length
Normal (*B*)	13.3 ± 1.6	225.8 ± 21.2	15.5 ± 3.8	20.0 ± 0.8	20.0 ± 1.1
Mutant (*fs*)	18.1 ± 2.5	151.9 ± 13.1	13.2 ± 3.2	15.1 ± 3.2	29.2 ± 6.7

Table 2. Inheritance of female sterility (*fs*).

Generation	No. observed Normal	No. observed Mutated	No. expected Normal	No. expected Mutated	Ratio tested	X^2	P
P_1 (normal)	22	0	22	0	1:0	--	--
P_2 (mutated)	0	40	0	40	0:1	--	--
F_1	20	0	20	0	1:0	--	--
F_2	140	42	136.5	45.5	3:1	0.42	0.05
$F_1 \times P_1$	78	0	78	0	1:0	--	--
$F_1 \times P_2$	54	60	57	57	1:1	0.21	0.05

Table 3. Measurements (cm) for five characters of twenty mutant (*lh2*) and twenty normal (B) cucumber plants.

Plant type	Hypocotyl length	Plant height	5th Leaf: Lamina Length	5th Leaf: Lamina Max. width	5th Leaf: Petiole Length
Normal (B)	13.3 ± 1.9	225.8 ± 21.2	15.5 ± 3.8	20.0 ± 0.8	20.0 ± 1.1
Mutant (*lh2*)	19.3 ± 1.9	375.6 ± 26.9	19.9 ± 1.0	25.0 ± 1.4	40.2 ± 5.8

Table 4. Inheritance of long hypocotyl (*lh2*).

Generation	Normal	Mutated	Normal	Mutated	tested	X^2	P
P_1 (normal)	22	0	22	0	1:0	--	--
P_2 (mutant)	0	21	0	21	0:1	--	--
F_1	25	0	25	0	1:0	--	--
F_2	124	46	127.5	42.5	3:1	1.44	0.05
$F_1 \times P_1$	79	0	79	0	1:0	--	--
$F_1 \times P_2$	34	37	35.5	35.5	1:1	0.13	0.05

The Relationship Between Storage Time and Viability of Cucumber Seeds (*Cucumis sativus* L.)

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Introduction. Although it is well known that plant seeds will lose their vigor and viability during storage, there is a saying in China that the potential value of the new seeds is higher than that of the old seeds. How long will the viability of cucumber seed remain high and what is the optimum storage period for cucumber? This study was designed to answer these questions.

Material and Methods. The seeds of cucumber cv. No.4 were stored under room temperature for 0, 1, 2, 3, or 4 years. Seed vigor was examined by germinating seed at 25C and estimating seed catalase activity during germination at 24 hr.

Results and Discussion. Catalase activity (SSR Test) in seeds decreased gradually with increased storage period (years)(Table 1). The SSR test shows that there were no significant differences in seed catalase activity between storage years 1 and 2, and 2 and 3. However, when the storage period reached 4 years, the catalase activity in seeds was significantly (P = 0.01%) lower than that of seeds stored for 1, 2 or 3 years. The catalase activity in new seeds was significantly (P = 0.05%) lower than that in seeds stored for 1 year and higher (P = 0.01) than that of seeds stored for 4 years.

There was also a trend that germination percentage, germination energy and germination index decreased with the increasing storage (Table 1). Although the SSR test showed differences between seeds stored for 1, 2 or 3 years, the catalase activity of seeds stored for 4 years was significantly lower than any other storage period. These data indicate that seeds stored under room temperature for 4 years may have lost a significant portion of their potential viability. Although there was no significant difference in the percent germination among seeds stored for 1, 2 and 3 years, the germination index of the seeds stored for 2 or 3 years was significantly lower than that of the seeds stored for 1 year. Although the germinating percentage and germinating energy of new seed was a higher than that of the stored seed, the germination index and the mean days of germination was than seed stored for 1 year. As the storage years increased from 1 to 4 years, the mean days of germination increased.

Correlation analysis showed that percent germination and catalase activity ($r^2 = 0.87$) were positively correlated with the percent germination. Moreover, germinating energy (r2 = 0.98) and the germination index (r2 = 0.90), were correlated with mean days to germination. A *t*-test showed that the correlation between catalase activity and the mean days of germination (P=0.05) and the germination index (P=0.01) were significant.

In summary, catalase activity and the germinating index were the highest in the seeds stored for 1 year among all the treatments. The seeds stored for 4 years under room temperature lost viability.

Table 1. Relationships between seed storage years, catalase activity, and the seed vigor index in cucumber (*Cucumis sativus* L.).

Seed storage (years)	Catalase activity H_2O_2 mg g^{-1} min	Germination	Germination energy (%)	Germination index	Mean days to germination
4	196.9 cB	46.0 bB	29.3 cB	7.9 cB	1.7 a A
3	372.4 bA	91.2 aA	67.3 bA	14.0 bA	1.6 ab A
2	453.4 abA	92.6 aA	81.4 abA	16.5 bA	1.5 ab A
1	531.6 a A	91.9 aA	88.7 abA	19.3 aA	1.2 b A
0	413.2 bA	100 aA	100 a A	17.2 bA	1.4 ab A

Effect of Hot Treatment on the Vigor of Newly-Harvested Cucumber Seeds

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Newly-harvested cucumber (*Cucumis sativus* L.) seeds pass through a physiological process called "after-ripening" before they are sown in China (2). Newly-harvested seed have low vigor and seedling establishment is often difficult. Xie (1) soaked newly-harvested cucumber seeds in H_2O_2 to increase seed vigor and observed a positive seedling growth response. This experiment describes the effect of extreme temperature treatment on the vigor of newly-harvested cucumber seeds.

Methods. Seeds of 'Jinyan 6' were taken from mature fruits and fermented on July 16. Seeds were washed and dried in the sun on July 18, and the experiment was initiated in the evening of the same day.

The experiment had two temperature treatments [hot (75C) and cold (-4C)] and two seed treatments (newly-harvested seeds and seeds stored for one year). Three replications were made in time. The experimental design proceeded stepwise as follows: 1) treating, 2) soaking, 3) germinating. Newly-harvested seeds were treated at either high temperature or low temperature for 24 hours, soaked in water together with control seeds (ck 1) for 6 hours, and then germinated at 30C. From the time when stored seeds (ck 2) just sprouted, germination number was recorded every 6 h for 3.5 days. Germination percentage, GS, PV, GI and MLIT were calculated. GS calculation was made at 1.75 days. When a seed's radicle length was half that of the seed's length, seeds were sown in a flower-pot (soil), and grown for observation in the seedling stage.

Results. Data show (Table 1) that there was no significant difference between new-harvested seeds and stored seeds in germination percentage representing viability, but there were significant differences in other indices representing vigor. This indicates that newly-harvested seeds have low vigor during the after ripening phase.

Hot treatment increased GS, PV and GI, and shortened MLIT greatly, indicating that hot treatment increased the vigor of newly-harvested cucumber seeds. Differences in seed vigor were also detected between not-treated seeds and controls (ck2).

Cold treatment had no effect on increasing the vigor of newly-harvested cucumber seeds.

Data indicate that improved seedling growth was consistent with high germination rate, and that hot treatment had an effect on promoting good plant growth (Table 2).

Discussion. Xie (1) concluded that the effect of H_2O_2 solution was due to its O_2 release which met the needs of germination. Theoretically, H_2O_2 decomposes into H_2O and O_2, and is metabolized by the seeds. It is believed that these events promote aerobic respiration in the seed and changed its oxidation- reduction pathways. Such alterations produce a metabolism which is favorable to germination. The seed-peeling treatment in Xei's experiment showed no favorable effect. So it can be concluded that the dormancy in newly-harvested cucumber seeds is not caused by limitations imposed by the seedcoat. The effect of hot treatment in our experiment can not be explained by changes in seed coat structure. Fu (2) found that hot treatment could shorten the after-ripening period in cluster mallow (*Malva verticillata* L.) seeds and could increase germination rate. We believe that hot treatment can accelerate a cucumber seeds' after-ripening period.

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Table 1. Germination characteristics of cucumber (*Cucumis sativus* L.) seeds treated with hot and cold temperatures.

Treatment	GP (%)	GS (%)	PV	GI	MLIT
Hot treatment	96 a[z]	70 B	35.2 ABb	28.2 B	0.89 Bb
Cold treatment	96 a	40 Cc	22.8 Bbc	24.2 Cc	1.04 ABa
CK1 (new)[y]	95 a	34 Cc	18.1 Bc	23.2 Cc	1.08 Aa
CK2 (stored)[x]	99 a	98 A	50.5 Aa	36.3 A	0.69 Cc

[z]Numbers in table was tested by LSR. Capital letters indicate tests at α=0.01, and small letters α=0.05.

[y]Control treatment of newly-harvested seed.

[x]Control treatment of seed stored for one year.

Table 2. Vigor of cucumber (*Cucumis sativus* L.) seedlings from seeds treated with various temperatures before sowing.

Treatment	July 22	July 24	July 25	July 26
Hot treatment	sown	3.0 cm high	9.1 cm high, cotyledons parted	11.0 cm high, main root 2.8 cm long & thick
Cold treatment	sown	outcropped	5.7 cm high, cotyledons inseparated	8.0 cm high cotyledons inseparated, main root 1.7 cm long & thin
CK1 (new)[z]	sown	outcropped	4.4 cm high, cotyledons close together	6.0 cm high, cotyledons inseparated, main root 1.5 cm long & thin

[z]Control treatment of newly harvested seed.

Alteration of Catalase Activity and Ethylene Release during Germination in Newly-Harvested Cucumber Seeds

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In cucumber (*Cucumis sativus* L.) breeding and seed production, we often want to utilize newly harvested seeds for multiplication. However, the vigor of these seeds is low and their regrowth is difficult. Therefore, an understanding of the vigor characteristics of newly-harvested cucumber seeds is important. Catalase activity can define a seed's vigor. Likewise, a seed's ability to producing ethylene can act as an index of its vigor (1). This experiment was designed to study catalase activity and ethylene release during germination in newly-harvested cucumber seeds.

Methods. Seeds of 'Jinyan 6' cucumber were taken from fruits and fermented on July 16. Seeds were washed and dried in the sun on July 18, and the experiment was started on the same day. Newly-harvested seeds and seeds stored for one year (as control) were soaked in water for 6 h, and then germinated at 30C. Catalase activity and ethylene release were assayed every 5 h after seeds had sprouted. Both treatment and control were replicated three times. Catalase activity and ethylene production were determined by iodometry (2) and gas chromatography, respectively. Thirty-five seeds (~1 g) were sealed in a 75 ml glass jar for 1.5 h, and then gas samples were taken.

Results. The catalase activity of newly-harvested seeds was lower than that of stored seeds, except for the initial 9 h and terminal 8 h of a 50 h period (Fig. 1). These data suggest that the metabolic level of oxidation and vigor of newly-harvested cucumber seeds is lower than that of stored seeds.

In the first 25 h of experimentation the ethylene production of newly- harvested seeds was lower than that of stored seeds. In contrast, in the latter half of the experiment, ethylene production of newly-harvested seeds was higher than that of stored seeds. The peak ethylene value of stored and newly-harvested seeds appeared at the 20th hour and at the 35th hour, respectively. These ethylene peaks were just 8 to 10 h after the germination peak. The different ethylene-producing patterns of newly-harvested and stored cucumber seeds indicates a difference which is attributable to their vigor.

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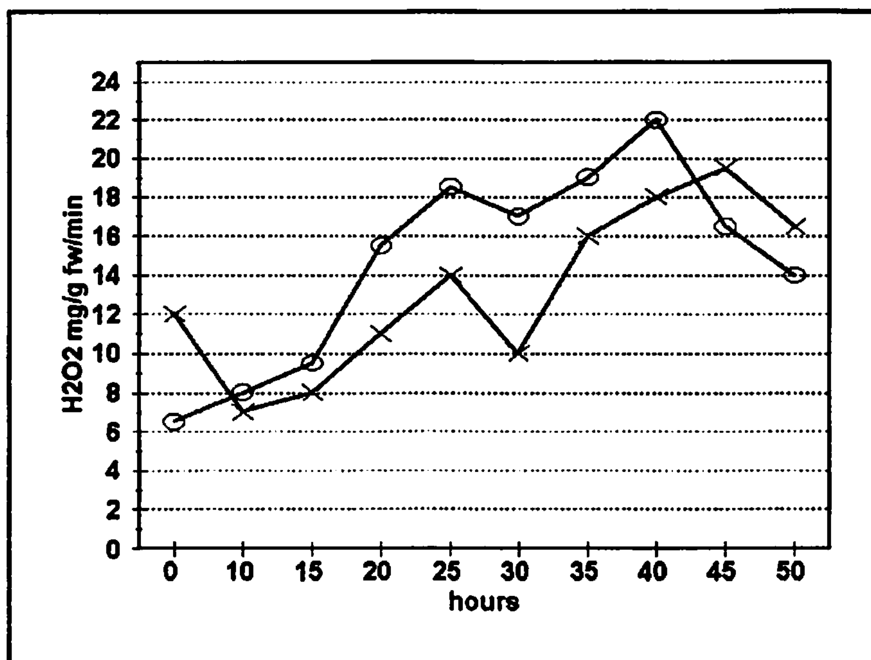

Figure 1. Changes in catalase activity during germination of newly-harvested (x) and stored (o) cucumber seeds.

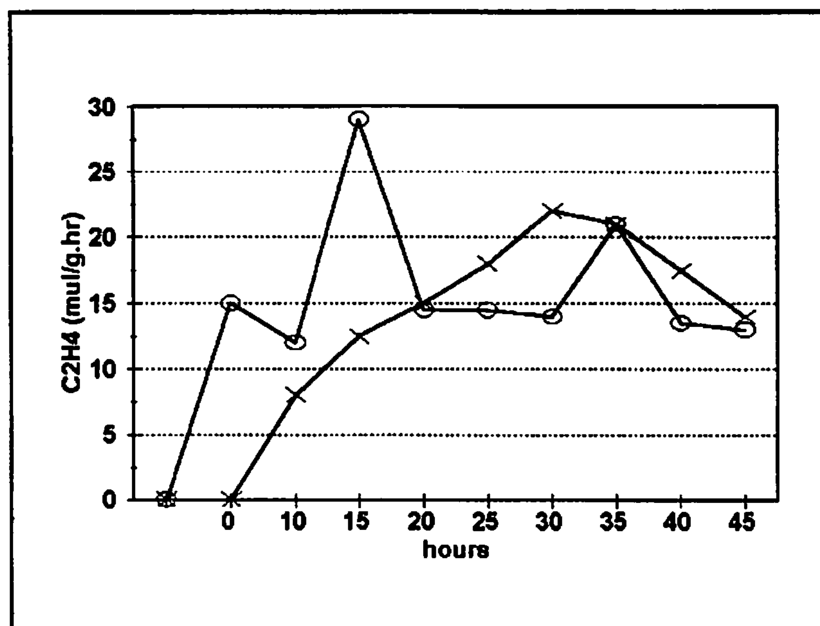

Figure 2. Alteration of ethylene release during germination of newly-harvested (x) and stored (o) cucumber seeds.

Chilling Sensitivity in Cucumber Seedlings: Ethylene Production

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Chilling injury can occur during cucumber production (2). The most feasible method of increasing the chilling resistance of crop plants is by genetic manipulation. Breeding for chilling resistance requires a method for evaluating chilling sensitivity. Results with cucumber fruit (3,4) and plants leaves in other species suggest that ethylene measurement (increase) after chilling could provide a means by which genotypes could be rated for chilling resistance. However, the effect of chilling on ethylene release in cucumber (seedling) has not been reported. The objective of this research was to study the relationship of ethylene release in cucumber seedlings after chilling and define a method for evaluating chilling resistance.

Methods. Chilling sensitive and tolerant cucumber cultivars [Heidan-1 (tolerant), Nongda-11 (tolerant), Jin-7 (sensitive), Xiong-58 (sensitive)] were grown in a growth chamber under a 12-h photoperiod (photon irradiance of 30000 lux) with mean day and night temperatures of 25 and 18C, respectively. The age of seedlings when chilling temperatures were applied was 12 days from seeding. The seedlings of each cultivar were divided into four lots, and assigned as either control (20C) or one of three chilling treatments (3.0 and -3C) cultivars were then incubated for 6, 18 or 36 h.

After the chilling exposure, the seedlings were transferred to a 20C room and held for 4 h. Then, about 3 g of cotyledonary tissue from plants in each treatment was sealed in 75 ml jars for 1 h. Subsequently, 1 ml samples were taken from each jar and ethylene were measured by gas chromatography.

Results and Discussion. Chilling injury varied with chilling temperature. The degrees of chilling injury could be reflected by rate of electrolytic leakage. The rate of electrolytic leakage increased by chilling stress (Table 1). Difference in chilling cultivar sensitivity were defined by rate of electrolytic leakage after chilling at -3C (18 h). 'Heidan-1' and 'Nongda-11' were tolerance to chilling, while 'Jin-7' and 'Xinong-58' were sensitive to chilling.

Table 2 shows that ethylene production of seedlings varied with chilling temperature. Ethylene evolution remained very low in seedlings exposed to 20C, and less ethylene was produced after chilling at 3C. Ethylene production increased rapidly, however, when seedlings were chilled at 0C, and decreased significantly with chilling at -3C when compared to ethylene production at 0C. This result agrees with previous studies.

After the transfer of cucumber seedlings from 0 to 20C for 4 h, ethylene production increased rapidly, and there were significant cultivar differences. Higher ethylene levels for extended periods were found in chilling tolerant cultivars when compared to sensitive cultivars (Table 3). This result indicates that ethylene production after chilling at 0C positively correlates (associates) with chilling resistance in cucumber cultivars. Moreover, these results suggest that ethylene production after rewarming of chilled seedlings could serve as a good indicator of chilling sensitivity.

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Table 1. Effect of chilling temperature on the rate of electrolyte leakage in cotyledons of four cucumber (*Cucumis sativus* L.) cultivars at 4 h after seedlings were transferred to 20C (%).

Cultivar[z]	20C	3C	0C	-3C
Heidan-1 (tolerant)	10.8	12.5	32.3	70.5
Nongda-11 (tolerant)	10.9	12.8	33.4	73.9
Jin-7(sensitive)	10.4	14.1	35.9	92.7
Xinong-58 (sensitive)	11.4	12.8	38.2	94.4

[z]Seedlings were chilled for 18 h before transferring.

Table 2. Effect of chilling temperature on ethylene production of four cucumber (*Cucumis sativus* L.) cultivars at 4 h after seedlings were transferred to 20C ($\mu g.g^{-1}.h^{-1}$).

Cultivar[z]	20C	3C	0C	-3C
Heidan-1 (tolerant)	0.2707	0.449	0.889	0.493
Nongda-11 (tolerant)	0.2510	0.451	0.778	0.464
Jin-7 (sensitive)	0.2674	0.344	0.619	0.392
Xinong-58 (sensitive)	0.2331	0.401	0.557	0.398

[z]Seedlings were chilled for 18 h before transferring.

Table 3. Changes of ethylene production of four cucumber (*Cucumis sativus* L.) cultivars with chilling periods at 0C after seedling transferred to 20C for 4 h ($\mu g.g^{-1}.h^{-1}$).

Cultivar	6 h	18 h	36 h
Heidan-1 (tolerant)	0.609 a	0.889 Aa	1.276 Aa
Nongda-11 (tolerant)	0.479 a	0.778 AaB	0.921 Abb
Jin-7 (sensitive)	0.383 a	0.619 Bb	0.618 Bc
Xinong-58 (sensitive)	0.401 a	0.557 Bb	0.538 Bc

Heredity Analysis of Photosynthetic Rate and Chilling Tolerance of Cucumber Seedlings Under Low Temperature

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Increased attention is now being given to cold resistance in cucumber (*Cucumis sativus* L.). Cold resistance in cucumber includes two aspects: low temperature tolerance (10-15C) and chilling tolerance (0-5C). Although considerable attention has been focused on chilling tolerance, the reports on low temperature tolerance of cucumber are sparse.

Low temperature affects photosynthesis (1). Varieties whose net photosynthetic rates under low temperature are higher can grow better than sensitive varieties under low temperature. Thus, net photosynthetic rate (PR) under low temperature can be used as an index of low temperature tolerance in cucumber. The chilling index (CI) indicates the extent of plant injury incur after chilling. Thus, CI can provide an indication of chilling tolerance in plants. This report examines PR and CI as potential selection indices for developing chilling tolerance in cucumber. Six cucumber inbreds were used in a 3x3 incomplete diallel crossing scheme. The PR and CI of nine hybrids were analyzed to estimate genetic parameters.

Materials and Methods. Six cucumber inbreds were chosen as parents based on differences in of their chilling sensitivity. The chilling susceptible female parents were: 'Jin-4' (No.1), 'Jin-6' (No.2), and 3511 (No.3). The chilling tolerance male parents were: 'Pingli' (No.4), 'Erzhaozi' (No.5), and 'Xixiabai' (No.6). The 3x3 incomplete diallel crosses produced 9 hybrids.

Seeds were sown in plastic pots filled with manure and soil (manure:soil=1:1). The diameter of the pots was 10cm and the height was 9cm. Seedlings in each pot were thinned to two per pot after the seedlings emerged. Plants in both experimental chambers were arranged in a completely randomized block design with 3 replications. Twenty days later, at the third leaf stage, uniform seedlings were chosen and moved to two control environments. The temperature in one chamber (N) was normal (25/15C, day/night for 5 days and 3C for 1 day). In another chamber (L), the temperature was lower (20/10C for 5 days, and 3C for 1 day). All other conditions in the chambers were similar (intensity of illumination was 33.78 w/m^2, 10 h per day; RH = 80-90%). The PR of the second leaf was estimated on the fifth day using an LI-6200 photosynthesis analysis system.

When the 3C treatment ended, the temperature in both chambers was returned to ambient temperature. Three days later, the injury of seedlings was recorded. Referring to the methods of Wang (1985) and Semeniuk (1986), the ranks of injury were divided as follows:

0 - no visible injury
1 - slight injury in edge of leaf
3 - visible injury in leaf, no visible injury in apical point
5 - slight injury in apical point or plant withered
7 - dead

Chilling index was calculated using the following formula:

$$CI = \frac{\Sigma\ r \times n}{r_{max} \times N}$$

where r = rank of injury, n = number of plants, r_{max} = the largest rank, and N = number of total plants investigated.

An analysis of variance was performed using treatment means, and estimates of variance components, and broad (B) and narrow (N) sense heritability estimates were made.

Results. At variance analysis showed that difference in PR and CI exist among hybrids at both temperatures (N:PR, F=2.722*/CI, F=5.406** L:PR, F=6.839**/CI, F=5.344**). Further analysis showed that, PR under normal temperature was significantly higher than under low temperature. CI under low temperature was significantly smaller than under normal temperature. Under low temperature, the covariance between PR and CI was significant (Cov (PR,CI) = 11.7**). This indicates that highly chilling tolerant varieties have lower photosynthetic rates under low temperatures when compared to chilling sensitive hybrids.

Variance analysis of combining ability reveals that the general combining ability of female parents for PR and CI under low temperature was significant ($\alpha = 0.01$). Likewise, general combining ability of male parents was significant ($\alpha = 0.05$). The effect of specific combining ability was not significant.

The hybrids with smaller CI were 1x6, 2x4, 3x5 (Table 1), and F1's with higher PR values were the higher PR F1 were 1x6, 3x4, and 2x5. The values of general combining ability for CI of No.3, No.5 and No.6 were negative, and the variance of special combining ability of No.3 and No.5 was comparatively large. Therefore, it could be predicted that more chilling tolerant progeny would be produced when using No. 3, No. 5 and No. 6 as parental stock. Progeny with higher PR generations would likely be produced when using No. 1, No. 3, and No. 4 as parents, because of their relatively high general combining ability values and the large specific combining ability recorded for PR under low temperature.

Estimates of genetic parameters are given in Table 2. Under low temperature (20/10C), the values of heritability of PR and CI were relatively high and genetic variances were conditioned by additive gene action. The heritability of CI under low temperature was higher than that under normal temperature (h^2B=56.49%). Data suggest that, if there had been no cold acclimation, the genetic potential of plants could not have been fully expressed. The selection of chilling tolerant varieties is likely to be very difficult because of the difficulty of distinguishing genotypes based on their phenotypes.

Discussion. Cold resistance is a trait in which genes are induced and expressed. These genes are only induced by certain environmental conditions (i.e., low temperature), and only after induction can the cold resistant genes be expressed. In this study, the chilling tolerance ability of cucumber was increased significantly after 5 days low temperature treatment (20/10C).

A study of cold resistance in tomato (3) showed that the effect of general combining ability, and its expression was mainly attributable to additive gene action. A study by Wehner (1984) showed that the heritability of cucumber germination percentage and germination speed under low temperature was high and was mainly controlled by additive genetic factors. The results of our study confirms the work of Wehner (4). Improvement of cold resistance in cucumber may be possible in the future. However, selection must be done in cross progeny which are fully induced by low temperature.

There is a negative covariance (correlation) between chilling tolerance and low-temperature tolerance in cucumber. In order to select cold-resistant cucumber varieties which are both tolerant to chilling and low temperature, the negative relationship among these traits must be broken. In this experiment, the hybrid 1x6 did not have acceptable commercial quality, but it endured exposure to low temperature and chilling. It will be difficult to select a chilling and low temperature tolerance cucumber variety. Nevertheless, we believe that the time and expense to do so is warranted.

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Table 1. Combining ability estimates for response to low temperature in cucumber (*Cucumis sativus* L.).

Inbred line	INBRED LINE No. 4 PR	No. 4 CI	No. 5 PR	No. 5 CI	No. 6 PR	No. 6 CI	g PR	g CI
No. 1	-0.21	-0.30	-0.06	1.85	0.28	-1.55	0.78 0.008*	3.66 1.145*
No. 2	-0.23	-1.90	0.21	-0.01	0.02	1.10	-0.17 -0.005*	0.09 -0.614*
No. 3	0.45	1.39	-0.15	-1.84	-0.30	0.45	-0.08 -0.103*	-3.75 0.947
g^	0.34 0.095*	2.11 -0.208*	-0.07 -0.019*	-0.98 1.591*	-0.26 0.030*	-1.13 0.095*		

*Indicates specific combining ability estimates.

Table 2. Genetic estimates of low temperature response in cucumber (*Cucumis sativus* L.).

Character	-a	-b	-ab	-c	$h^2B(\%)$	$h^2N(\%)$
PR	0.514	0.049	0.052	0.244	71.62	65.53
CI	12.575	2.198	0.731	8.157	65.52	62.44

Histopathology of Cucumber Resistance to Downy Mildew

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Downy mildew, *Pseudoperonospora cubensis* (Berk. et Curt.) Rastow, is the most destructive cucumber disease in China. Breeding for disease resistance is the most effective control method. Although a number of resistant cultivars have been developed, mechanisms of resistance are not clear. Considerable experimentation has been directed towards the elucidation of *Pseudoperonospora cubensis* resistance in species other than cucumber (1,3,6). Riggle and Dunleavy (1981) studied the histology of leaf infection of susceptible and resistant soybeans by *Peronospora manshurica* (4). However, limited research has been carried out on downy mildew of cucumber in China. Li. et al. (1991) discussed changes in the host-pathogen relationship but failed to study the changes of the fungus itself (5). In order to provide a scientific basis for downy mildew resistance in China, we studied the resistance mechanism of various Chinese cucumber cultivars.

Materials and Methods

Plants and pathogen. Four cucumber cultivars [Jinzha-2 (resistant), Jinyan-6 (moderately resistant), Heidan-1 (moderately susceptible), and 'Changchun Mici' (susceptible)] were grown in a greenhouse. An isolate of *Pseudoperonospora cubensis* obtained from infected cucumber plants in the field was maintained on cucumber plants growing in a growth chamber.

Inoculation. Before inoculation, spores on all leaves were removed by washing with clean water. Plants were then maintained at 100% RH for 24 h. The freshly produced sporangia were gently brushed off into distilled water. After a suspension of sporangia was sprayed on the 2nd leaf of plants at the 4-leaf stage, plants were held at 100% RH for 16 h and then transferred to chambers and grown under 10,000 lux irradiance for 16h at 18-22C for the duration of the experiment.

Sampling, staining and microscopic observation. Samples taken at 4, 6, 12, 24, 48, 72 and 96 h after inoculation were made transparent with saturated trichloroacetaldehyde monohydrate, then stained with 0.1% lactophenol-cotton blue solution for 15 min. Penetration, mycelial growth, haustorium formation and plant cell necrosis were observed using light microscopy. Spore germination on leaf surfaces was observed after calcofluor staining under fluorescence microscopy.

Results

Penetration. The sporangia on leaves germinated to release zoospores. The zoospores encysted on stomata. After germination the germ tubes penetrated through stomatal openings. Subsequently, substomatal vesicles of pyriform or irregular shapes formed. Usually only one penetration site formed on a stoma. However, occasionally two penetration sites were observed which produced substomatal vesicles and intercellular hyphae separately. These processes were not different in the cultivars which were examined.

Mycelial growth and haustorium development. After penetration, the fungus produced intercellular hyphae. Valvate or spherical haustoria were then produced from each intercellular hypha. Several haustoria formed in a single host cell. Occasionally substomatal vesicles were produced directly by inoculation. However, the average number of haustoria was distinctly higher on susceptible leaves than on resistant leaves. There were an average of 0.70 haustoria per penetration in susceptible leaves by 6 h after inoculation, whereas resistant leaves had only 0.21 haustoria per penetration. Similarly, by 48 h there were 11.17 and 2.53 haustoria observed per penetration on the leaves of susceptible and resistant cultivars, respectively (Table 1).

The intercellular hyphae penetration was slow until 24 h after inoculation, and was extremely rapid thereafter (48 h). Cultivars differed markedly in mycelial growth. At 48 h, the mycelium was 164.6 m long in susceptible leaves, and 64.7 m long in resistant leaves (Table 2). The

mycelial growth on moderately-resistant and moderately-susceptible cultivars fell between the extreme values. Mycelial growth tended to accord with haustorium formation. With mycelial growth, more haustoria were formed.

The necrosis of leaf cells. During the progress of infection, rapid necrosis of host cells is an important event which relates to the expression of resistance. It was observed that leaf cell necrosis occurred in resistant and moderately resistant cultivars by 24 h after inoculation. In contrast, necrosis commenced in moderately susceptible and susceptible cultivars at 48 h and 72 h, respectively. By 72 h after inoculation, 13.7% of the penetration sites had necrosis cells in resistant leaves, with 40.7% in susceptible leaves. Data indicate that the time and rate of host cell necrosis differed between resistant and susceptible cultivars.

Discussion

Cohen (1981) reported that *Pseudoperonospora cubensis* could infect the leaves both of susceptible and resistant cucumber cultivars, and produce intercellular hyphae and haustoria (2). The results of our experiment confirm Cohen's observation, but are contrary to the argument of Li et al. (1991) which suggests that the infection process does not occur in resistant leaves (5). We have, however, found that the histopathological characteristics of leaves which were infected by *P. cubensis* differed among cucumber cultivars.

The formation of haustoria marks the establishment of parasitic relationship between the fungus and its host plant. Although every cultivar had formed haustoria by 6 h after inoculation, 65.6% of the penetration sites formed haustoria on susceptible leaves, only 21% was observed on resistant leaves. This result shows that, at the early stage of haustorium formation, a resistant cultivar has already expressed its resistance to *P. cubensis*. Compared with the infection on the susceptible cultivars, the process of infection is apparently inhibited on resistant cultivars. The formation of haustoria in leaves of resistant cultivars is slower and haustoria are less in number. Mycelial growth eventually slows down and fungal growth stops, at which time tiny spots appear on the plant's surface. These histological characteristics only mirror processes involved in infection inhibition. The exact biological mechanisms for such inhibition are not clear.

Li et al. (1991) observed cell necrosis in infected resistant cultivars. We found that host cell necrosis existed in the susceptible cultivar as well as the resistant cultivar, although the time and incidence of the necrosis differed distinctly among cultivars. Cell necrosis occurred at 24 h in the resistant cultivar, but at 72 h in the susceptible cultivar. In addition, the number of necrotic cells in the susceptible cultivar is very limited and did not affect the growth of the fungus. The earlier that necrosis occurs, the less the number of haustoria and the stronger the host resistance. Whether the necrosis of host cells is the cause/consequence of earlier inhibition or the death of the invading fungus and the histopathological characteristics of immune cultivars and non-host plant resistance is not clear.

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Table 1. Comparison of haustoria of *Pseudoperonospora cubensis* among different cucumber (*Cucumis sativus* L.) cultivars.

		Average number of haustoria per penetration*					
Resistance level	Cultivar	6h	12h	24h	48h	72h	96h
Resistant	Jinzha-2	0.21	0.66	0.91	2.53	3.82	4.68
Moderately resistant	Jinyan-6	0.55	1.02	1.26	4.15	6.33	7.71
Moderately susceptible	Heidan-1	0.63	1.12	1.64	8.15	10.90	13.52
Susceptible	Changchun Mici	0.70	1.38	2.15	11.17	13.25	15.57

*Thirty penetration sites were investigated at each sampling time.

Table 2. Mycelial growth on various cucumber (*Cucumis sativus* L.) cultivars after infection with *Pseudoperonospora cubensis*.

		Mycelial length at various times after inoculation (µm)*			
Resistance level	Cultivar	24h	48h	72h	96h
Resistant	Jinzha-2	16.4	64.7	73.9	82.3
Moderately resistant	Jinyan-6	19.5	75.0	98.1	107.4
Moderately susceptible	Heidan-1	25.4	117.6	127.8	176.2
Susceptible	Changchun Mici	27.9	164.4	176.2	190.7

*Thirty penetration sites were investigated at each sampling time.

Split-Root Technique for Multiple Nematode Resistance in Cucumber

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Currently there are no cucumber cultivars that have resistance to the root- knot nematodes that are detrimental to cucumber production in the southeastern United States: *Meloidogyne arenaria*, *M. javanica* and *M. incognita*. We have identified resistance to several root-knot nematodes in *Cucumis sativus* var. *hardwickii* line LJ 90430 (2). That line has resistance to *M. arenaria* races 1 and 2, and *M. javanica*. We have started a breeding program to develop inbreds resistant to three nematodes. Thus, it is necessary to test each plant for three nematodes.

In order to overcome that problem, a split-root technique was developed in which the root system of each plant was split equally into three 10-cm plastic pots filled with a 1:1 mixture of steam-sterilized sand and soil (Fig. 1). That permitted us to evaluate segregating material for three root-knot nematodes simultaneously.

Materials and Methods. A greenhouse study was conducted to compare our standard (single-root) technique with the split-root technique. For the split-root technique, seeds were planted in trays containing vermiculite, then transplanted two weeks later into pots. Two weeks after transplanting, pots were inoculated with 5000 eggs of the respective root-knot nematode (*M. arenaria* races 1 or 2, or *M. javanica*) utilizing a 1% NaOCl solution to extract eggs from infected roots of 'Rutgers' tomato (1). With the standard technique, cucumber seeds were planted into 5-cm peat pots containing Metromix 220. Peat pots with plants at the 2 to 3 leaf stage were then planted directly into 15-cm diameter plastic pots containing a 1:1:1 mixture of soil:sand:peat. Pots were watered using drip irrigation and fertilizer injection. That watering system minimized pot to pot contamination of nematodes in the split-root treatment. Three NCH1 families being developed for root-knot nematode resistance were used to compare the split-root technique with the standard transplanting technique. Each treatment combination had 10 replications. The number of days to first flower and vine length (cotyledon to shoot apex) at three and six weeks were determined.

Results. Plants grown with the split-root technique were slower to flower, and were stunted in growth at both three and six weeks compared to plants grown with the normal technique (Table 1). Transplant shock was occurring more with the split-root technique, probably as a result of roots recovering from exposure to desiccation in the soil during transplanting. It is unlikely that the delay was due to nematodes, since the plants had been inoculated only one week before the first vine lengths were recorded.

A 3 to 8 day delay in flowering date occurred with the split-root technique (Table 1). Vine growth at 3 weeks was significantly reduced in the split-root technique compared to the normal technique. By the 6th week, plants in the split-root technique had recovered, but vines were shorter than when grown with the standard technique. Plants eventually recovered in the split-root treatment, and formed large fruits with viable seeds. Therefore, the cost associated with the split-root technique was a suppression in plant growth and a delay in flowering. That resulted in fruit being harvested 1 to 2 weeks later in the split-root technique compared to the standard technique. However, the delay is manageable, and the extra information on nematode resistance well worth the trouble.

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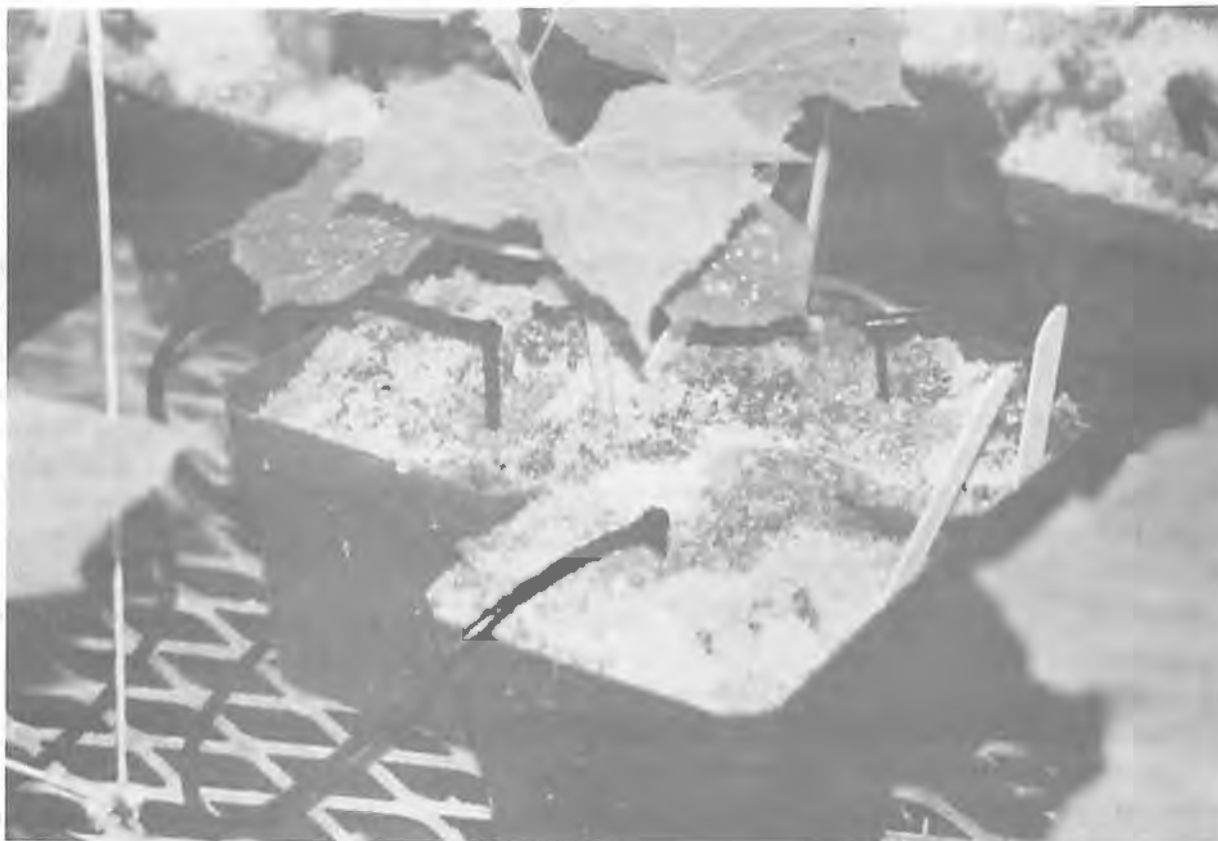

Figure 1. Cucumber plant with roots split into 3 separate pots, each pot inoculated with a different nematode.

Table 1. Comparison of the split root-technique in three families of cucumbers that were transplanted normally for days to first staminate flower and vine length at 3 and 6 weeks after transplanting[z].

Technique	Family	Days to first Flower	Vine length (cm) 3 weeks	Vine length (cm) 6 weeks
Standard	NCH1-1	35	32	178
	NCH1-2	36	22	154
	NCH1-3	35	35	191
Split-root	NCH1-1	42	4	93
	NCH1-2	44	4	76
	NCH1-3	38	8	123
LSD (5%)		*2*	*4*	*14*

[z]Data are means of 10 replications of 1 S_4 plant each.

Paternal Inheritance of Mitochondrial DNA in Cucumber (*Cucumis sativus* L.)

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Linkage analysis has been performed in cucumber using RFLP markers and the *acr* locus (5). At that time, almost all of the RFLP clones segregated in Mendelian ratios, except for two genomic clones (B-174 and P-146) which resulted in F_2 progeny with the same RFLP pattern as that of paternal lines.

Since polymorphisms were observed between the two inbred lines homozygous for these clones, monomorphic banding patterns were not predicted. Therefore, we studied the genotypes of F_1 plants and origin of these two clones to determine the genetic nature of this phenomenon.

Methods. Ten adapted inbred lines and one wild strain were reciprocally crossed to produce F_1 progeny. To assure the genetic purity of these parental lines, samples of total DNA for Southern hybridization were isolated from parental germplasm. Mitochondrial and chloroplast DNA was isolated from F1 progeny of a cross between NB-1 and GF-1. Experimental procedures to isolate total, mitochondrial and chloroplast DNAs were according to Murray and Thompson (7), Umbeck and Gengenback (9), and Hirai *et al.* (2), respectively. Three DNA clones, P-061, *atp6* and pSB8, were used as control probes in Southern hybridization experiments. One of the genomic clones, P-061, is derived from nuclear DNA because F2 progeny segregated 1:2:1. The clones, *atp6* and pSB8, are mitochondrial and chloroplast DNAs, respectively. These clones were obtained from rice by Kadowaki *et al.* (1990) and Hiratsuka *et al.* (1989). Southern hybridization was done according to Matsuura and Fujita (1994a).

Results. *RFLP patterns of reciprocal hybrids.* RFLP patterns of 11 parental lines and 14 reciprocal hybrids are shown in Figure 1. Since these F_1 hybrids produce biparental signals for P-061, these plants were considered hybrids. In contrast, all hybridization with B-174 and P-146 produced banding patterns like paternal lines in the reciprocal hybrids. Polymorphisms were observed between W-103 (lane No. 5: *Cucumis sativus* var. *hardwickii*) and other inbred lines when DNA was hybridized to *atp6*. Two reciprocal combinations which used W-103 as a parent showed the same signal as that of the paternal lines. Polymorphisms were not detected among these inbred lines when total DNAs were digested by *Bam*HI and *Eco*RI and hybridized with pSB8.

Origin of the two genomic clones. P-061, *atp6* and pSB8 hybridized intensively with total mitochondrial and chloroplast DNAs, respectively (Fig. 2). Likewise, B-174 and P-146 hybridized intensively with mitochondrial DNA.

Discussion. These results suggest that the some parts of the mitochondrial DNA are inherited paternally in cucumber. Paternal inheritance of mitochondrial DNA has been reported in some plant species (8,1). However, these species are distantly related to the Cucurbitaceae. In seed production of an F_1 hybrid, cucumber breeders usually use gynoecious lines as the female parent and monoecious lines as the paternal parent. If some important agronomically characters are coded for in mitochondrial genes and polymorphisms were existed among the inbred lines, then attention must be given to the source of the paternal parent. It is important to determine whether these kind of polymorphisms exist in cultivated cucumber.

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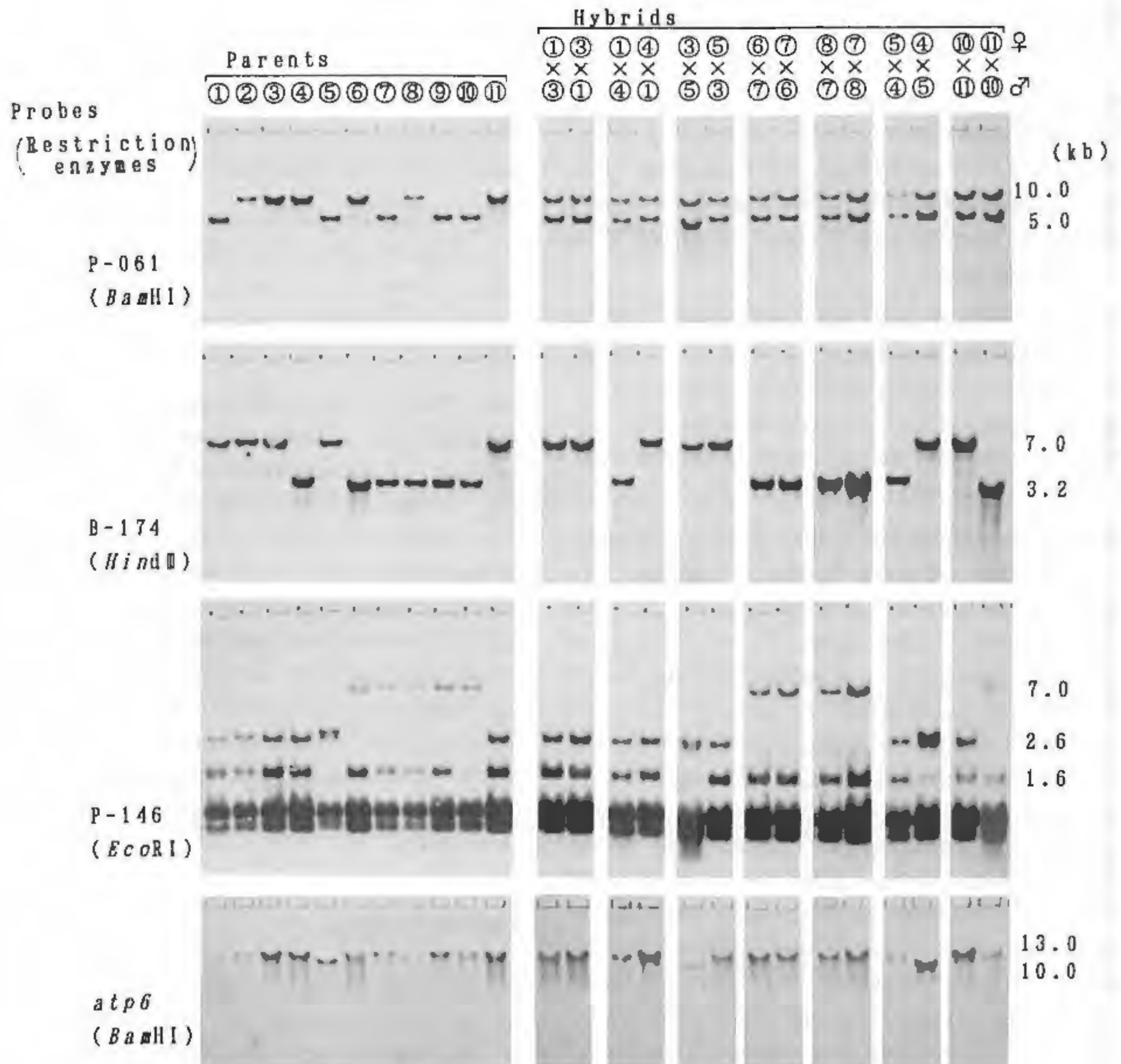

Figure 1. RFLP patterns resulting from Southern hybridization of RFLP clone P-061 to BamHI digested DNA, B-174 to HindIII-digested DNA, P-146 to EcoRI-digested DNA and *atp6* to BamHI digested DNA which were isolated from 11 parents and 14 reciprocal hybrids.

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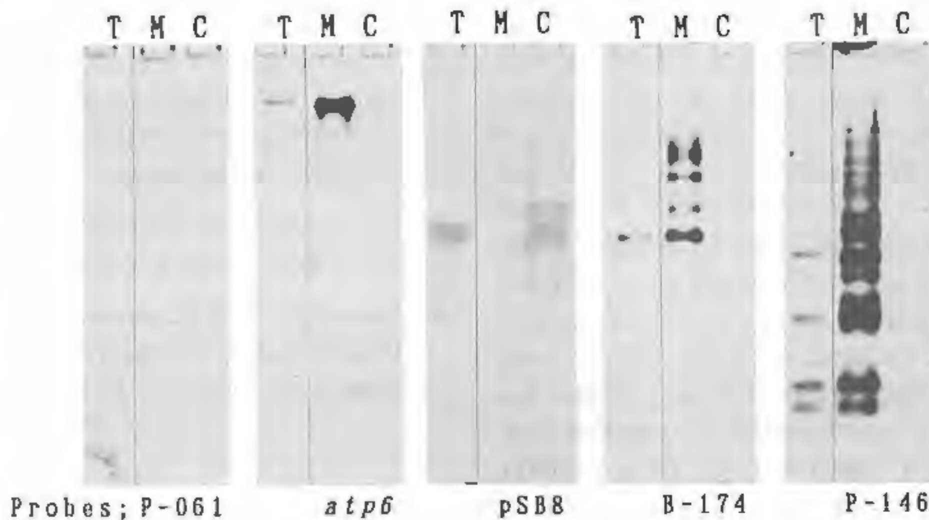

Figure 2. Southern hybridization analysis for total (T), mitochondrial (M) and chloroplast (C) DNAs from a cucumber cultivar (F_1; NB-1 x GF-1). These DNAs were digested by EcoRI, and P-061 (nuclear), *atp6* (mitochondrial), pSB8 (chloroplast), B-174 and P-146 used as probes.

A Combining Ability Study in Muskmelon Using Line x Tester Analysis

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Muskmelon, (*Cucumis melo* L), is predominantly a cross-pollinated crop, and its ability to produce plenty of seeds per fruit facilitates heterosis breeding. Pollination mechanisms (viz. monoecy, gynoecy and male sterility) have been exploited for heterosis breeding. On the other hand, vigour is not depressed by inbreeding (3) and most cultivars have been developed by selection and controlled inbreeding. The present investigation was undertaken to estimate combining ability effects using line x tester analysis excluding parents. This information will be useful to identify superior cross combinations that could be pursued for the development of superior cultivars and/or hybrids.

Material and Methods: Thirty F_1 hybrids involving two females (one monoecious and one gynoecious) and fifteen testers were grown during summer 1993 using three replications in RBD. Data were recorded for eight economic characters and were analysed following model of Kempthorne (1).

Results and Discussion: The ANOVA for the design (Table 1) revealed significant differences between hybrids for all the characters studied. Total variation among hybrids was further partitioned into different components corresponding to the combining ability of lines, testers and lines x testers interaction. Significance of MS due to lines (except node number to first female flower) and testers indicated that parents selected for the present study were genetically divergent. The results further indicated that both GCA and SCA effects were important for all the characters studied. These results confirmed earlier reports (2,4). Further, var. SCA hybrids accounted for greater part of the variation compared to var. GCA (lines) and var. GCA (testers), indicating a preponderance of non-additive, non-fixable gene effects.

GCA estimates of selected parents are given in Table 2. Parents E142 and B112 are good general combiners for most of the characters studied. R271 was good general combiner for days to picking, yield per plot and TSS%, three important economic characters in muskmelon. C121 had a highest GCA estimate for days to picking. These parents could be used in single and multiple crosses for isolating probable transgressive segregants. Of two females, M221 was a good general combiner for TSS and W321 for days to picking, fruit weight, fruit number per vine, yield per plot and flesh thickness. Results pertaining to SCA estimates of selected F_1 hybrids are listed in Table 3. Cross M221 x G161 exhibited significant and desirable SCA effects for all the characters studied. Cross W321 x H171 was second best. Cross W321 x M227 had significant desirable SCA estimates for yield per plot and TSS%. Crosses M221 x P253, M221 x I181, and M321 x H171 exhibited the highest SCA effects for days to picking, yield per plot and TSS%, respectively. But these crosses are not expected to yield desirable recombinants as they do not involve good x good general combiners. These crosses need to be studied minutely for their commercial utilization.

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Cucurbit Genetics Cooperative Rept. 18:34-36 (1995)

Table 1. Analysis of variance for combining ability.

Source	d.f.	Days to first female flower	Node No. to first female flower	Days to picking	Fruit weight (g)	Fruit No. per vine	Yield/ plot (kg)	Flesh thickness (cm)	T.S.S. (%)
Replicates	2	4.13	0.236	15.34	2491.5	0.002	0.02	0.016	0.486
Hybrids	29	117.72**	0.895**	99.67**	118676.8**	0.324**	10.98**	0.560**	7.22**
Lines	1	642.67**	0.215	889.85**	829055.6**	0.711**	58.27**	2.304**	11.38**
Testers	14	111.86**	0.638**	88.52**	149543.2**	0.213**	10.71**	0.547**	8.49**
Lines x Tester	14	86.58	1.200*	54.37**	37068.9**	0.408**	7.86**	0.449**	5.65**
Error	58	4.37	0.136	6.30	3913.1	0.012	0.24	0.052	0.39
Var. gca Lines	-	12.36	-	18.56	17599.7	0.007	1.120	0.041	0.127
Var. gca Testers	-	4.13	-0.074	5.69	18745.7	-0.032	0.475	0.016	0.473
Var. sca hybrids	-	27.40	0.355	16.02	11051.9	0.131	0.543	0.132	1.752

** = Significant at P=0.01

Table 2. General combining ability effects of selected parents.

	Days to first female flower	Node No. to first female flower	Days to picking	Fruit weight (g)	Fruit No. per vine	Yield per plot (kg)	Flesh thickness (cm)	T.S.S. (%)
				Females				
M221	-2.67	-0.05	3.14**	-95.9**	-0.09**	-0.80**	-0.16**	0.36**
W321	2.67	0.05	-3.14**	95.9**	0.09**	0.80**	0.16**	-0.36**
				Males				
1 7 50	-0.73	0.0	-0.76	-178.34**	0.18**	-2.37**	-0.07	1.04**
E142	-5.32	-0.59**	-3.09**	111.16**	0.50**	3.16**	0.06	0.96**
C121	4.27	0.09	-3.76**	-98.3**	-0.20**	-1.32**	0.60**	-1.38**
H173	7.35	0.21	4.58**	-72.1**	-0.04	-0.33	-0.09	1.62**
B112	-0.40	-0.32*	-2.76**	83.8**	0.06	0.73**	0.36**	2.21**
R271	3.68	0.41**	-3.59**	-84.8**	0.23**	0.51**	0.08	0.71**
M223	2.12	0.23	7.58**	124.8**	0.06	0.62**	-0.49**	1.63**
M253	-1.40	0.11	-2.26*	37.8	-0.14**	-0.32	-0.17	-0.38
E141	-7.65	-0.86*	-2.42*	48.4	-0.22**	0.48*	0.00	-1.54**
C123	0.18	-0.09	5.58	377.6**	-0.07	1.72**	0.55**	-1.46

*, ** = Significant at P=0.05 and P=0.01, respectively

Table 3. List of hybrids showing significantly desirable sca effects.

	Days to first female flower	Node No. to first female flower	Days to picking	Fruit weight (g)	Fruit No. per vine	Yield per plot (kg)	Flesh thickness (cm)	T.S.S. (%)
M221 x 1 7 50	0.92	0.00	-3.31**	90.48**	-0.09*	2.11**	-0.01	0.39
M221 x E142	0.84	-0.52**	0.69	55.64**	-0.21**	-1.02**	0.16	1.14**
M221 x I181	-4.33**	-0.42**	-0.64	86.64**	0.39**	2.23**	-0.17	0.39
M221 x B112	-5.58**	-0.28	-0.64	-30.69**	0.16**	0.41*	-0.07	-0.11
M221 x R271	3.17**	0.85**	0.52	15.98**	0.06	0.14	0.14	1.23**
M221 x M223	-5.16**	-0.20	-3.64**	-139.7**	0.42**	1.16**	-0.19*	-0.94**
M221 x P253	-5.25**	0.05	-5.14**	-1.02	-0.11*	-1.57**	-0.37**	0.14
M221 x G161	-3.41**	-0.63**	-2.81*	38.81**	0.12**	0.68**	0.33**	0.73**
M221 x E141	4.67**	0.15	0.69	-162.7**	0.44**	-0.35	0.06	0.31
M221 x C123	-0.50	-0.35*	3.02**	-26.86**	-0.11*	-1.08**	-0.32**	0.89**
W321 x E142	-0.84	0.52**	-0.69	-55.64**	0.21**	1.02**	-0.16	-0.14**
W321 x H171	-4.76**	-0.48**	-2.18*	-44.97**	0.41**	1.20**	-0.34**	2.19**
W321 x C121	-4.26**	-0.40**	1.31	-93.81**	0.04	-0.26	-0.49**	1.02**
W321 x H173	-1.01	-0.72**	-3.02**	84.02**	0.14**	1.05**	0.22*	-0.47
W321 x M227	-1.84*	-0.02	-1.02	-20.31**	0.31**	1.12**	0.36**	1.27**
W321 x M223	5.16**	0.20	3.64**	139.7**	-0.42**	-1.16**	0.19*	0.94**
W321 x P253	5.24**	-0.05	5.14**	1.02	0.11*	0.57**	0.37**	-0.14
W321 x E141	-4.67**	-0.15	-0.69	162.7**	-0.44**	0.35	-0.06	-0.31
W321 x K201	-2.76**	0.25	-6.36**	1.69	0.14**	0.54**	-0.19*	0.19
W321 x C123	0.49	0.35*	-3.02**	26.86**	0.11*	1.08**	0.32**	-0.89**

*, ** = Significant at P=0.05 and P=0.01, respectively

A virescent mutant in melon

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A mutant of *Cucumis melo* L. has been described with white cotyledons which later turn green and light green young leaves which turn normal green when becoming older (Pitrat *et al*, 1991). The genetic control of this character has not published. The F1 hybrid with a normal melon line is normal indicating a recessive control of the virescent character. In an F_2 progeny the segregation observed (235 normal *vs* 66 virescent) fits well with a monogenic recessive control (c = 1.516, Prob = 22 %).

Another virescent mutant has been described by Hoffman and Nugent (1973). The F_1 hybrid between this virescent mutant (symbol *v*) and the new one is normal. The control of the two virescent mutants is recessive; moreover in the F_2 progeny, normal green plants are observed indicating that the two genes are not allelic.

A second virescent mutant (*virescent-2*, symbol *v-2*) has been found by Dyutin (1967) but seeds are not avalaible and an allelism test cannot be made.

We propose for the new virescent mutant the name *virescent-3* and the symbol *v-3*.

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Cochleare folium, a mutant with spoon-shaped leaf in melon

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In a breeding program in 'Galia' type melon (*Cucumis melo* L.), a spontaneous mutant has been observed. Leaf margins are curled upward, giving more or less a spoon shape. This character can be observed more clearly in the summer with high temperature than during the other periods of the year. It is not very clear on the first or second leaf and plants can be scored quite clearly at the 3rd leaf stage.

The F_1 hybrid with a standard melon line has a normal phenotype (no curled leaves) and in the F_2 progeny the observed segregation can be explained by the action of one recessive gene: 266 plants with normal leaves and 89 with spoon-shaped leaves (c = .0009, Prob = 98 %).

A mutant with curled leaf (symbol *cl*) has been described (Cox, 1985). Plants with *cl* mutation are usually male and female sterile. We have not been able to obtain seeds of this mutant and the allelism test has not been done but as the male and female fertilities of the new mutant are not affected, we assume that the two mutants are different. We propose the name *cochleare folium* (symbol *cf*) from the latin *cochlearis* = spoon-shaped and *folium* = leaf.

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Interaction between monoecy and male sterility in melon

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In the original *male sterile-4* mutant (*ms-4*) of *Cucumis melo* the first male flowers turn yellow at bud stage (when the flower is about 1-2 mm) and do not open (2). This abortion of the male flowers is very clear on young plants. When the plants are older, the male flowers do not drop at an early stage; the corolla opens and the anthers are very small with no viable pollen indicating a true male sterility. This line is also monoecious. A cross between this monoecious male sterile line and an andromonoecious male fertile line ('Margot' of Charentais type) has been made and 185 F_2 plants were studied. Plants were grown in soil under a greenhouse in good growing conditions so that the flower yellowing and abortion cannot be explained by irrigation or nutritional stresses. The flower types have been noted (monoecious *vs* andromonoecious and male fertile *vs* male sterile) and also the day when the first male flower was blooming.

As expected, segregations correspond clearly to monogenic controls (3:1 segregation): monoecious *vs* andromonoecious (gene *a*: X^2 = 0.088, Prob = 77%) and male-fertile *vs* male-sterile (gene *ms-4*: X^2 = 2.207, Prob = 14%). These two genes are independent (X^2 = 2.512, Prob = 47%) as already described (3). The first male flowers bloom much more later on the sterile monoecious [a^+ *ms-4*] plants than on the fertile ones [*a*+ *ms-4*+] (Fig 1). The difference is significant at the 1% level according to the Kolmogorov-Smirnov two-sample test. But there is also a difference among the sterile andromonoecious [*a ms-4*] and the fertile andromonoecious [*a ms-4*+]. The monoecious sterile [*a*+ *ms-4*] blooms later than the andronomoecious sterile [*a ms-4*] but the difference is not significant.

The same study has been conducted using the *male sterile-5* mutant (*ms-5*) (1). An andromonoecious male sterile line has been crossed with a monoecious fertile line (MR-1) and 186 F_2 plants have been observed under greenhouse. No distortions of segregation have been observed: the observed segregations fit well with 3:1 segregation for monoecious vs andromonoecious (gene *a*: X^2 = 0.179, Prob = 67%) or male fertile vs male sterile (gene *ms-5*: X^2 = 0.065, Prob = 80%) and 9:3:3:1 for the independence between *a* and *ms-5* (X^2 = 1.737, Prob = 63%). As in the case of *ms-4* there are no differences between the andromonoecious fertile [*a ms-5*+] and the monoecious fertile [*a*+ *ms-5*+] plants for the date when the first male flower blooms (Fig 2). But there is a very strong difference for the monoecious sterile [*a*+ *ms-5*] plants which bloom much more later than the andromonoecious sterile [*a ms-5*] plants (significant at the 1% level according to the Kolmogorov- Smirnov two-sample test).

In conclusion there is an interaction between monoecy and male sterility. This interaction is very clear in the case of *ms-5*: the [*a*+ *ms-5*] plants exhibit an abortion of the first male flowers and the male flowers bloom about 15 days later than on [*a ms-5*+], [*a ms-5*] or [*a*+ *ms-5*+] plants. The interaction between *a* and *ms-4* is not as clear even if there is the same tendency.

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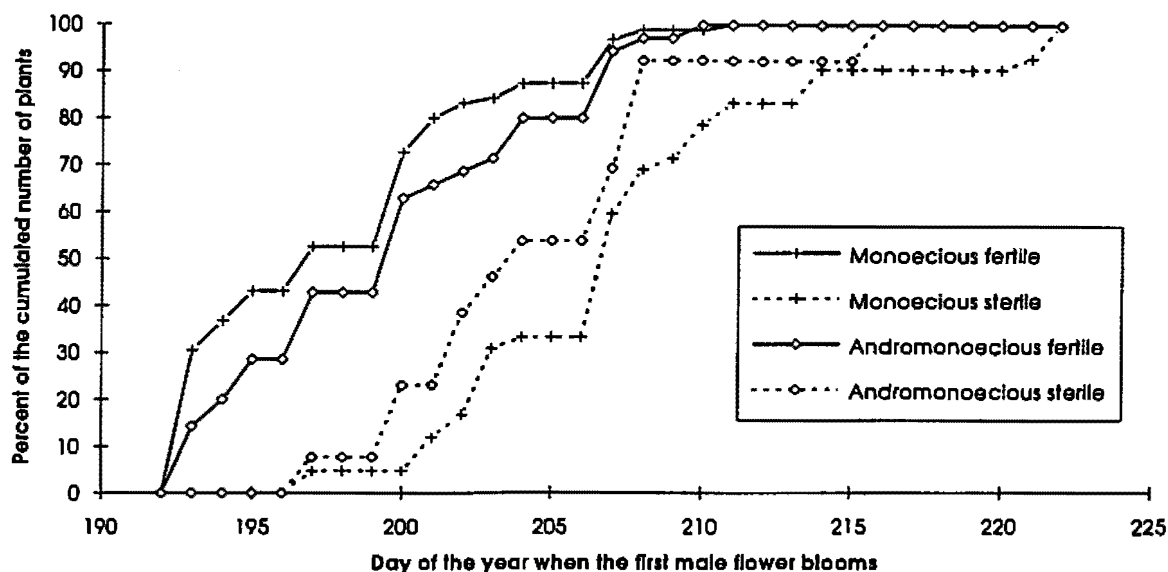

Figure 1. Day of the year when the first male flower blooms on 185 plants of an F2 progeny of the cross between male sterile-4 and Margot segregating for monoecious *vs* andromonoecious (gene *a*) and male sterile *vs* male fertile (gene *ms-4*).

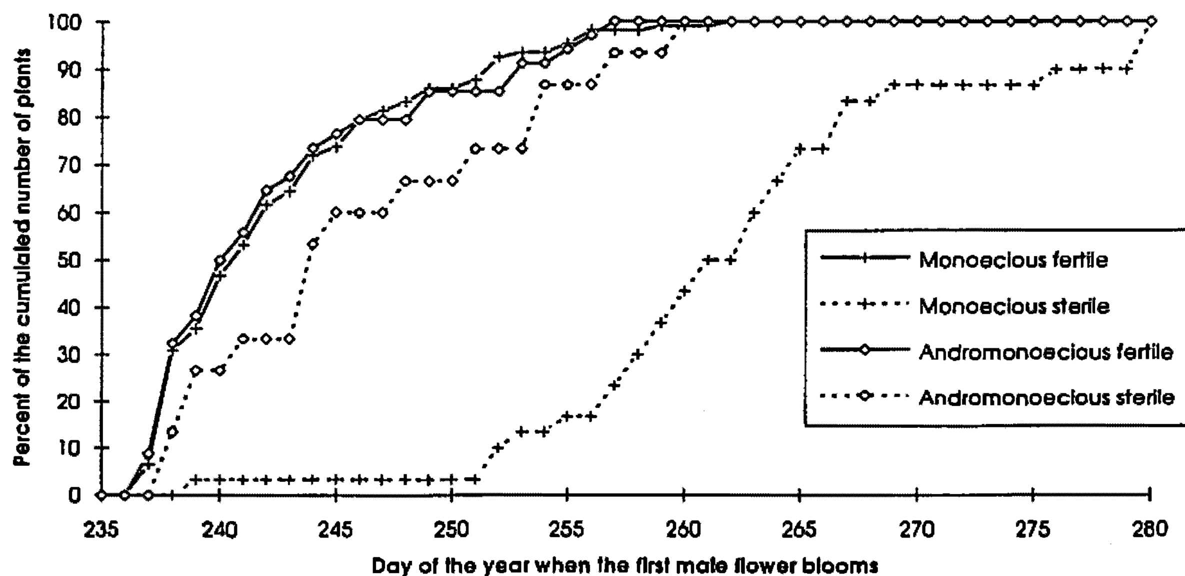

Figure 2. Day of the year when the first male flower blooms on 186 plants of an F2 progeny of the cross between male sterile-5 and MR-1 segregating for monoecious *vs* andromonoecious (gene *a*) and male sterile *vs* male fertile (gene *ms-5*).

New Sources for Powdery Mildew Resistance in Melon From Spanish Local Cultivars

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Resistance to powdery mildew (*Sphaerotheca fuliginea* [Schlech. ex Fr.] Poll.), was firstly found in a seed lot from India (5). That material has been extensively used in many breeding programs until today and most of the work done concerned with powdery mildew resistance in melon is mainly based in this first material, although other sources of resistance have been reported (3).

Spain is a secondary diversification center for *Cucumis melo* L. (2) and varietal characteristics of Spanish accessions are quite different to those of the Hindu material. For this reason a program to screen this Spanish material was thought to be of interest. The research we present in this paper, was the continuation of a preliminary study carried out in 1986 (1).

For that purpose 10 plants for each genotype of a collection of 44 Spanish accessions of *Cucumis melo* L. kindly supplied by the Vegetable Germplasm Bank of Zaragoza, were grown in pots containing a mixture of peat: sand: loamy soil (1:1:1 by volume) and placed in a growth chamber at 24C constant temperature, 15 hours of light and 9 of darkness. Light intensity was about 1,300 microeinsteins m^2 x sg^1 provided by "Sylvania day light" tubes.

Artificial inoculation was done by spraying over the second true leaf of the plants a suspension of conidia of *S. fuliginea* race 1 (40,000 sp/ml) as described before (4).

To assess resistance, thirteen days post-inoculation the number of conidia/cm^2 x ml was estimated according to the method described before (4), and visual symptoms were recorded:

With both methods, we could classify the cultivars in three different classes:

- Resistance: Less than 10% of affected tissue, or less than 1 conidia/cm^2 x ml.
- Intermediate: Among 10% to 30% of affected tissue, or 1 to 4 conidia/cm^2 x ml.
- Susceptible: More than 30% of affected tissue, or more than 4 conidia/cm^2 x ml.

After the results shown in Table 1 new sources of resistance can be reported.

Six local cultivars were found to be resistant to *S. fuliginea* race 1:

- 'Amarillo', *C. melo*, var. *sacharinus* (Naud.), yellow skinned
- 'BG069', *C. melo* var. *inodorus* (Naud.), green skinned
- 'Común', *C. melo* var. *inodorus* (Naud.), green skinned
- 'Mochuelos', *C. melo* var. *sacharinus* (Naud.), green skinned
- 'Moscatel Grande', *C. melo* var. *sacharinus* (Naud.), green skinned
- 'Negro', *C. melo* var. *inodorus* (Naud.), dark green skinned
- 'Tendral 1', *C. melo* var. *inodorus* (Naud.), green skinned

Also fourteen moderately resistant cultivars were found. These cultivars were:

- 'Agostizo', *C. melo* var. *sacharinus* (Naud.), green skinned
- 'BG064', *C. melo* var. *sacharinus* (Naud.), green skinned
- 'Invernizo', *C. melo* var. *inodorus* (Naud.), green skinned
- 'Loperano', *C. melo* var. *sacharinus* (Naud.), yellow skinned
- 'Melón de Olor', *C. melo* var. *cantalupensis* (Naud.), yellow skinned

- 'Mochuelo 1', *C. melo* var. *sacharinus* (Naud.), green skinned
- 'Negros', *C. melo* var. *inodorus* (Naud.), green skinned
- 'Rajado', *C. melo* var. *sacharinus* (Naud.), yellow skinned
- 'Relancia', *C. melo* var. *sacharinus* (Naud.), yellow skinned
- 'Roteño', *C. melo* var. *sacharinus* (Naud.), green skinned
- 'Tendral 2', *C. melo* var. *inodorus* (Naud.), green skinned
- 'Tendral 3', *C. melo* var. *inodorus* (Naud.), green skinned
- 'Tendral Temprano', *C. melo* var. *inodorus* (Naud.), green skinned

All of them, moderately resistant and resistant cultivars, were white or yellow-white fleshed.

These 21 local cultivars could be useful for future breeding program, specially for Spanish melon types, and in general, as a source of new genes for resistance to melon powdery mildew.

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Table 1. Means and variances of the percentage of affected tissue and number of conidia /cm^2 x ml at 13 days post-inoculation with a suspension of *S. fuliginea* race 1 of 44 Spanish accessions of *C. melo*.

Accessions	% affected tissue		n° of conidia/cm^2 x ml*	
	mean	variance	mean	variance
Moscatel Grande	1.0	0.0	0.15	0.05
Amarillo	2.6	0.1	0.10	0.18
Tendral 1	4.2	3.2	0.45	0.29
Negro	5.0	0.0	0.60	0.23
BG. 069	7.0	20.0	1.15	0.83
Invernizo	10.0	0.0	1.85	0.62
Tendral 2	10.0	0.0	2.85	0.70
Mochuelos	10.0	0.0	0.59	0.15
Común	11.0	5.0	0.80	0.10
BG. 064	15.0	0.0	1.40	0.30
Tendral Temprano	16.0	36.0	1.70	1.80
Rajado	22.0	45.0	3.20	1.41
Mochuelo 1	23.0	20.0	3.05	0.98
Melón de olor	25.0	0.0	3.22	3.12
Negros	25.0	50.0	3.15	3.36
Relancia	26.0	30.0	3.05	0.98
Agostizo	29.0	5.0	2.75	0.63
Loperano	30.0	0.0	2.88	4.55
Roteño	30.0	0.0	3.55	1.32
Tendral 3	40.0	150.0	4.00	0.87
Marina	42.0	20.0	8.50	6.46
Amarillo oro	44.0	30.0	4.50	0.20
Baza	46.0	30.0	7.40	7.33
Tempranillo	46.0	80.0	9.05	25.04
Melao	50.0	150.0	9.65	1.89
Moscatel	50.0	50.0	6.85	4.20
Cuenca	50.0	0.0	10.96	1.35
Banda	50.0	70.0	7.15	7.33
Caña dulce	54.0	80.0	12.09	0.74
Esento	54.0	80.0	9.40	3.51
Piel de Sapo	56.0	330.0	6.15	11.92
Amarillo cáscara pinta	56.0	130.0	8.45	3.79
Pipa blanca	56.0	30.0	11.67	1.60
Mochuelo 2	60.0	0.0	11.92	3.43
BG. 045	60.0	0.0	10.44	5.46
Tortuga	64.0	80.0	10.55	0.23
Amarillo manchado	66.0	130.0	9.55	2.60
Pedroso	76.0	280.0	15.95	32.45
Escrito	84.0	280.0	17.75	4.43
BG. 4078	88.0	320.0	20.85	5.33
PS. Piñonet	92.0	120.0	16.25	21.06
Rocket	100.0	0.0	13.60	1.33

*Observed value x 10,000

Field Screening of Melon Varieties and Lines for Multiple Race Resistance to *Fusarium oxysporum* f. sp. *melonis*

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The symptoms for Fusarium wilt were first reported from New York (1), but the disease was described and pathogenicity confirmed in 1933 from Minnesota (4). The disease has occurred sporadically in New York during the past 10 years without causing major losses. In 1992, Fusarium wilt was very severe on one farm, causing widespread collapse of the variety Saticoy. Three isolates from the affected plants were subsequently identified as race 1 (6). Isolates collected from the same farm and held in culture since 1985 were identified as race 2. With the apparent recent introduction of race 1 into New York, a study to evaluate varieties with multiple race resistance was undertaken.

In 1993, 14 entries (varieties and lines) were evaluated in a field in Washington Co. where race 1 was particularly severe in 1992. The experimental design was a randomized complete block with 14 treatments per block and four blocks in total. Data were recorded at the end of the growing season by counting the number of plants that remained alive. Pathogenicity was established by isolation of the pathogen at the end of the season.

Race 1 was recovered from the randomly sampled plants showing symptoms of Fusarium wilt. Varieties or lines with 100% survival were 'Athena' (Rogers NK), 'Elton' and 'Laro' (Petoseed), HSR 336 (Hollar Seed), and MR-1 and CM17-187. Two lines from Timothy Ng, University of Maryland (MD 91805 and MD 8654) showed 62 and 12% survival, respectively. Other varieties evaluated with the percent survival were 'Market Star' (46), 'Top Mark' (25), 'Perlita FR' (8), and 'Top Mark FR', 'Delicious 51', and 'Saticoy' (0). Attempts to repeat this experiment in 1994 were unsuccessful because deer destroyed the entire plot.

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Specificity of Transmission of Melon Yellowing Viruses by *Trialeurodes vaporariorum* and *Bemisia tabaci*

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In 1982, symptoms of melon-yellowing disease were detected in melon (*Cucumis melo* L.) crops cultivated under plastic greenhouses in the southwest of Spain (Soria and Gómez-Guillamón, 1989). The approximately 950 nm long closterovirus causal agent involved in these outbreaks is transmitted semipersistently by the greenhouse whitefly *Trialeurodes vaporariorum* West. (2,5). However, from 1989, we observed a pronounced increase of the populations of *Bemisia tabaci* at the same time as a decrease in the populations of *Trialeurodes vaporariorum* (1). *B. tabaci* transmits semipersistently another clostero-like particle approximately 790 nm long, and this appears to be responsible for the melon-yellowing disease that affects present-day melon crops in this area (3).

The fact that the two viruses are both clostero-like particles (2,3) and also the similarity of the symptomatologies of the yellowing diseases they produced in melon crops led us to design and carry-out a simple experiment to test for possible specificity of the transmission of one of the two viruses by one or the other of the two whitefly species. We attempted to transmit both types of virus using as vectors the two whitefly species, *Trialeurodes vaporariorum* and *Bemisia tabaci*. Eighty groups of approximately 50 insects were used in this work. Twenty groups of each whitefly species were allowed to feed on one of the two sources of inoculum for 48h. At the end of this period, each group of whiteflies were transferred to healthy melon plants at the two-true-leaf stage and allowed to feed for 72h. After this period, the flies were removed and the plants were transferred to a greenhouse and kept within a fly-proof mesh to wait the appearance of symptoms. The controls were ten *C. melo* plants which had never had contact with the two vector species. At the 15th day following the three-day inoculation period, the leaves on which the whiteflies were feeding were eliminated to prevent subsequent infection.

In the experiments that used *T. vaporariorum* as vector fifty-five percent of the plants were infected and showed symptoms of disease produced by the virus associated with *T. vaporariorum*, but no plants were infected with the virus associated with *B. tabaci*. In the experiments with the *B. tabaci* vector, ninety-five percent of the plants were infected with the melon-yellowing virus associated with this species, but no plants were infected with the virus associated with *T. vaporariorum*. These results of this present work clearly demonstrated the specificity of the transmission of a single melon-yellowing-disease virus by each whitefly species.

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Screening of Melons for Silverleaf Whitefly Resistance: 1994

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Sweetpotato whitefly, *Bemisia tabaci* Genn. (SPWF) B strain, virtually destroyed the Fall 1991 melon crop in the lower desert valleys of Arizona and California (8). This whitefly strain was re-designated silverleaf whitefly (SLWF), but not without controversy (1, 2, 9, 10, 11, 12).

From 1991-1993, approximately 530 melon plant introductions (PI) were evaluated in naturally-infested field tests in Imperial Valley, California for resistance to SLWF. In 1991, 17 of 150 PIs from India appeared to have some level of resistance to SLWF (5). In 1992, these 17 PIs were re-tested for SLWF resistance along with 108 previously untested PIs from India plus 27 standard cultivars, breeding lines, and F_1, F_2 and backcross families from crosses of susceptible parents with lines identified as potentially resistant to lettuce infectious yellows virus (transmitted by SPWF strain A) or SLWF (6). None of the entries was superior for whitefly resistance. In 1993, 276 melons from Afghanistan and Pakistan were evaluated for whitefly resistance in a naturally-infested field test (7). Also included in the 1993 test were: three cultivars (PMR 45, Top Mark, GF Honeydew), breeding line WMR 29, Snakemelon from the Middle East, and progenies 28479 (an F_1 from the cross Top Mark FR x Snakemelon), 28478 (a backcross from the series Top Mark FR (Snakemelon (Freeman Cucumber x Snakemelon))), and 28481 and 28482 which are backcrosses from the series PMR Honeydew (Snakemelon (Freeman Cucumber x Snakemelon)). Nine of the entries in the 1993 test showed potential resistance four weeks post-planting, but by eight weeks post-planting all entries were dead. None of the entries tested to date appears to be highly resistant to SLWF. It is, therefore, necessary to continue field testing PI for resistance to SLWF.

In 1994, a field test to evaluate SLWF resistance was planted on 26 August at the University of Arizona, Yuma Agricultural Center. This test site is also in the northern portion of the Sonoran Desert and is approximately 120 km from Brawley, California the site of the three previous tests. This test included 266 wild melons from Afghanistan, India and Turkey plus six cultivars (PMR 45, Top Mark, GF Honeydew, Primo, Perlita, Mainstream), breeding lines WMR 29 and PMR Honeydew, and progeny 28481 from the backcross series PMR HD (Snakemelon (Freeman Cucumber x Snakemelon)). Plots were planted on 80 inch centers and consisted of five two-plant hills spaced 30 inches apart. The test was evaluated on a plot basis four weeks and eight weeks post- planting for number of live plants, plant size, plant condition, yellowing, leaf burn and flowering. As in previous years, plots were not treated with any pesticides.

There were statistically significant differences among the entries for SLWF resistance in the field four and eight weeks post- planting for plant size, condition, leaf burn and leaf yellowing. Eight weeks post-planting, mean plant condition ranged from 2.5 to 7.5 (Table 1). This is in stark contrast to 1993 when all plants were dead eight weeks post-planting. Top Mark had a mean plant condition rating of 5.3. PMR 45 and Mainstream which were slightly better than Top Mark; and Perlita which was slightly worse than Top Mark did not differ significantly from Top Mark. GF Honeydew was significantly worse than Top Mark. In contrast, PMR Honeydew was significantly better than Top Mark. Eight (PI 116915, PI 125861, PI 125890, PI 125918, PI 125951, PI 126966, PI 125997, PI 126165) of the nine best lines four weeks post-planting in 1993 had mean plant condition ratings lower than Top Mark. Progeny 28481 had a higher rating for plant condition but it was not significantly better than Top Mark. Only PI 237257 was significantly better than Top Mark.

Eighteen entries were noted in one of the replications during the evaluation to have some merit for further evaluation (entries in Table 1 noted with the [x]). An additional eight entries were noted in both replications to have some merit for further evaluation (entries in Table 1 denoted with the [y]).

Table 1. Mean plant condition eight weeks post-planting in response to whitefly feeding, 1994.[z]

Mean	Entries					
7.5	237257[y]					
7.0	PMR HD[y]	532841[y]	179248[x]	167266[x]		
6.5	344342[y]	183675	177362	172831[x]	164852[x]	164662
	124433[x]					
6.0	344318	344316	182951	179907[x]	176930[y]	175682
	175675[x]	175668	174157	171598[x]	171594[x]	164680[x]
	124105	117162[x]	28481[x]			
5.5	PMR 45	Mainstream	532840	344346[y]	344069	277280
	179900	179898[x]	179675	179251	176955	176949
	175678	175676	172833	172825[x]	172821[x]	169320
	167221	164855	164637	109479		
5.3	Top Mark					
5.0	Primo	503324	344334	344320	344307	293922
	210076	183676	183674	183302	183046	182944
	180428[y]	179914	179897	177355	177341	176935
	176506	174165	174148	174133	172827	172813
	171599	169379	169360	169355	169348	169322
	169318	169312	169305	167044	166966	165031
	165025	164976	164820	164611[x]	164584	125997
	124207	116915				
4.5	490995	344341	344335	344322	344309	183301
	183047	183034	182954	182186	179257	179247
	177353	177348	177347	177345	177336	176507
	176505	175684	174162	174138	173672	172819
	169374	169371	169367	169331	169327	169323
	169317	169313	169309	169307	169303	167057[x]
	166190	165032	165022	164996	164822	164610
	164609	164432	164357	164328	124093	123688
	117158	116666	18100			
4.0	Perlita	344345	344344	344338	344317	344308
	344306	344305	245735	231130	204691	183304
	183042	183027	182955	182950	179254	179245
	177338	177335	177334	176948	176942	176940
	176929	176510	176504	176503	176502	175674
	174168	174144	174137	174136	174134	173673
	172828	172822	172816	172814	169370	169366
	169347	169336	169329	169325	169321	169310
	169302	165003	164974	164664	164364	164313
	164269	136181	136180	125966	124445	124435
	124432	124430				

Table 1. Mean plant condition eight weeks post-planting in response to whitefly feeding, 1994.[z]

Mean	Entries					
3.5	344337	344333	344330	344321	344315	344311
	344303	258353	210768	182958	182956	182187
	179908	178880	177351	176937	176511	174176
	174175	174156	174150	172836	172834	172826
	169368	169362	169343	169333	169330	169311
	167058	167032	164395	126165	125951	125890
	124104	124099				
3.2	344302	183053	174151	125918		
3.0	GF HD	490997	344343	344339	344326	344323
	344314	344310	176941	175673	174140	171593
	169349	169344	169314	169306	164990	125861
2.5	503325	183039	176946	169364		

[z]Condition was rated on a 1 (dead) to 9 (vigorous, flowers) scale; $LSD_{0.05} = 1.7$; $LSD_{0.01} = 2.2$.
[y]Entry was notable in both replications.
[x]Entry was notable in one replication.

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Regeneration Response of a Few Genetic Marker Lines and Commercial Cultivars of *Cucumis melo* L.

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Introduction: A few known marker lines (5) were obtained from Montfavet, France, in order to use the marker genes in somatic hybridization studies. These studies were initiated to investigate the possibility of overcoming interspecific incompatibility (2) in order to incorporate disease resistance genes into cultivars (6). Thus, it became necessary to characterize the marker lines for their ability to regenerate under the conditions conducive for regeneration in cv. Pusa Madhuras (PM) (3) and a developing line M_4 (4).

Materials and Methods: Regeneration response of epicotyl and cotyledonary explants of cultivars and seven known genetic marker lines was studied on a pre-standardized callus formation medium of MS+0.5 mg/l benzyladenine (MB) and a differentiation medium of MS+1.0 mg/l IAA and 5.0 mg/l kinetin (MIK) (3,4). The various marker lines were classified based on their regeneration response in 1993.

Results: No marker line except EC-327434 [PI 124112, (*Pm-4*, *Pm-5*)] was found to be responsive to regeneration (Table 1). Cotyledonary leaves explant callus of EC-327434 was found to be responsive to shoot buds differentiation on MIK medium. The epicotyl explant callus could not differentiate into shoot buds. Success of shoot buds differentiation from callus was obtained in only 9.1 per cent of the explants; 81.8 per cent of explants remained in the undifferentiated callus stage. EC-327434, known for carrying powdery mildew resistant genes *Pm-4* and *Pm-5*, however, could not grow beyond the vegetative stage in the field and was found to be sensitive to Fusarium wilt (5). Among the cvs Arka Jeet and M_4, cotyledonary leaves explant callus exhibited differentiation in the range of 63.6 per cent and 30.5 6.8 per cent, respectively. Cv. Pusa Madhuras epicotyl explant callus was more regenerative than cotyledonary explant callus. The shoot buds differentiation was observed in 66.7 7.2 per cent of calli.

Discussion: A known genetic marker line EC-327434, being maintained as a genetic stock at Montfavet, France, can be utilized in somatic hybridization studies for marker genes *Pm-4* and *Pm-5* with the available indigenous cv. PM, a developing line M_4 and with other commercial cultivars (1) after outlining their regeneration response. Cv. PM and M_4 have already been identified for a genetic marker *G* for high regeneration potential (4) but with incomplete expressivity in resistance for CGMMV and Fusarium wilt (5, 6). Marker lines EC-327435, known for genetic marker *Pm-1* and *Pm-2*, and EC-327440, known for genetic marker *Fom-3*, cannot be utilized in somatic hybridization studies as they do not differentiate into callus. However, they were found to reach the seeded fruit stage (5) in the field. Cv. Arka Jeet is not suitable for cultivation in Delhi (5).

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Table 1. Regeneration response of a few known genetic marker lines and cultivars of *Cucumis melo* L.

Accessions/Cvs	[z]Explant	[y]Callus prolif-eration	Callus differentiation into: Shoot buds	Roots	No change
Accessions:					
EC-327434	[x]Cot. lvs.	9.1	72.7	18.2	0.0
	[w]epicot.	81.8	9.1	0.0	9.1
EC-327435	Cot. lvs.	0.0	0.0	0.0	100
	epicot.	0.0	0.0	0.0	100
EC-327436	Cot. lvs.	0.0	0.0	0.0	100
	epicot.	0.0	0.0	0.0	100
EC-327437	Cot. lvs.	0.0	0.0	0.0	100
	epicot.	0.0	0.0	0.0	100
EC-327438	Cot. lvs.	0.0	0.0	0.0	100
	epicot.	0.0	0.0	0.0	100
EC-327439	Cot. lvs.	0.0	0.0	0.0	100
	epicot.	0.0	0.0	0.0	100
EC-327440	Cot. lvs.	0.0	0.0	0.0	100
	epicot.	0.0	0.0	0.0	100
Earlibush	Cot. lvs.	0.0	0.0	0.0	100
Crenshaw	epicot.	0.0	0.0	0.0	100
Indigenous Cvs.					
Arka Jeet	Cot. lvs.	27.3	63.6	0.0	9.1
	epicot.	27.3	9.1	63.6	0.0
Pusa	Cot. lvs.	0.0	1.7 ± 2.9	0.0	98.3 ± 2.9
Sharbati	epicot.	0.0	0.0	0.0	100
Pusa	Cot. lvs.	83.3 ± 28.9	16.7 ± 2.9	0.0	0.0
Madhuras	epicot.	33.3 ± 7.2	66.7 ± 7.2	0.0	0.0
M_4	Cot. lvs.	56.1 ± 20.3	30.5 ± 6.8	0.0	13.4 ± 4.2
	epicot.	75.2 ± 12.3	23.8 ± 10.8	0.0	1.0 ± 0.7

[z]Callus formation on MS+0.5 mg/l benzyladenine.

[y]Callus proliferation and differentiation on MS +lmg/l IAA + 5mg/l kinetin.

[x]Cotyledonary leaves.

[w]Epicotyl

A Simple and Inexpensive Method for DNA Extraction from *Cucumis melo* L.

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The applications of current nucleic acid technologies to crop improvement include gene mapping, genetic fingerprinting, population studies and phylogenetic analyses. These techniques have application for the improvement of melon (*Cucumis melo* L.). This species is one of the most important vegetable crops in the world, but few molecular biology studies have been published. Phylogenetic studies have been recently performed using RFLP markers (7).

DNA extraction for breeding purpose needs to be simple, rapid and inexpensive. We tried various methods for extracting DNA from melon (1,3,8) including modifications of these methods. However, DNA extraction was unusable because sticky contaminants, probably polysaccharides, were not removed. The method of Liechtenstein and Drapper (4) was modified and good quality DNA was obtained from cotyledons and leaves of plants grown in a greenhouse. This DNA is suitable for restriction digestion, hybridization and amplification in the polymerase chain reaction.

Materials and Methods: For extraction of melon genomic DNA, we used young leaves or cotyledons harvested and dried in a food dehydrator at 30C for 24 to 36 hours (8), and stored at -20C until use.

Solutions :

Extraction buffer :10 mM sodium EDTA, 50 mM Tris-HCl pH=8.0, 0.7 M NaCl, 1% CTAB (acetyltrimethylammonium bromide), 1 % (w/v) ß-mercaptoethanol (ß-ME). The solution was made up without ß-ME on a heated stirrer avoiding foaming. It should be autoclaved. The ß-ME is added just before use.

Chloroform:octanol :Chloroform:octanol 24:1 (v/v)

CTAB:NaCl :CTAB 10 % (w/v), 0.7 M NaCl

Precipitation buffer :10 mM sodium EDTA, 50 mM Tris-HCl pH=8.0, 1% CTAB, RNAase A 10 mg/mL

Ethanol:Acetate :Ethanol 76% (v/v), sodium acetate 0.2 M

TE buffer :1 mM sodium EDTA, 10 mM Tris-HCl pH=8.0 and autoclaved

Protocol:

- Grind 1.0 g of dried leaves or cotyledons in a fine herb electric mill (Moulinex 534) to a very fine powder. This is probably the most important step in efficent disruption of the plant cell wall and the key for good DNA recovery. It is possible to store this powder at -20C until use.
- Tip the powder into a 50 mL polypropylene centrifuge tube. Add 15.0 mL of extraction buffer (at 56C), cap the tube and mix gently by inversion.
- Incubate in water bath at 56C for 20 min, occasionally agitating the tube gently to keep the extract mixed.
- Allow the incubation mixture to cool to room temperature. The temperature should not fall below 16C as precipitation of CTAB will occur.
- Add 15.0 mL of chloroform:octanol. Cap the tube and mix by gently inverting the tube 20 to 25 times to form an emulsion.
- Pellet the debris and separate out the organic and aqueous phase by centrifugation at 3,000xg for 20 min at 20C.
- Pour off the aqueous phase (top layer) into a clean 50 mL centrifuge tube.
- Add 2.0 mL of CTAB:NaCl and mix gently. Add 15.0 mL of chloroform:octanol, mix by gentle inversion until one phase emulsion (white or yellow colour) forms and separate the new aqueous phase by centrifugation at 3,000xg for 20 min at 20C.
- Pour off the supernatant into a new clean 50 mL centrifuge tube containing 15.0 mL of precipitation buffer, avoiding the interphasic debris. Mix gently and leave to stand at room temperature for one hour while the precipitate forms.
- Pellet the precipitate at 1,500xg for 10 min at room temperature. Do not pellet the precipitate too hard as a compact pellet is difficult to redissolve. In a good preparation the pellet should be whitish or slightly discoloured, but sometimes at this step, the pellet may be yellowish. This colour will disappear with the RNAase A step.
- Drain the pellet by inverting the tube, held in a rack, onto a paper towel, for 2 min.

- Dissolve the nucleic acid in CTAB pellet with 2 mL NaCl 1.0 M. If the pellet is too hard to dissolve, heat to 56C for few minutes until dissolution.
- When the pellet is fully dissolved, add 30 L of RNAase A and incubate at 37C for half to one hour.
- Add two volumes of freezed (-20C) absolute ethanol, mix by gentle inversion until DNA strands begin to appear.
- With a 'Pasteur hook' take the DNA strands and wash in 2.0 mL ethanol:acetate for 10 min. At this step, the DNA extract should be white.
- Drain the DNA strands and put into a sterile microfuge tube with 200-400 L of TE buffer.
- Quantify DNA in a spectrophotometer at A_{260} or in an agarose gel with a phage scale of concentration.
- DNA can be stored at -20C over months and at -80C over years.

Results and discussion: DNA yield from *C. melo* by this procedure ranges from 0.25 to 0.5 mg/g of dried leaf or cotyledons tissues with a ratio A_{260}/A_{280} between 1.8 and 2.0. The procedure is simple and fast, and 36 to 48 DNA samples may be processed in a single day. Sufficient quantities of DNA were obtained from 10 grams of fresh leaf for large scale RFLP or RAPD analyses. The native DNA was not degraded, and the digestion by restriction endonuclease was complete. This CTAB-based procedure used for DNA extraction is modified from Liechtenstein and Draper (4), and does not involve centrifugation in a CsCl gradient. This technique does not use liquid nitrogen to assist in the grinding of plant material, the plant tissues being dehydrated and ground in a fine herb mill. This method is easier and less expensive than the original one. It is possible to store ground dehydrated tissue for a long time at -20 C until use. Sample of DNA extracted from one gram of dried tissue cost approximately $1 U.S. with this method.

The polysaccharides are difficult to separate from DNA (6). These compounds are easily identifiable in the DNA preparation as they result in a sticky, viscous consistency to the DNA preparation, making it difficult to dissolve in TE buffer. Polysaccharides interfere with several enzymes such as polymerases, ligases and restriction endonucleases (5). Fang *et al.* (2) found that 1 M NaCl facilitated the removal of polysaccharides by increasing their solubility in ethanol. In our method, three CTAB steps facilitated the removal of polysaccharides, and the final addition of 1 M NaCl facilitated the DNA solubility in TE buffer. Complete digestion with restriction endonucleases and amplification in PCR indicate a good elimination of polysaccharides in DNA samples.

In melon, because a few intracellular RNAase exists, a large quantity of RNA was extracted with the DNA. Because this RNA interferes with spectrophotometer quantification, a digestion with RNAase A proved to be necessary.

We have used DNA prepared by this method in a number of molecular marker-based studies of *C. melo*, including analysis of genetic diversity and mapping using RFLP and RAPD markers.

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Germplasm Resources of *Citrullus lanatus* in the Genebank of the Polytechnic University of Valencia

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The Genebank of the Polytechnic University of Valencia holds 5436 accessions of vegetable species. Of these, 2221 of them belong to the *Cucurbitaceae*, 201 of which are watermelon (*Citrullus lanatus* (Thunb.) Matson and Nakai). Approximately one third of the accessions have already been characterized, with the others in the process of characterization.

Most of the watermelon accessions were collected in Spain. Some of them come from Latin-America, the Mediterranean basin and a few from other countries (1,3,4). An important number of accessions were collected in the states of Cataluña (27% of accessions), Valencia (18%), Canarias (16%) and Andalucia (14%) (Fig. 1). Andalucía and Valencia are the two principal watermelon producers in Spain. In these areas, and in Cataluña, the majority of the crop is irrigated. Extremadura and Castilla-La Mancha occupy third and fourth places, respectively, in relation to yield. Nevertheless, this is a secondary crop in these areas and is grown as a dry land crop.

The following are the characteristics recorded in field trials:

- *Fruit characteristics*: shape, skin color, spots on the skin, blossom scar, weight, longitudinal and transverse sections, skin width, flesh color, color of the cortical zonal and °Brix.
- *Vegetative characteristics*: leaf length and width, number of leaf lobes, shape of the first lobe (double or single), width of the lobes.
- *Other agricultural characteristics*: fruit set, set homogeneity, number of fruits per plant, agricultural interest.

Accessions regenerated and characterized have been classified into groups, depending on fruit weight, shape, skin color, flesh color and seed coat color (2, 5). Table 1 shows the accessions grouped by fruit size, and their place of origin.

Acknowledgments: Expeditions for material collecting for the Polytechnic University of Valencia Genebank have been subsidized by IBPGR and INIA.

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Table 1. Characteristics of *Citrullus lanatus* accessions grouped by fruit size.

Shape	Skin color	Fruit surface	Flesh color	Seed coat color	Accessions[z]
Small-fruited accessions (< 4 kg)					
globular	light green	netted, lighter	white	black	CA-CI-4
			pink	tan	V-CI-17
				black	CA-CI-2, CA-CI-7, V-CI-3, V-CI-14, V-CI-30, A-CI-3
	dark green	smooth	pink	tan	MU-CI-3
				black	AN-CI-10, AN-CI-13
			red	black	AN-CI-21, AN-CI-24
		netted, darker	pink	tan	MU-CI-2, AN-CI-1, AN-CI-15, CL-CI-11, V-CI-33
oval	light green	netted, darker	white	tan	AN-CI-26-(1)
				black	AN-CI-26-(2)
			pink	black	V-CI-31, CM-CI-6, CM-CI-11-(1)
	dark green	smooth	pink	tan	E-CI-4, A-CI-4
Medium-fruited accessions (4-6 kg)					
globular	light green	smooth	red	tan	AN-CI-7
		netted, darker	white	tan	CM-CI-1
				black	V-CI-32
			yellow	black	AN-CI-14
			pink	black	AN-CI-16, AN-CI-2, V-CI-21, CM-CI-7-(1)
			red	black	AN-CI-25, V-CI-16-(1), V-CI-16-(2)
	dark green	smooth	pink	tan	V-CI-18, CM-CI-2, AN-CI-14
				black	A-CI-6
			red	white	C-CI-1
			red	tan	CA-CI-8, CM-CI-11-(2)
			red	black	C-CI-3
		netted, lighter	red	tan	CM-CI-7-(2)
		netted, darker	red	black	AN-CI-6, V-CI-16-(2)
elliptical	light green	netted,darker	pink	tan	11620
Large-fruited accessions (6-8 kg)					
globular	light green	smooth	red	black	11621, 10357
		netted, darker	red	black	CA-CI-17
	dark green	smooth	red	black	C-CI-6, CA-CI-6
elliptical	light green	smooth	pink	tan	CA-CI-5
Very-large-fruited accessions (8-12 kg)					
globular	dark green	smooth	pink	black	CA-CI-1
elliptical	light green	smooth	pink	black	10198
		netted, lighter	pink	tan	10278
			red	black	V-CI-15, 9599

[z] In the accessions collected in Spain, the first letters of the code indicate the place of origin: Aragón (A), Andalucia (AN), Cataluña (C), Castilla-La Mancha (CM), Castilla-León (CL), Extremadura (E), Murcia (MU), and Valencia (V). An exclusively numeric code has been given to accessions coming from other countries.

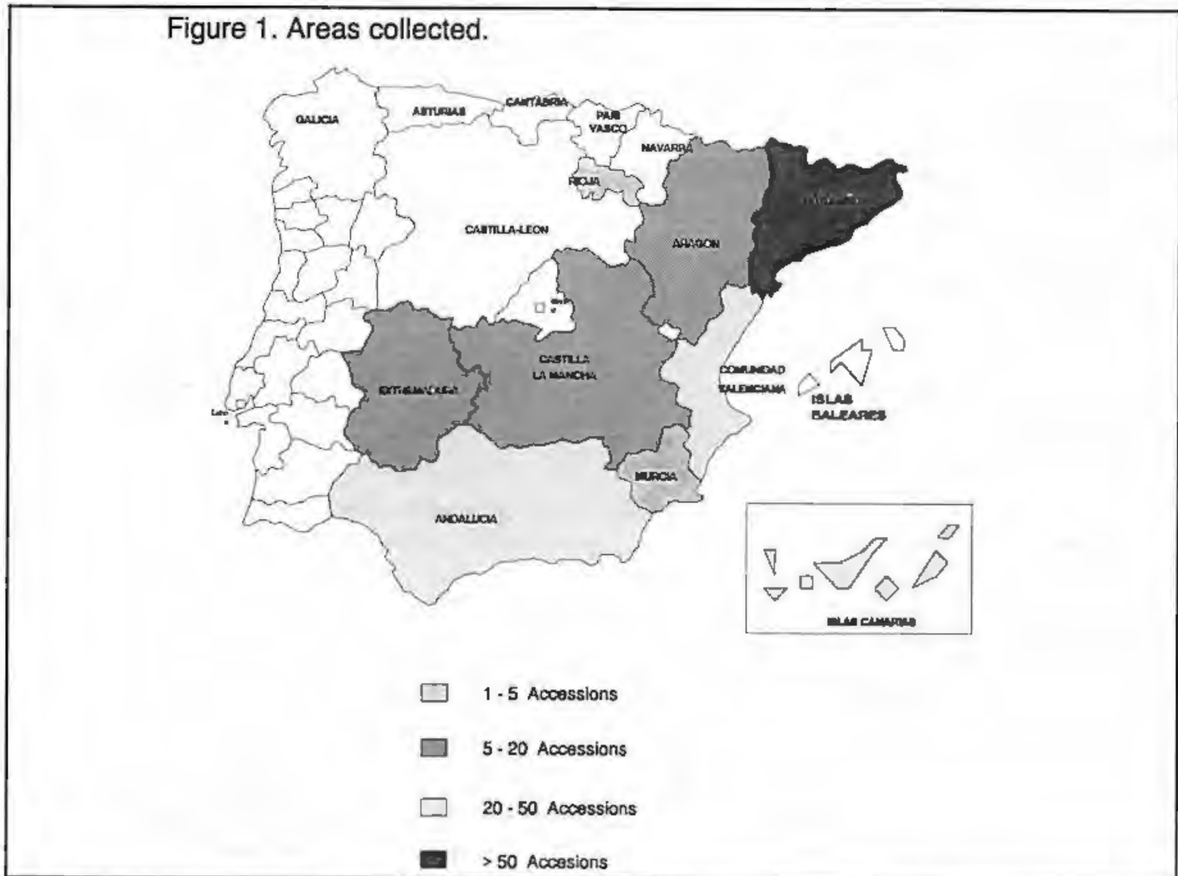

Figure 1. Areas collected.

Powdery Mildew Attacks Commercial Watermelon Cultivars in Sudan

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Powdery mildews have always been serious diseases on cultivated cucurbits in Sudan. Squashes, pumpkins, melons, cucumbers and snake cucumbers are susceptible to severe attack when grown during the mild dry winters. Susceptible cultivars survive only after the application of strong chemical control measures. However, commercial watermelon cultivars such as 'Congo' and 'Charleston Grey', have not been observed to develop powdery mildew symptoms and generally do not require chemical measures to protect the crop. On the other hand, viruses, like WMCSV, WMMV 1 and 2, ZYMV and CABYV, may cause serious damage to watermelon, and breeding programs are directed toward screening for resistance to these viruses.

The only reported incidence of powdery mildew attacking watermelons in Sudan was from a germplasm collection mission from the University of Gezira (1). While collecting seeds of land races grown in Western Sudan, one plant was observed with clear symptoms of the disease. Then, during December 1994, while evaluating a population of parents, F_2s and backcrosses for resistance to WMCSV, powdery mildew was noticed to develop in all of the material grown. Mildew colonies developed in stems, petioles and leaves. Towards mid-January, profuse sporulation was noticed in some land races and in a commercial hybrid from France, 'Confire', leading to dryness of foliage and death of plants. Commercial cultivars like 'Congo' and 'Charleston Grey', and some land races, developed clear symptoms but seemed less susceptible.

Not a single land race or commercial cultivar proved resistant. Parental lines of other powdery mildew resistant cucurbits, like melons and snake cucumber, grown in the same field were not attacked. 'PMR 5', 'Ananas PMR', 'Augen', 'Gallia' F_1, 'PMR Honey Dew', and a number of PMR snake cucumber breeding lines remained free of the disease. It is not known at the moment whether this indicates the evolution of a new race, or whether a more conducive environment enhanced the aggressiveness of an existing race belonging to any of the powdery mildew fungi known to attack cucurbits in Sudan. The first assumption seems more likely, but the final word will require more investigation on the subject.

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Coordinators note: Dr. Omara has written that he would like to receive germplasm from anyone who believes they have material that could be of value to their breeding program. Of course, he is happy to share their material with interested individuals.

Triploid Watermelons Resist Fruit Blotch Organism

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Watermelon fruit blotch disease (WFB), presently attributed to the bacterium *Acidovorax avenae* subsp. *citrulli*, is a devastating disease which renders infected watermelon [*Citrullus lanatus* (Thunb.) Matsumura and Nakai] fruits unmarketable. This disease is transmitted initially through infected seed (3) and secondarily by mechanical means of water movement and direct contact emanating from cultural operations (5). Favorable environmental conditions of high relative humidity, warm temperature and frequent rainfall may cause WFB to rapidly reach epidemic proportions. Symptoms may appear within 72 h after the inoculum contacts immature fruits (5). The potential for spread is exacerbated by establishing the crop with greenhouse grown transplants which were exposed to infected seedlings.

Somodi *et al.* (5) described the symptoms on watermelon fruit as large, firm dark-green, water soaked lesions with irregular margins; symptoms also occurred on foliage. These workers found the bacterium to be similar but not identical to *Pseudomonas pseudoalcaligenes* subsp. *citrulli*, a previously described pathogen on watermelon. Lesions developed on all 36 cultivars in their test. In another study with 22 cultivars, Hopkins *et al.* (2), reported a gradation of resistance with light colored rind types being more susceptible than dark green rind types. Rhodes *et al.* (4) used WFB to inoculate the three genotypes reported most resistant to *P. pseudoalcaligenes* subsp. *citrulli* by Sowell and Schaad (6), and found resistance in PI 295843 and foundation seed of 'Congo'.

In previous outbreaks of WFB, we observed no damage to triploids in the vicinity of infested plantings. We were uncertain if this difference was due to resistance or absence of the organism.

In this experiment, our initial objective was to compare several commercially available triploid watermelon cultivars with tissue cultured lines for plant vigor, yield and fruit quality. Coincidentally, WFB symptoms appeared and different responses between diploid and triploid cultivars are reported here.

Materials and Methods: A field study was established 17 May 1994 at the Pee Dee Research and Education Center, Florence, SC, on a Norfolk loamy sand soil (a structureless, fine loamy, siliceous, thermic, Typic Kandiudult) with pH 6.0. Twenty triploid cultivars, using greenhouse grown transplants, were evaluated in a replicated trial. Diploid watermelons ('Crimson Sweet' and 'SC-7') were utilized as pollinizers.

The experimental design was a randomized complete block of four replications. Plots were 15.24 m long and within-row plant spacing was 1.5 m. Rows were spaced 1.83 m apart. The plots were prepared for planting in a conventional manner to form 15-cm high, broad, flat-topped beds. Recommended cultural practices for South Carolina were followed (1). Each triploid plot was flanked on either side by a pollinizer row.

Overhead sprinkler irrigation was applied as needed to prevent moisture stress. As the test approached maturity, cloudy days with frequent precipitation predominated (12 days with measurable precipitation during the 21 days prior to harvest). Harvest was made 8 August 1994, 83 days after transplanting.

Since all pollinizer plants were uniformly infested with WFB, each row of diploid plants was evaluated by randomizing a point on the row from 1 to 50 and rating the diploid fruit nearest that point. The severity rating scale consisted of 1=no blotch; 3=mild blotch, affected area totaling 6.45 cm^2; 5=severe blotch 6.45 cm^2 but no open wounds; 7=open wounds, cracked rind, or decay. Each triploid fruit 3.63 kg and larger was evaluated for WFB symptoms.

Results and Discussion: The field was heavily and uniformly infested with WFB as shown by the percentage of fruits infected in the pollinizer plots (Table 1). Hardly a fruit could be found among the diploids that was not symptomatic of WFB. The severity ranged from mild to open wounds with data being skewed strongly toward the latter rating (average 5.42).

All triploid cultivars had fewer fruits affected by WFB (Table 1) with many fruits of some cultivars showing no symptoms. It was not uncommon to have a triploid fruit with no symptoms lying in contact with a diploid fruit

with open wounds and rot. The severity of WFB symptoms on triploid fruits was substantially less when compared with diploid fruit symptoms. Rarely was a triploid fruit rated with severe symptoms, and no triploid fruit was found to have open wounds or rot (average rating 3.07). WFB infection for the triploid cultivars ranged from 9.7 to 29.8 percent while the diploids were above 92 percent. The mean infection for all triploids was 18.7 percent.

We conclude from these data that triploid watermelons are more resistant to the WFB organism than diploid watermelons. The difference among triploids is sufficient to be exploited.

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Table 1. Responses of triploid and diploid watermelons to watermelon fruit blotch organism.

Genotypes	Percentage of infection (%)		Severity of symptoms[z]	
Diploids				
SC-7	95.0	a[y]	5.75	a
Crimson Sweet	92.3	a	5.09	ab
Triploids				
Nova	29.8	b	3.55	bc
Triten	24.9	b	3.28	bc
Jack of Hearts	23.4	b	3.46	bc
King of Hearts	22.9	b	3.40	bc
Tri-5	22.3	b	3.27	bc
93-CUT-1	21.6	b	3.06	bc
Queen of Hearts	21.4	b	3.34	bc
Deuce of Hearts	21.2	b	3.47	bc
AC-5244	20.5	b	3.47	bc
Honeyheart	19.6	b	3.18	bc
ACR-94W003	18.9	b	3.30	bc
Tri-3	17.0	b	3.25	bc
93-Delta-3	16.7	b	2.50	c
Crimson Jewel	15.8	b	3.35	bc
Ace of Hearts	15.7	b	2.49	c
ACR-92W036	15.0	b	3.25	bc
AC-2532	13.7	b	1.81	c
93-CUT-2	13.2	b	3.00	bc
AC-3731	10.6	b	2.67	c
ACR-94W001	9.7	b	2.25	c

[z]Rating scheme: 1=no blotch; 3=mild blotch, affected area totaling 6.45 cm^2; 5=severe blotch 6.45 cm^2 but no open wounds; 7=open wounds, cracked rind, or decay.

[y]Mean separation within columns by Duncan's Multiple Range Test; P=0.01.

Seedling Screens for Resistance to Gummy Stem Blight in Squash

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Gummy stem blight (GSB) is a particularly severe disease of squash (*Cucurbita* spp.) owing to the fact that the pathogen can infect all above ground parts as well as causing black rot symptoms on the fruits. The disease is caused by the fungus *Didymella bryoniae* (Auersw.) Rehm. There are many reports on resistance for the disease in cucumber (1-4) and melon (5-7), but not in squash. There is no resistance source in the cultivated *Cucurbita* spp. although breeders have observed large differences among genotypes in levels of susceptibility. The objective of this study was to evaluate available squash accessions from the USDA Plant Introduction (PI) collections by using a greenhouse screen method. We are reporting here the preliminary results from greenhouse seedling screens for resistance to GSB in *Cucurbita* spp. accessions.

Methods. Seeds were germinated on paper towels in a 25° C incubator for 2 days and selected for transplant to assure even stands. Germinated seeds were transplanted in 4x8-cell Speedling trays in peat lite mix. Each accession was represented by 7 plants/replication x 2 replications/screen or 4 plants/replication x 4 replications/screen. *C. martinezii* (obtained by Henry Munger from T.W. Whitaker and used in a Cornell breeding program as the sources of resistance to cucumber mosaic virus and powdery mildew) and 'Butternut' were used as resistant and susceptible check plants, respectively. All plants were grown on the benches of a temperature-controlled greenhouse held at about 24° C. An isolate of *D. bryoniae* collected from Onondaga County NY was maintained on V-8 agar plates containing 200 ml/l V-8 juice, 3.0 g/l $CaCO_3$, 15.0 g/l agar and cultured at room temperature (22° C) with 14 hours light. For all inoculations, conidial suspensions were prepared by growing *D. bryoniae* at room temperature for 10-14 days, flooding the culture with distilled water, gently scraping the cultures and straining the suspension through two layers of cheesecloth. The inoculum suspension was adjusted to 10^{5} spores/ml with a nutrient solution containing 0.1% sucrose and 0.05% hydrolyzed casein (Sigma). The suspensions were atomized onto the stem and leaves of plants at the 3-4 leaf stage at 10 psi until run off. A 0.01% concentration of Triton X 100 was added to the suspension to enhance adherence. Immediately after inoculation the plants were incubated in a mist chamber for 72 hours at 25° C before being transferred to a greenhouse for observation. Ratings of disease development on both leaves and stems were made 7 days after inoculation. Each plant was given a rating which was averaged within a replication, and across the two replications, to determine a mean rating for each accession. Foliar symptoms were assessed as follows: 1 = no disease; 2 = 1-25% of the leaf area affected; 3 = 26-50%; 4 = 51-75%; and 5 = 76-100%. Stem damage rates were made initially using a 1 to 5 scale with 1 = no damage; 2 = single lesion 10 mm in length or composite 20 mm; 3 = lesion 20 mm with girdling of the stem; 4 = stem withered; and 5 = seedling dead. Mean SE was analyzed by using StatView™SE+Graphics (Abacus Concepts, Inc.).

Results. In our preliminary experiment, the *C. martinezii* line, used in the Cornell breeding program, revealed very high resistance to GSB and was used as the resistant control in all *Cucurbita* spp. screens. A total of 308 PI accessions of *Cucurbita spp.*, including seven *C. martinezii*, 142 *C. moschata*, and 159 *C. pepo* were screened in greenhouse. All seven *C. martinezii* (406683, 438968, 512099, 512103, 512106, 540899 and 540900), two *C. moschata* (201474 and 438579), and three *C. pepo* (10107, 358969 and 442312) showed high resistance to the disease (Table 1).

In addition to resistance to GSB, *C. martinezii* is resistant to cucumber mosaic virus and powdery mildew. It can be crossed to both *C. moschata* and *C. pepo*, and provide a multiple disease resistant source for squash breeding programs. We have made crosses and backcrosses using *C. martinezii* as the donor parent to transfer GSB, cucumber mosaic virus and powdery mildew resistance to squash.

In our greenhouse experiment, the symptoms developed on squash are less severe than those on melon plants when the same concentration of inoculum (10^5 spores/ml) was used. This might be an indication that squash is less susceptible to GSB than melon. In order to obtain clear screen results, we suggest using a higher inoculum concentration (at least 10^6 spores/ml) to screen squash materials.

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Table 1. Resistance of some *Cucurbita* ssp. USDA Plant Introduction accessions to gummy stem blight in greenhouse screens at Ithaca, NY.

			Disease indices[z]			
			Leaf		Stem	
Rank[y]	Accession	Species	Mean	± SE	Mean	± SE
1	438698	*C. martinezii*	1.64	0.20	1.00	0
2	406683	*C. martinezii*	2.00	0.18	1.00	0
3	201474	*C. moschata*	2.11	0.11	1.33	0.17
4	442312	*C. pepo*	2.21	0.11	1.43	0.14
5	*C. martinezii*	*C. martinezii*	2.24	0.04	1.06	0.01
6	540899	*C. martinezii*	2.36	0.13	1.00	0
7	512103	*C. martinezii*	2.43	0.14	1.00	0
8	540900	*C. martinezii*	2.50	0.14	1.00	0
9	358969	*C. pepo*	2.57	0.14	1.14	0.10
10	512099	*C. martinezii*	2.64	0.13	1.00	0
11	512106	*C. martinezii*	2.64	0.13	1.00	0
12	438579	*C. moschata*	2.64	0.13	1.07	0.07
13	10107	*C. pepo*	2.79	0.11	1.79	0.11
14	Butternut		3.97	0.04	1.93	0.03
15	438700	*C. pepo*	4.29	0.16	1.50	0.17
16	163232	*C. moschata*	4.79	0.11	3.50	0.14

[z] Disease indices were rated for both foliar and stem lesions on a 1 to 5 scale: on leaf, 1 = no disease, 2 = 1-25% of the leaf area affected, 3 = 26-50%, 4 = 51-75%, and 5 = 76-100%; on stem, 1= no damage, 2 = single lesion < 10 mm in length or composite < 20 mm, 3 = lesion > 20 mm with girdling of the stem, 4 = stem withered, and 5 = plant dead. There were two replications in 1992 greenhouse screens and four replications for all other experiments.

[y] Accessions were ranked on leaf mean ratings over all experiments.

Rind Maturity and Susceptibility of Butternut Squash to Didymella bryoniae

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Many cucurbit fruit are susceptible to infection by the black rot fungus *Didymella bryoniae* in the field or during storage (1, 2, 3). Wounding is known to be important for fungal entry during harvesting and storage operations, but little is known about the impact of rind maturity on infection with and without wounding.

Butternut (*Cucurbita moschata* cv. Waltham) fruit were collected from the field with the following visual classification: **I** = pale green, immature; **II** = beige color; **III** = tan color; and **IV** = orange, mature. They were held in a cold room (15C) until inoculated. Squash were gently washed in warm water, air dried, and measured with a Minolta colorimeter which was calibrated for measuring white light. The colorimeter categorized color into three classifications: *L* value measured lightness; *A* value distinguished between green and red; and *B* value distinguished between yellow and blue. There was little variation for the *L* and *B* values between fruit, while the *A* value varied greatly. Fruit were split in half and both halves were placed in plastic boxes lined with moistened paper towels. Fruit were wiped with 70% ethanol and punctured with a 4 mm cork borer. Inoculum consisted of a plug of the fungus cut with a 4 mm cork borer from an actively growing culture of *D. bryoniae* (Onondaga isolate). Inoculum was placed on two different sites on each fruit half (neck and base), with the wounded and nonwounded sites on the opposite side of each fruit half (ground vs. sky side). At each site the fungal plug was covered with a 5 X 5 cm square of clear plastic tape. Boxes were covered and incubated at room temperature. Each inoculation site was measured lengthwise and crosswise at 4 and 7 days after inoculation (DAI). The site wounded with the cork borer had a general wound area of 16. and this value was subtracted from their values in order to provide a more accurate comparison to the nonwounded sites. The experiment was repeated four times during the course of the season and data were analyzed by ANOVA.

There was a strong correlation between the visual categories and the colorimeter values, and suggested that the higher the *A* value, the less fruit infection would occur. The visual class and corresponding mean *A* value were **I** (-5.18), **II** (0.16), **III** (2.88), and **IV** (5.29), respectively, and were correlated at 0.93 (Spearman's correlation coefficient). There was no significant difference between the fruit halves (ground vs. sky) nor between the neck and the base of the fruit for susceptibility. There were significant differences in lesion size between the different color categories when the mean values were combined for both the wounded and nonwounded areas (Fig. 1). Just 4 DAI, fruit in category **I** were significantly more susceptible than fruit in the other 3 categories. By 7 DAI there were significant differences between categories **I** and **II** and between these two categories and categories **III** and **IV**. When data were analyzed to separate the importance of wounding vs. nonwounding, additional information was learned. Wounding the tissue was a major contributing factor for fungal invasion in all maturity classes (Fig. 2A). The area of tissue invaded was relatively the same for readings taken either 4 or 7 DAI. Although the fungus was able to invade the tissue in all categories without wounding, the amount of invasion was significantly higher for immature fruit in category **I**, and dropped dramatically as the rind matured (Fig. 2B).

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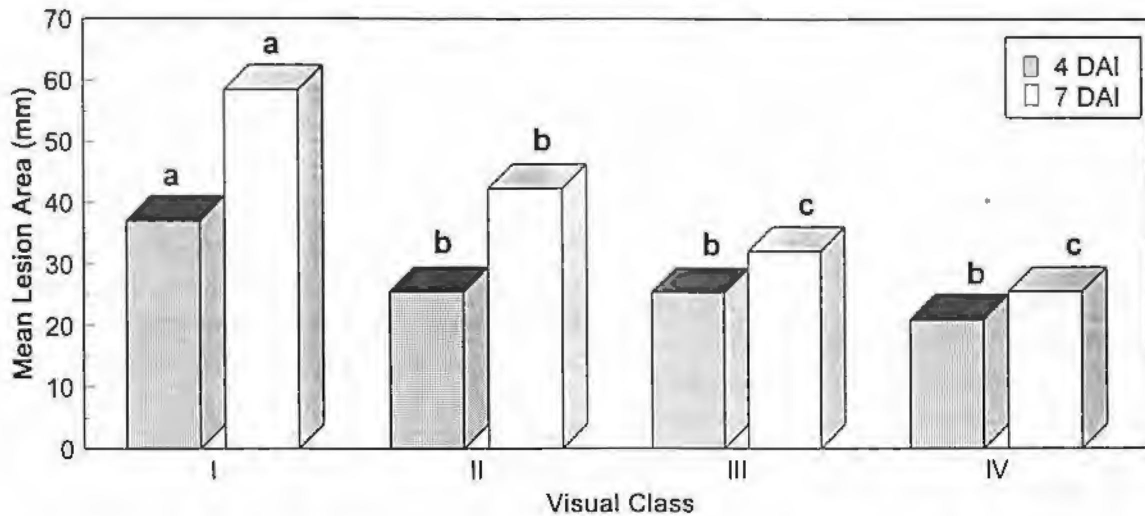

Figure 1. Mean lesion area caused by *Didymella bryoniae* for each visual class at 4 and 7 days after inoculation (DAI). Ratings taken on the same date with the same letter were not significantly different from one another using Fisher's LSD (P=0.05).

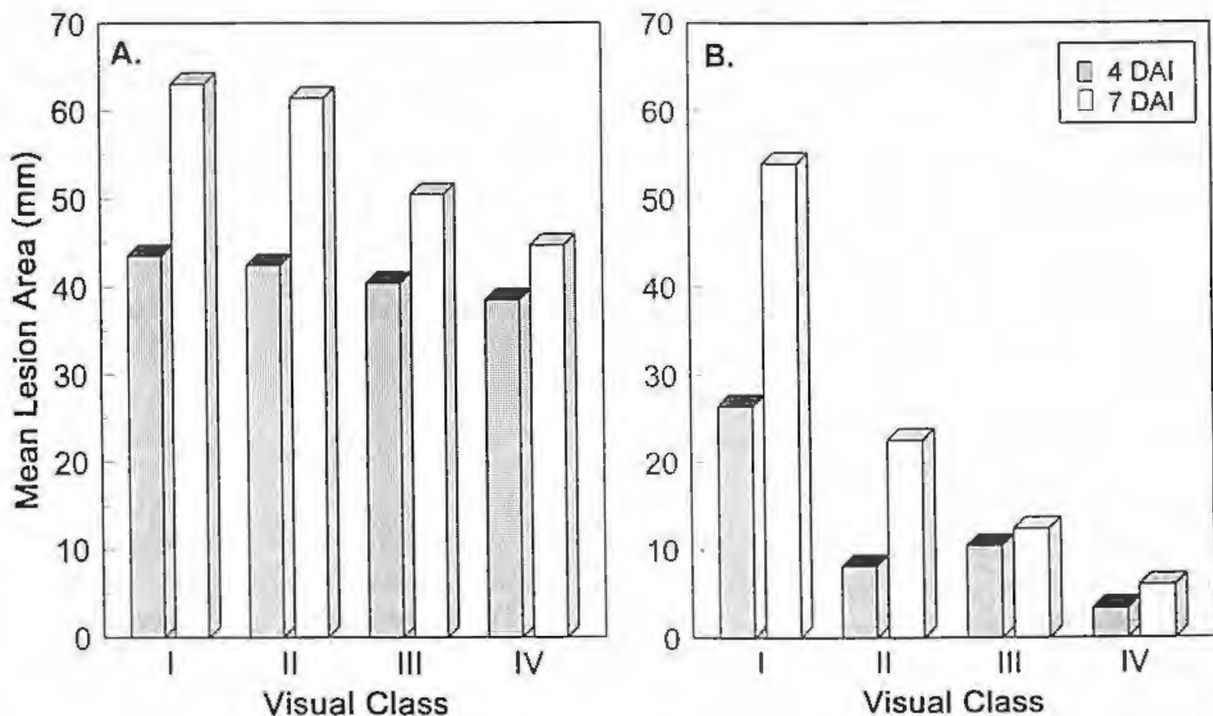

Figure 2. Mean lesion area caused by *Didymella bryoniae* for **(A)** wounded and **(B)** nonwounded tissues for each visual class at 4 and 7 days after inoculation (DAI).

The Production of Buddha's Hand in China

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The Buddha's hand (*Sechium edule* swartz.) is a perennial root vegetable of Mexican origin. It is suitable for production in the tropic and subtropic regions. Its name comes from its fruit shape which looks like a closed pair of bent palms. It likes the warm weather but can not stand scorching heat or severe cold. When the frost comes, its shoots wither. However, its roots can endure cold and overwinter to sprout in the spring provided the soil does not freeze. The favorite growth temperature is 18-25°C. There is only one flat big seed in a fruit. Because of the close contact between the seed and the fruit flesh, the separated seed will easily loose its moisture and viability. Therefore, the whole fruit with seed is usually planted in production. When the main vine grows longer, the lateral buds sprout from each node and become side vines. The lateral buds on the side vines can also grow to shoots. A two or three year old Buddha's hand plant may grow 40-60 side vines each of which can stretch to 10 m long. A fully grown plant may cover 50-80 m^2 of ground with its shoots which have the ability to climb because of their tendrils. The fruit is pear or circular cone shaped and green or yellowish green in color. Each fruit weighs about 300-600 g. A single plant can produce more than 500 fruits which weigh about 200-400 kg.

The Buddha's hand was brought to China by the overseas Chinese at the end of the 19th century, and was only grown in temple yards on a small scale. Until the 1960's, its good horticultural characteristics were overlooked. Since then, its cultivation has gradually spread such that it has become an important autumn fruit/vegetable in southern China. In this region it grows year round producing fruits not only in autumn but also in spring. In recent years, the Buddha's hand has been introduced into northern China and cultivated on a larger scale. According to a rough estimate, the land devoted to production of Buddha's hand reached 453 ha in 1986-1987 in 15 counties of Yantai and Weihai, Shandong province. Between 1986-1988, the planting area of this crop increased to 1360 ha in Shandong province. In addition to Shandong, other provinces in northern China are also being encouraged to produce the crop.

In the past, the Buddha's hand was mainly grown in the front and back of houses and in small pieces of land, but now large scale growing is increasing. In northern China, the popularized large plastic film tents which are mainly used to grow spring-summer fruit and vegetables provide a convenient structure for field production of Buddha's hand. Farmers usually transplant their Buddha's hand seedlings along each side of the tent after the spring-summer vegetable is about to mature and the plastic film has been removed. In this way, the vines of the Buddha's hand climb up the tent frame and cover the whole structure. Some farmers plant certain shade tolerant vegetables under the shade in the tent during the hot season.

In northern China, the Buddha's hand is planted each year. The seedlings are raised in protected seedling beds and transplanted to fields when after the last frost. The traditional seedling raising method in which the whole fruit is planted results in a low sprouting percentage (40-82%) and low commercial seedling percentage (30-60%). In recent years, researchers have developed a new seedling raising technique by using the bare embryo instead of using the whole fruit. This new technique produces not only high sprouting percentage (~100%) and high commercial seedling percentage (~100%), but also uses the seed removed fruit as commercial vegetable.

There are many edible portions of the Buddha's hand of which the most important are the nutrient rich fruits. The perennial Buddha's hand can also produce tubers (enlarged roots which look like the potato tuber). The tuber's white flesh is tender and juicy and can also be eaten. The tender shoot of the Buddha's hand called "Dragon's Beard" is a newly developed vegetable in Taiwan. The shoots are harvested 15-20 cm long and appear in markets in bundles. Because it is nutritious, free from chemicals and appears in the market during the short summer, it is widely welcomed as a healthy vegetable.

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A Multi-Viral Resistant Cultivar of Bottle Gourd (*Lagenaria siceraria* from Taiwan)

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According to Heiser (3) bottle gourd or calabash gourd (*Lagenaria siceraria L.*) in prehistoric times was exclusively cultivated throughout the tropical and subtropical areas of both hemispheres and in some regions of the temperate zone. It was used for food, medicine, floats, musical instruments and other artistic endeavors. Before the introduction of pottery, its dry fruits were used as containers for both liquid and dry material. Thus, the Latin name of this species seems to specify one of its important functions: *Lagenaria* from *lagena* = 'large flask' and *siceraria* from *sicera* = (for) 'strong drink'.

Bottle gourd is probably a native of Africa, from where it spread throughout the warm and temperate regions of the world, including the Americas. While some forms are edible, others are mainly grown as gourds for their hard- shelled fruits. They can vary in size, length and shape (club shaped, bottle shaped, globular, disk-like, and others). In the Mediterranean area, before the discovery of America, the edible types of this species were commonly eaten as is the present summer squash. In the last few centuries, the cultivated species of the genus *Cucurbita* have replaced bottle gourd in the highly evolved agricultural regions, but it is still preferred in developing countries, where it requires very limited care for fruit production. In the USA, fruits of bottle gourd can be found in some supermarkets and special vegetable stores, but they are more common in oriental vegetable markets.

As are the other cultivated cucurbits, bottle gourd is affected by viral diseases causing considerable reduction in the quantity and quality of its crops. Resistance to the most common viruses was found in some plant introductions (PI) of this species (2,4,5). One line from China (PI 391602) and another from India (PI 271353) exhibited resistance to four and five viruses, respectively (4). In a recent visit to Taiwan, we noted that a commonly cultivated cultivar ('Cow Leg') appeared to be free of viral infection in several localities of that island. In order to evaluate this cultivar, we obtained seeds from commercial sources and also from Dr. T-D Liou, Director of Tropical Horticultural Experiment Station, Fengshan, Taiwan.

Plants of 'Cow Leg' were tested with strains of cucumber mosaic virus (CMV), papaya ringspot virus, papaya pathotype (PRSV-P) and watermelon pathotype (PRSV-W) (ex WMV-1), squash mosaic virus (SqMV), tobacco ringspot virus (TRSV), tomato ringspot virus (TmRSV), watermelon mosaic virus 2 (WMV-2), and zucchini yellow mosaic virus (ZYMV). For each strain of the viruses, the cotyledons and first three leaves of 20 plants of 'Cow Leg' were mechanically inoculated twice. All the work was conducted in a greenhouse maintained at

27-30 C., where the plants were kept until reaching the 25-leaf stage. As is evident from the data presented in Table 1, except for one strain of CMV and three TmRSV, plants of 'Cow Leg' failed to show any systemic symptoms. Recovery tests and enzyme-linked immunosorbent assays (ELISA) clearly demonstrated that inoculated leaves were infected, but viruses had failed to move systemically. Hence this cultivar is uniquely resistant to most of the strains of seven viruses that were collected in the USA, mainland China, Egypt, and Taiwan. Also under our field conditions, where CMV and WMV-2 are prevalent, 'Cow Leg' remained completely free of any viral infection.

Although 'Cow Leg' appears to be susceptible to TmRSV, resistance to this virus is available in PI 188809 (Philippines) and in PI 271353 (India) (4). A strain of cucumber green mottle virus was found to infect bottle gourd in Taiwan (1), but no culture of this virus was available to test 'Cow Leg'. In Taiwan, as well as in other tropical regions of the world, some diseases of bottle gourd are caused by whitefly transmitted viruses. However, little is known about their identity, and whether any resistance is available. Consequently, more studies should be conducted with his valuable cucurbit crop. 'Cow Leg' is probably one of the most popular cultivars grown in Taiwan, and because of its productivity, quality, and multi-viral resistance, it should be grown in the USA to supply fruit to oriental markets.

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TABLE 1. Reaction of the multi-viral resistant *Lagenaria siceraria* 'Cow Leg' from Taiwan to strains of: cucumber mosaic virus (CMV), papaya ringspot virus, papaya pathotype (PRSV-P); papaya ringspot virus, watermelon pathotype (PRSV-W), squash mosaic virus (SqMV), tobacco ringspot virus (TRSV), tomato ringspot virus (TmRSV), watermelon mosaic virus 2 (WMV-2), and zucchini yellow mosaic virus (ZYMV). [R=Resistant; S=Susceptible;* = Legume strain.]

Virus	Strain	Origin	Reaction	Virus	Strain	Origin	Reaction
CMV	93	California	S	TmRSV	NY	New York	S
	CH	China	R		OH	Ohio	S
	B*	New York	R		PA	Pennsylvania	S
	C	New York	R				
	L-2	New Jersey	R	WMV-2	93	California	R
					95	Florida	R
PRSV-W	FL-83	Florida	R		NJ	New Jersey	R
	GE-88	Georgia	R		ROB	New York	R
	MD	Maryland	R		TX	Texas	R
PRSV-P	TW	Taiwan	R	ZYMV	CT	Connecticut	R
					FL	Florida	R
SqMV	A-II	Arizona	R		EGY	Egypt	R
	NY	New York	R		CA	California	R
					CH	China	R
TRSV	FL	Florida	R		TW-1	Taiwan	R
	NY	New York	R		TW-2	Taiwan	R

Growth Regulator Effects on Sex Expression of Luffa Sponge Gourd

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Luffa sponge gourd (*Luffa aegyptiaca* Mill) is increasingly popular in North Carolina for use in cosmetics and cleaning products. We are interested in developing luffa cultivars suited to industry in the southeast U.S. However, most of the cultivars and breeding lines we are working with are monoecious. In order to make hybrid production easier, we would like to make the plants gynoecious. Sex expression of another cucurbit, the cucumber (*Cucumis sativus* L.), can be altered using growth regulators to increase the percentage of pistillate flowers (1) or the percentage of staminate flowers (2). Our objective was to study the effects of the growth regulator, ethephon, on sex expression in luffa sponge gourd.

Seeds of 'Fletcher' luffa were planted on raised, shaped beds in the field on 20 May 1993. Plants were supported by a trellis 1.8 m high. The experiment was a randomized complete block design with 12 replications of 5 plants per plot. Ethephon was sprayed onto seedlings when they reached the first true leaf stage at a rate of 100 mg/L (+4 drops Tween-20) until runoff. Ethephon was applied 1 time (1st true leaf stage) or 2 times (1st and 3rd true leaves), or 0 times for the control.

Traits measured were percentage of seeds that emerged as seedlings (counted at the 1st true leaf stage), percentage of the total flowers that were pistillate in the first 20 nodes, total number of fruits per plot at harvest (5 October), and percentage of fruits that were marketable (total - cull - immature) or early (total - immature). Data were analyzed using the general linear models procedure of SAS.

Seedlings treated with ethephon had no change in sex expression (Table 1). If anything, there was a slight (but non-significant) trend for a smaller percentage of pistillate flowers as the number of ethephon applications was increased. In cucumber, ethephon applications used in this experiment would result in plants that had more than 90% pistillate flowers.

The only significant effect observed in this experiment was for a lower percentage of early fruits in the treatment receiving 1 application of ethephon. We were unable to explain that effect, but ethephon may cause some plant injury after application. In conclusion, none of the ethephon treatments affected the percentage of pistillate flowers in 'Fletcher' luffa. Perhaps sex expression can be modified with different concentrations or numbers of applications of ethephon, or with other growth regulators.

Literature cited:

1. McMurray, A.L. and C.H. Miller. 1968. Cucumber sex expression modified by 2-Chloroethanephosphonic acid. Science 162:1396-1397.
2. Pike, L.M. and C.E. Peterson. 1969. Gibberellin A4/A7 for induction of staminate flowers on the gynoecious cucumber. Euphytica 18: 106-109.

Table 1. Ethephon treatment of luffa sponge gourd for attempted alteration of sex expression[z].

No. ethephon applications	% emergence	% pistillate nodes	Total fruits/plot	% marketable	% early
0	63	21	10	70	60
1	65	20	10	60	42
2	59	18	11	66	51
Mean	63	20	11	66	51
LSD (5%)	12	7	3	16	14
CV (%)	22	39	29	29	33

[z]Data are means of 12 replications of 5 plants per plot.

Gene List for Watermelon

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Lists of the genes of watermelon (*Citrullus lanatus* (Thunb.) Matsum and Nakai) have been published previously in HortScience, 1976 (35), and in the Cucurbit Genetics Cooperative Reports in 1979 (3), 1982 (4), 1985(5), 1991(6) and 1992(7). The current list provides an update of the known genes in watermelon.

The first report on *dg* (Rhodes, 34) concluded that another nonallelic gene was interacting with *dg*. However, we (Zhang *et al.*, submitted for publication) now observe in advanced material, only a single recessive gene with no evidence of epistasis. Other reports on this gene are encouraged. Perhaps a better name for this gene is *virescent*. Another revision is necessary for the gene originally designated *b l*, and a full description of this pleiotropic gene is being prepared.

Scientists should consult the following list as well as the rules of gene nomenclature for the *Cucurbitaceae* (see appendix) before choosing a gene name and symbol.

Gene symbol: Preferred	Synonym	Character	Reference
a	-	*andromonoecious*. Recessive to monoecious.	28, 29, 37
Aco-1	-	*Aconitase-1*.	23
Aco-2	-	*Aconitase-2*.	23
$Adh\text{-}1^{+}$	-	*Alcohol dehydrogenase-*1^{+}. One of five codominant alleles, each regulating one band.	24, 25, 47
$Adh\text{-}1^{1}$	-	*Alcohol dehydrogenase-*1^{1}. One of five codominant alleles, each regulating one band. Found in *C. lanatus* var. *citroides* and *C. colocynthis*.	24, 25, 47
$Adh\text{-}1^{2}$	-	*Alcohol dehydrogenase-*1^{2}. One of five codominant alleles, each regulating one band. Found in *C. lanatus* and *C. lanatus* var. *citroides*.	24, 25, 47
$Adh\text{-}1^{3}$	-	*Alcohol dehydrogenase-*1^{3}. One of five codominant alleles, each regulating one band. Found in *Praecitrullus fistulosus*.	24, 25, 47

Gene symbol Preferred	Synonym	Character	Reference
Adh-1[4]	-	*Alcohol dehydrogenase-1*[4]. One of five codominant alleles, each regulating one band. Found in *Acanthosicyos naudinianus*.	24, 25, 47
Af	-	*Aulacophora faveicollis* resistance. Resistance to the red pumpkin beetle. Dominant to susceptibility.	41
Aps-1	*Acph-A*	*Acid phosphatase-1*.	23, 24, 25, 47
Aps-2[1]	-	*Acid phosphatase-2*[1]. One of two codominant alleles, each regulating one band. Found in *C. lanatus* and *C. colocynthis*.	23, 24, 25
Aps-2[2]	-	*Acid phosphatase-2*[2]. One of two codominant alleles, each regulating one band. Found in *Acanthosicyos naudinianus*.	23, 24, 25
Ar-1	*B, Gc*	*Anthracnose resistance to race 1* of *Glomerella cingulata* var. *orbiculare*.	9, 14, 46
Ar-2 [1]	-	*Anthracnose resistance to race 2* of *Colletotrichum lagenarium* derived from PI 299379 and PI 189225. Resistance in *Citrullus colocynthis* is due to other dominant factors.	17, 18, 39 40, 46
b l	-	*branch less*. Only half as many branches, originating at the first five nodes.	15
C	-	*Canary yellow* flesh. Dominant to pink.	28
d	-	*dotted seed coat*. Black dotted seeds when dominant for *r*, *t*, and *w*.	12, 29, 30
db	-	*Resistance to gummy stem blight* caused by *Didymella bryoniae* from PI 189225. Recessive to susceptibility.	27
dg	-	*delayed green*. Cotyledons and young leaves are initially pale green but later develop chlorophyll. First reported to be hypostatic to *I-dg*. More recent evidence (submitted for publication) indicate simple recessiveness.	34

Gene symbol Preferred	Synonym	Character	Reference
Dia-1	-	*Diaphorase-1*.	24
dw-1	-	*dwarf-1*. Short internodes, due to fewer, shorter cells than normal. Allelic to $dw\text{-}1^s$.	16, 21, 22
$dw\text{-}1^s$	-	*short vine*. Allelic to *dw-1*. Vine length intermediate between normal and dwarf. Hypocotyl somewhat longer than normal vine and considerably longer than dwarf. $dw\text{-}1^s$ recessive to normal.	8
dw-2	-	*dwarf-2*. Short internodes, due to fewer cells.	16, 21, 22
e	*t*	*explosive rind*. Thin, tender rind, bursting when cut.	28, 31
$Est\text{-}1^+$	-	$Esterase\text{-}1^+$. One of six codominant alleles, each regulating one band. Found in *C. lanatus*.	23, 24, 25
$Est\text{-}1^1$	-	$Esterase\text{-}1^1$. One of six codominant alleles, each regulating one band. Found in *C. lanatus* var. *citroides* and *C. colocynthis*.	23, 24, 25
$Est\text{-}1^2$	-	$Esterase\text{-}1^2$. One of six codominant alleles, each regulating one band. Found in *C. colocynthis*.	23, 24, 25
$Est\text{-}1^3$	-	$Esterase\text{-}1^3$. One of six codominant alleles, each regulating one band. Found in *Praecitrullus fistulosus*.	23, 24, 25
$Est\text{-}1^4$	-	$Esterase\text{-}1^4$. One of six codominant alleles, each regulating one band. Found in *C. ecirrhosus*.	23, 24, 25
$Est\text{-}1^5$	-	$Esterase\text{-}1^5$. One of six codominant alleles, each regulating one band. Found in *Acanthosicyos naudinianus*.	23, 24, 25
$Est\text{-}2^+$	-	$Esterase\text{-}2^+$. One of five codominant alleles, each regulating one band. Found in *C. lanatus*.	23, 24, 25
$Est\text{-}2^1$	-	$Esterase\text{-}2^1$. One of five codominant alleles, each regulating one band. Found in *C. colocynthis*.	23, 24, 25

Gene symbol Preferred	Synonym	Character	Reference
Est-2^2	-	*Esterase-2*^{2}. One of five codominant alleles, each regulating one band. Found in *C. colocynthis*.	23, 24, 25
Est-2^3	-	*Esterase-2*^{3}. One of five codominant alleles, each regulating one band. Found in *Praecitrullus fistulosus*.	23, 24, 25
Est-2^4	-	*Esterase-2*^{4}. One of five codominant alleles, each regulating one band. Found in *Acanthosicyos naudinianus*.	23, 24, 25
f	-	*furrowed* fruit surface. Recessive to smooth.	28
Fdp-1	-	*Fructose 1,6 diphosphatase-1*.	24, 25
Fo-1	-	Dominant gene for *resistance to race 1* of *Fusarium oxysporum* f. sp. *niveum*.	11, 26
For-1	-	*Fructose 1,6 diphosphatase-1*	23
Fwr	-	*Fruit fly resistance* in watermelon. Dominant to susceptibility to *Dacus cucurbitae*.	13
g	*d*	*light green* skin. Light green fruit recessive to *dark green* (*D*) and *striped green* (d^s)	28, 31, 45
g^s	d^s	*striped green* skin. Recessive to dark green but dominant to light green skin.	28, 45
Gdh-1	-	*Glutamate dehydrogenase-1*. Isozyme located in cytosol.	24
Gdh-2	-	*Glutamate dehydrogenase-2*. Isozyme located in plastids.	23, 24
gms	ms_g	*glabrous male sterile*. Foliage lacking trichomes; male sterile - caused by chromosome desynapsis.	33, 43, 44
go	*c*	*golden*. Yellow color of older leaves and mature fruit.	1
Got-1$^+$	-	*Glutamate oxaloacetate transaminase-1*$^+$. One of four codominant alleles, each regulating one band. Found in *C. lanatus*.	23,24,25, 47

Gene symbol Preferred	Synonym	Character	Reference
Got-1^{1}	-	*Glutamate oxaloacetate transaminase-1*^{1}. One of four codominant alleles, each regulating one band. Found in *C. colocynthis* and *Praecitrullus fistulosus*.	23,24,25,47
Got-1^{2}	-	*Glutamate oxaloacetate transaminase-1*^{2}. One of four codominant alleles, each regulating one band. Found in *C. lanatus* var. *citroides*.	23,24,25,47
Got-1^{3}	-	*Glutamate oxaloacetate transaminase-1*^{3}. One of four codominant alleles, each regulating one band. Found in *Acanthosicyos naudinianus*.	23,24,25,47
Got-2^{+}	-	*Glutamate oxaloacetate transaminase-2*$^{+}$. One of five codominant alleles, each regulating one band. Found in *C. lanatus*.	23,24,25, 47
Got-2^{1}	-	*Glutamate oxaloacetate transaminase-2*^{1}. One of five codominant alleles, each regulating one band. Found in *C. colocynthis*.	23,24,25,47
Got-2^{2}	-	*Glutamate oxaloacetate transaminase-2*^{2}. One of five codominant alleles, each regulating one band. Found in *C. ecirrhosus*.	23,24,25,47
Got-2^{3}	-	*Glutamate oxaloacetate transaminase-2*^{3}. One of five codominant alleles, each regulating one band. Found in *Praecitrullus fistulosus*.	23,24,25,47
Got-2^{4}	-	*Glutamate oxaloacetate transaminase-2*^{4}. One of five codominant alleles, each regulating one band. Found in *Acanthosicyos naudinianus*.	23,24,25,47
Got-3	-	*Glutamate oxaloacetate transaminase-3*.	47
Got-4	-	*Glutamate oxaloacetate transaminase-4*.	23, 47
I-dg	-	*Inhibitor of delayed green*. Epistatic to *dg*: *dg dg I-dg I-dg* and *dg dg I-dg i-dg* plants are pale green; and *dg dg i-dg i-dg* plants are normal. This gene was not present in more advanced germplasm.	34

Gene symbol Preferred	Synonym	Character	Reference
Idh-1	-	*Isocitrate dehydrogenase-1*.	47
l	-	*long* seed. Long recessive to medium length of seed; interacts with *s*.	30
Lap-1	-	*Leucine aminopeptidase-1*.	23, 24
m	-	*mottled* skin. Greenish white mottling of fruit skin.	28, 45
ms	-	*male sterile*.	48, 49
Mdh-1^{+}	-	*Malic dehydrogenase-1*$^{+}$. One of two codominant alleles, each regulating one band. Found in *C. lanatus*.	25, 47
Mdh-1^{1}	-	*Malic dehydrogenase-1*^{1}. One of two codominant alleles, each regulating one band. Found in *Praecitrullus fistulosus*.	25, 47
Mdh-2^{+}	-	*Malic dehydrogenase-2*$^{+}$. One of three codominant alleles, each regulating one band. Found in *C. lanatus*.	25
Mdh-2^{1}	-	*Malic dehydrogenase-2*^{1}. One of three codominant alleles, each regulating one band. Found in *C. colocynthis*.	25
Mdh-2^{2}	-	*Malic dehydrogenase-2*^{2}. One of three codominant alleles, each regulating one band. Found in *Praecitrullus fistulosus*.	25
Me-1^{+}	-	*Malic enzyme-1*$^{+}$. One of three codominant alleles, each regulating one band. Found in *C. lanatus*.	23,24,25,47
Me-1^{1}	-	*Malic enzyme-1*^{1}. One of three codominant alleles, each regulating one band. Found in *Praecitrullus fistulosus*.	23,24,25,47
Me-1^{2}	-	*Malic enzyme-1*^{2}. One of three codominant alleles, each regulating one band. Found in *C. colocynthis*.	23,24,25,47

Gene symbol Preferred	Synonym	Character	Reference
Me-2	-	*Malic enzyme-2.*	47
nl	-	*nonlobed* leaves. Leaves lack lobing; dominance incomplete.	20
O	-	*Elongate* fruit. Incompletely dominant to spherical.	28,45
p	-	*pencilled* lines on skin. Inconspicuous; recessive to netted fruit.	28, 45
Pgd-1$^+$	*6 Pgdh-1$^+$*	*6-Phosphogluconate dehydrogenase-1$^+$.* One of three codominant alleles, each regulating one plastid band. Found in *C. lanatus.*	23,24,25,47
Pgd-1^1	*6 Pgdh-1^1*	*6-Phosphogluconate dehydrogenase-1^1.* One of three codominant alleles, each regulating one plastid band. Found in *Praecitrullus fistulosus.*	23,24,25,47
Pgd-1^2	*6 Pgdh-1^2*	*6-Phosphogluconate dehydrogenase-1^2.* One of three codominant alleles, each regulating one plastid band. Found in *Acanthosicyos naudinianus.*	23,24,25,47
Pgd-2$^+$	*6 Pgdh-2$^+$*	*6-Phosphogluconate dehydrogenase-2$^+$.* One of five codominant alleles, each regulating one cytosolic band. Found in *C. lanatus.*	25, 47
Pgd-2^1	*6 Pgdh-2^1*	*6-Phosphogluconate dehydrogenase-2^1.* One of five codominant alleles, each regulating one cytosolic band. Found in *C. ecirrhosus.*	25, 47
Pgd-2^2	*6 Pgdh-2^2*	*6-Phosphogluconate dehydrogenase-2^2.* One of five codominant alleles, each regulating one cytosolic band. Found in *Praecitrullus fistulosus.*	25, 47
Pgd-2^3	*6 Pgdh-2^3*	*6-Phosphogluconate dehydrogenase-2^3.* One of five codominant alleles, each regulating one cytosolic band. Found in *C. colocynthis.*	25, 47
Pgd-2^4	*6 Pgdh-2^4*	*6-Phosphogluconate dehydrogenase-2^4.* One of five codominant alleles, each regulating one cytosolic band. Found in *Acanthosicyos naudinianus.*	25, 47

Gene symbol Preferred	Synonym	Character	Reference
Pgi-1^{+}	-	*Phosphoglucoisomerase-1*$^{+}$. One of three codominant alleles, each regulating one plastid band. Found in *C. lanatus*.	23, 24, 25
Pgi-1^{1}	-	*Phosphoglucoisomerase-1*^{1}. One of three codominant alleles, each regulating one plastid band. Found in *C. colocynthis*.	23, 24, 25
Pgi-1^{2}	-	*Phosphoglucoisomerase-1*^{2}. One of three codominant alleles, each regulating one plastid band. Found in *Acanthosicyos naudinianus*.	23, 24, 25
Pgi-2^{+}	-	*Phosphoglucoisomerase-2*$^{+}$. One of six codominant alleles, each regulating one cytosolic band. Found in *C. lanatus*.	23,24,25,47
Pgi-2^{1}	-	*Phosphoglucoisomerase-2*^{1}. One of six codominant alleles,each regulating one cytosolic band. Found in *C. lanatus* and *C. colocynthis*.	23,24,25,47
Pgi-2^{2}	-	*Phosphoglucoisomerase-2*^{2}. One of six codominant alleles, each regulating one cytosolic band. Found in *C. ecirrhosus*.	23,24,25,47
Pgi-2^{3}	-	*Phosphoglucoisomerase-2*^{3}. One of six codominant alleles, each regulating one cytosolic band. Found in *Praecitrullus fistulosus*.	23,24,25,47
Pgi-2^{4}	-	*Phosphoglucoisomerase-2*^{4}. One of six codominant alleles, each regulating one cytosolic band. Found in C. *lanatus* var. *citroides*.	23,24,25,47
Pgi-2^{5}	-	*Phosphoglucoisomerase-2*^{5}. One of six codominant alleles, each regulating one cytosolic band. Found in *Acanthosicyos naudinianus*.	23,24,25,47
Pgm-1^{+}	-	*Phosphoglucomutase-1*$^{+}$. One of four codominant alleles, each regulating one plastid band. Found in *C. lanatus*.	23,24,25,47
Pgm-1^{1}	-	*Phosphoglucomutase-1*^{1}. One of four codominant alleles, each regulating one plastid band. Found in *C. colocynthis*.	23,24,25,47

Gene symbol Preferred	Synonym	Character	Reference
Pgm-1^2	-	*Phosphoglucomutase-1*^{2}. One of four codominant alleles, each regulating one plastid band. Found in *Acanthosicyos naudinianus*.	23,24,25,47
Pgm-1^3	-	*Phosphoglucomutase-1*^{3}. One of four codominant alleles, each regulating one plastid band. Found in *Praecitrullus fistulosus*.	23,24,25,47
Pgm-2$^+$	-	*Phosphoglucomutase-2*$^+$. One of four codominant alleles, each regulating one cytosolic band. Found in *C. lanatus*.	25, 47
Pgm-2^1	-	*Phosphoglucomutase-2*^{1}. One of four codominant alleles, each regulating one cytosolic band. Found in *Acanthosicyos naudinianus*.	25, 47
Pgm-2^2	-	*Phosphoglucomutase-2*^{2}. One of four codominant alleles, each regulating one cytosolic band. Found in *C. lanatus*.	25, 47
Pgm-2^3	-	*Phosphoglucomutase-2*^{3}. One of four codominant alleles, each regulating one cytosolic band. Found in *Praecitrullus fistulosus*.	25, 47
pm	-	*powdery mildew* susceptibility. Susceptibility to *Sphaerotheca fuliginea*.	36
Prx-1$^+$	-	*Peroxidase-1*$^+$. One of seven codominant alleles, each regulating one band. Found in *C. lanatus*.	23, 24, 25
Prx-1^1	-	*Peroxidase-1*^{1}. One of seven codominant alleles, each regulating one band. Found in *C. colocynthis*.	23,24,25
Prx-1^2	-	*Peroxidase-1*^{2}. One of seven codominant alleles, each regulating one band. Found in *Praecitrullus fistulosus*.	23, 24,25
Prx-1^3	-	*Peroxidase-1*^{3}. One of seven codominant alleles, each regulating one band. Found in *C. lanatus*.	23, 24, 25

Gene symbol Preferred	Synonym	Character	Reference
Prx-1^4	-	*Peroxidase-1*^{4}. One of seven codominant alleles, each regulating one band. Found in *C. ecirrhosus*.	23, 24, 25
Prx-1^5	-	*Peroxidase-1*^{5}. One of seven codominant alleles, each regulating one band. Found in *C. lanatus* and *C. colocynthis*.	23, 24, 25
Prx-1^6	-	*Peroxidase-1*^{6}. One of seven codominant alleles, each regulating one band. Found in *Acanthosicyos naudinianus*.	23, 24, 25
Prx-2	-	*Peroxidase-2*.	23
Prx-3	-	*Peroxidase-3*.	23
r	-	*red* seed coat. Interacts with *w* and *t*.	30
s	-	*short* seeds. Epistatic to *l*.	30
Skdh-1	-	*Shikimic acid dehydrogenase-1*.	47
Skdh-2$^+$	-	*Shikimic acid dehydrogenase-2*$^+$. One of six codominant alleles, each regulating one band. Found in *C. lanatus*.	23, 24, 25
Skdh-2^1	-	*Shikimic acid dehydrogenase-2*^{1}. One of six codominant alleles, each regulating one band. Found in *C. colocynthis*.	23, 24, 25
Skdh-2^2	-	*Shikimic acid dehydrogenase-2*^{2}. One of six codominant alleles, each regulating one band. Found in *C. colocynthis*.	23, 24, 25
Skdh-2^3	-	*Shikimic acid dehydrogenase-2*^{3}. One of six codominant alleles, each regulating one band. Found in *Acanthosicyos naudinianus*.	23, 24, 25
Skdh-2^4	-	*Shikimic acid dehydrogenase-2*^{4}. One of six codominant alleles, each regulating one band. Found in *C. ecirrhosus*.	23, 24, 25

Gene symbol Preferred	Synonym	Character	Reference
Skdh-2^5	-	*Shikimic acid dehydrogenase-2*^{5}. One of six codominant alleles, each regulating one band. Found in *Praecitrullus fistulosus*.	23, 24, 25
slv	-	*Seedling leaf variegation*. Conferred by a single recessive gene. Dominant allele at same locus in PI 482261.	32
Sod-1$^+$	-	*Superoxide dismutase-1*$^+$. One of three codominant alleles, each regulating one band. Found in *C. lanatus*.	23, 24, 25, 47
Sod-1^1	-	*Superoxide dismutase-1*^{1}. One of three codominant alleles, each regulating one band. Found in *C. colocynthis*.	23, 24, 25, 47
Sod-1^2	-	*Superoxide dismutase-1*^{2}. One of three codominant alleles, each regulating one band. Found in *Acanthosicyos naudinianus*.	23, 24, 25, 47
Sod-2$^+$	-	*Superoxide dismutase-2*$^+$. One of two codominant alleles, each regulating one band. Found in *C. lanatus*.	25
Sod-2^1	-	*Superoxide dismutase-2*^{1}. One of two codominant alleles, each regulating one band. Found in *Acanthosicyos naudinianus*.	25
Sod-3$^+$	-	*Superoxide dismutase-3*$^+$. One of two codominant alleles, each regulating one band. Found in *C. lanatus*.	25
Sod-3^1	-	*Superoxide dismutase-3*^{1}. One of two codominant alleles, each regulating one band. Found in *Praecitrullus fistulosus*.	25
Sp	-	*Spotted* cotyledons, leaves and fruit.	34
Spr-1	-	*Seed protein-1*.	24
Spr-2	-	*Seed protein-2*.	24
Spr-3	-	*Seed protein-3*.	24

Gene symbol		Character	Reference
Preferred	Synonym		
Spr-4	*Sp-4*	*Seed protein-4*.	23, 24
Spr-5	*Sp-5*	*Seed protein-5*.	23, 24
su	*Bi*, su^{Bi}	*suppressor of bitterness*. Non-bitter fruit. Bitterness in *C. colocynthis* is due to *Su Su* genotype.	2, 23
t	b^t	*tan* seed coat. Interacts with *r* and *w*.	19, 30
$Tpi\text{-}1^+$	-	*Triosephosphatase isomerase-1*$^+$. One of four codominant alleles, each regulating one band. Found in *C. lanatus*.	23, 24, 25
$Tpi\text{-}1^1$	-	*Triosephosphatase isomerase-1*^{1}. One of four codominant alleles, each regulating one band. Found in *C. colocynthis*.	23, 24, 25
$Tpi\text{-}1^2$	-	*Triosephosphatase isomerase-1*^{2}. One of four codominant alleles, each regulating one band. Found in *Praecitrullus fistulosus*.	23, 24, 25
$Tpi\text{-}1^3$	-	*Triosephosphatase isomerase-1*^{3}. One of four codominant alleles, each regulating one band. Found in *Acanthosicyos naudinianus*.	23, 24, 25
$Tpi\text{-}2^+$	-	*Triosephosphatase isomerase-2*$^+$. One of three codominant alleles, each regulating one band. Found in *C. lanatus*.	25
$Tpi\text{-}2^1$	-	*Triosephosphatase isomerase-2*^{1}. One of three codominant alleles, each regulating one band. Found in *Acanthosicyos naudinianus*.	25
$Tpi\text{-}2^2$	-	*Triosephosphatase isomerase-2*^{2}. One of three codominant alleles, each regulating one band. Found in *Praecitrullus fistulosus*.	25
Ure-1	-	*Urease-1*.	25
w	-	*white* seed coat. Interacts with *r* and *t*.	30

Gene symbol		Character	Reference
Preferred	Synonym		
Wf	*W*	*White flesh*. *Wf* is epistatic to the second gene b (or *C*?) which conditions *yellow* (*Canary yellow*?) and red flesh. *Wf_B_* and *Wf_bb* are white fleshed, *wf wf B_* is yellow fleshed, and *wf wf b b* is red fleshed.	38
y	*r*	*yellow* flesh ('Golden Honey' type). Recessive to *Y* (*red* flesh).	10,28,31
y^o	-	*orange* flesh (from 'Tendersweet Orange Flesh'). Allelic to *y*. *Y* (*red* flesh) is dominant to y^o (*orange* flesh) and *y* (*yellow* flesh); y^o (*orange* flesh) is dominant to *y* (*yellow* flesh).	10
Yl	-	*Yellow* leaf (from 'Yellow Skin'). Incompletely dominant to green leaf.	42

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Cucumber:	T. C. Wehner	*Cucurbita* spp.:	R.W. Robinson
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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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Lim, Haktae Department of Horticulture, Kangnung National University. Kangnung, Kangwon-Do, South Korea. 210-702. Plastid gene regulation: organelle genetics: RFLP mapping; somatic hybridization.

Lin, Depei Sichuan Academic Agric. Science. Hortseed Center, Chengdu 61006, People's Rep. China. Ph: (028) 4436732. Fax: (028) 4442025.

Love, Stephen Loyd Aberdeen R&E Center, P.O. Box AA. Aberdeen, ID 83210. Ph: (208) 397-4181. Fax: (208) 397-4311. Small scale private watermelon breeding with emphasis on adaptation to cold climates.

Lower, Richard L. Coll. Agriculture, Univ. Wisconsin. 1450 Linden Drive, Room 136, Madison, WI 53706. Ph: (608) 262-2349. Fax: (608) 262-4556. E-mail: *richard.lower@ccmail.adp.wisc.edu.* Effects of plant type genes on yield, sex- expression, growth parameters, pest resistance & adaptability.

Loy, J. Brent Plant Biology Dept., Nesmith Hall, University of New Hampshire, Durham, NH 03824. Ph: (603) 862-3216. Fax: (603) 862-4757. Squash, melon, pumpkin. Genetics, breeding, plasticulture, mulch, rowcovers.

Lydon, Lewis R.B. Arthur Yates & Co. Pty. Limited, Research Farm, Burroway Road, Narromine, N.S.W. 2821. Australia. Ph: (068) 89-1144.

Maluf, Wilson Roberto DAG/ESAL. Cx Postal 37, 37200-000 Lavras-MG, Brazil. Ph: (035) 821-4793. Fax: (035) 829-1100. Cucumbers, melons, squashes.

Maneesinthu, Likhit Thep Watana Seeds Co., Ltd., 293-293/1-2, Surwongse Road, Bangkok 10500, Thailand. Ph: 66-2-2376540. Fax: 66-2-2376543. Breeding and seed production of cucumber, watermelon, melon and pumpkin.

Markiewicz-Ladd, Krystyna 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.

Marshall, Dale E. USDA-ARS, Farrall Agr. Eng. Hall, Michigan State University, East Lansing, MI 48824-1323. Ph: (517) 353-5201. Fax: (517) 353- 8982.

Matsuura, Seiji Kiyohara Breeding Sta., Tohoku Seed Co., 1625 Nishihara, Himuro, Utsunomiya, Japan. Ph: 0286-34-5428. Fax: 0286-35-6544.

Maynard, Donald N. Univ Florida-IFAS, Gulf Coast R&E Ctr. 5007 60th Street East, Bradenton, FL 34203. Ph: (813) 751-7636. Fax: (813) 751-7639. Tropical moschata improvement: watermelon variety evaluation and production practices.

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.

McCreight, J.D. USDA-ARS, 1636 E. Alisal St., Salinas, CA 93905. Ph: (408) 755-2864. Fax: (408) 753-2866. E-mail: *jmccreig@asrr.arsusda.gov.* Melon breeding and genetics.

McGrath, Desmond John Dept. Primary Ind., Hortic. Res. Sta., P.O. Box 538, Bowen, Queensland 4805, Australia. Ph: +61-77-852255. Fax: +61-77-852427. Disease resistance in *Cucumis melo*, particularly gummy stem blight.

Meadows, Mike Rogers Seed Co., 10290 Greenway Road, Naples, FL 33961.

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Milotay, Peter Vegetable Crops Research Institute, P.O. Box 116, Kecskemet, 6000, Hungary.

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Miyoshi, K. Sakata Seed Corp., Kakegawa Breeding Sta. 1743-2 Yoshioka, Kakegawa, Shizuoka 436-01, Japan.

Mochizuki, Tatsuya Kurume Br. Natl Res Inst Veg/Orn/Tea, 1823 Mii-machi, Kurume, Fukuoka 830, Japan.

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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.

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Murdock, Brent A. Coll. Agric., Sultan Qaboos Univ., P.O. Box 34, Al-Khod 123, Muscat, Sultanate of Oman. Watermelon breeding; genetic improvement of neglected tropical vegetables.

Nance, John Willhite Seed, Inc., P.O. Box 23, Poolville, TX 76487. Ph: (817) 599-8656. Fax: (817) 599-5843.

Navazio, John P. Garden City Seeds, 1324 Red Crow Road, Victor, MT 59875. Ph: (406) 961-4837. Fax: (406) 961-4877. Breeding for increased carotenes in cucumber and squash.

Nea, Larry Petoseed Woodland Research Station, 37437 State Highway 16, Woodland, CA 95695. Ph: (916) 666-0931. Fax: (916) 668-0219. Cucumbers, melons, squash, watermelon.

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Paris, Harry Div. Vegetable Crops, A.R.O., Newe Ya'ar Expt Sta, PO Box 31900, Haifa 31900, Israel. Ph: 972-4-894516. Fax: 972-4-836936. Breeding and genetics of squash, pumpkin, melon and watermelon.

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Poostchi, Iraj 97 St. Marks Road, Henley-on-Thames RG9 1LP, England.

Price, E. Glen American Sunmelon Research Center, P.O. Box 153, Hinton, OK 73047. Ph: (405) 542-3456. Fax: (405) 542-3457. Seedless watermelon; polyploidy, genetics, breeding, cytogenetics.

Provvidenti, Rosario Cornell Univ., Dept. Plant Pathology, NY State Agric. Experiment Sta., Geneva, NY 14456-0462. Ph: (315) 787-2316. Fax: (315) 787-2389. Breeding & genetics of resistance to viral diseases of cucumber, squash, melon, watermelon & other cucurbits.

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harjo@sfu.ca. Tissue culture, genetic transformation and disease resistance of cucumber.

Ray, Dennis Department of Plant Sciences, University of Arizona, Tucson, AZ 85721. Ph: (602) 621-7612. Fax: (602) 621-7186. E-mail: *dtray@ccit.arizona.edu*. Genetics and cytogenetics of *Cucumis melo* and *Citrullus* spp.

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Robledo, C. Asgrow - France, Centre de Recherches, Mas d'Aptel, 30510 Generac, France. Ph: 66 01 89 07. Fax: 66 01 31 68. Melon breeding.

Roig, Luis A. Departamental Biotechnology, ETS Ingen. Politec., Camino de Vera 14, 46022 - Valencia, Spain. Ph: 34(6) 3877424. Fax: 34(6) 3877429.

Rumsey, Anthony E. New World Seeds Pty Ltd., P.O. Box 18, Dural 2158, 22-24 Crosslands Road, Galston, N.S.W., Australia.

Scheirer, Douglas M. The Nestle Food Co./Baking/Libby, 216 N. Morton Ave., P.O. Box 198, Morton, IL 61550. Ph: (309) 263-2133. Breeding, cultural practices, etc., associated with processing pumpkin (*Cucurbita moschata*) Dickinson.

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.

Schultheis, Jonathan R. Dept. Horticulture, 264 Kilgore Hall, North Carolina St. University, Raleigh, NC 27695-7609. Ph: (919) 515-3131. Fax: (919) 515-7747.

Semillas Fito, S.A., c/. Selva de Mar, 111, 08019 Barcelona, Spain.

Shifriss, Oved 21 Walter Avenue, Highland Park, NJ 08904. Ph: (908) 246-0028. Regulation of the B genes in *Cucurbita*.

Shiga, Toshio Plant Biotech. Ctr., Sakata Seed Corp., 358 Uchikoshi, Sodegaura, Chiba 299-02, Japan. Ph: 0438-75-2369. Fax: 0438-75-2594. Cell biology.

Shintaku, Yurie 2-10-2, Shimizu, Suginami-ku, Tokyo, 167, Japan.

Simon, Philipp W. 5125 Lake Mendota Drive, Madison, WI 53705. Ph: (608) 264-5406. Fax: (608) 262-4743. E-mail: *simon@macc.wisc.edu*. Breeding and genetics.

Sipeyre, Bruno Mas de Rouzel, Chemin des Canaux, 30900 Nimes, France. Ph: 66.84.21.32. Fax: 66.38.09.42.

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@ux1.cso.uiuc.edu*. Micropropagation; somaclonal variation.

Snyder, James W. 1231 Kirkwood Drive, Vineland, NJ 08360. Ph: (609) 794-3880.

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Stern, Joseph Royal Sluis Inc., 910 Duncan Road, San Juan Bautista, CA 95045.

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Teppner, Herwig Institute of Botany, Univ. Graz, Holteigasse 6, A-8010 Graz, Austria. Ph: 316-380-5656. Fax: 316-38-12-21. Systematics, morphology, ecology, crops & medicinal plants (teaching) and small scale breeding.

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Thompson, Gary Dept. Plant Sciences, University of Arizona, Tucson, AZ 85721.

Tolla, Greg Asgrow Seed Company, Rt. 1, Box 1907, Tifton, GA 31794. Ph: (912) 386-8701. Fax: (912) 386-8805. Cucumber breeding and genetics.

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Vakalounakis, Demetrios J. Plant Protection Inst., N.A.R.F., P.O. Box 1803, 711 10 Heraklion Crete, Greece. Ph: 081-245858.

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Vardi, Eyal Hazera Ltd.. Mivhor Farm Doar. Sede Gat 79570. Israel.

Vecchio, Franco Pioneer Hi-Bred Italia SpA. via Provinciale 42/44. 43018 Sissa (PR). Italy.

Walters, Terrence W. The Montgomery Foundation. 11901 Old Cutler Road. Miami. FL 33156-4242. Ph: (305) 667-3800. Fax: (305) 661-5984. Communication via "The Cucurbit Network": the whole family *Cucurbitaceae*.

Wang, Ming Department of Horticulture. Northwestern Agricultural University. Yangling. Shaanxi 712100. P.R. China.

Wann, E. Van South Central Agric. Res. Lab. USDA-ARS. P.O. Box 159. Lane. OK 74555. Ph: (405) 889-7395. Fax: (405) 889-5783. Stress tolerance in cucumber.

Warid, Warid A. Paseo de las Fuentes No. 18. Col. Valle Verde. 83200 Hermosillo. Sonora. Mexico. Breeding of cucurbits.

Wasilwa, Lusike Dept. Horticulture & Forestry. University of Arkansas. Fayetteville. AR 72701.

Wehner, Todd C. Dept. Horticultural Science. Box 7609. North Carolina St. Univ.. Raleigh. NC 27695-7609. Ph: (919) 515-5363. Fax: (919) 515-7747. E- mail: *todd_wehner@ncsu.edu*. Pickling/slicing cucumber. watermelon. luffa gourd: selection. disease resistance. yield. genetics & chilling.

Weng, Chris S&G Seeds. No. 2. Chang Hsing 1 St.. Tai Tzu Tsuang. Jen Te. Tainan. Taiwan. Republic of China. Ph: (06) 272-6366~8. Fax: (06) 272-1386.

Wessel-Beaver, Linda Department of Agronomy & Soils. Coll. Agriculture. Univ. Puerto Rico. Mayaguez. PR 00681. Ph: (809) 832-4040. Fax: (809) 265-0220. E-mail: *l_beaver@rumac.upr.clu.edu*. Pumpkin & squash breeding: disease resistance: insect resistance.

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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.

Wu, Mingzhu Hort Inst. Xinjiang Acad Agric Sci. Nanchang Road NO. 38. Urumqi. Xinjiang. People's Rep. China. Ph: 0991-4840311-2094.

Wunderlin, Richard P. Institute for Systematic Botany. Dept. Biology. Univ. South Florida. Tampa. FL 33620-5150. Ph: (813) 974-2359. Fax: (813) 874-3557. E-mail: *rwunder@cfrvm.cfr.usf.edu*. Taxonomy of neotropical species: *Zanonioideae*.

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Yamanaka, Hisako Yamato-Noen Co.. Ltd.. 110. Byodobo-cho. Tenri-City. Nara. Japan 632. Ph: 07436-2-1182.

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Yorty, Paul Rogers NK Seed Co.. P.O. Box 104. Twin Falls. ID 83303-0104. Ph: (208) 733-0077. Cucurbit breeding.

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Zhao, Yanru 2018 SW 143rd Street. Newberry. FL 32669. Breeding of resistance to WMV and ZYMV in watermelon (*Citrullus lanatus* L.).

Zitter, Thomas A. Cornell Univ.. Dept. Plant Pathology. 334 Plant Science Building. Ithaca. NY 14853-5908. Ph: (607) 255-7857. Fax: (697) 255-4471. E- mail: *taz1@cornell.edu*. Fungal and viral diseases: disease resistance.

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Ma Cruz Ayuso
Pilar Corella
M. Luisa Gomez-Guillamon
Peter Kraakman
Fernando Nuez
Gloria Palomares
Luis A. Roig
Semillas Fito, S.A.

Sudan
Ali Elamin El Jack
Yousif Fadlalla Mohamed
Sadig Khidir Omara

Sultanate of Oman
Brent A. Murdock

Sweden
Louis Carl Lehmann

Thailand
Likhit Maneesinthu

United Arab Emirates
Ahmed A. Al Masoum

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 Coordinating Committee.

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

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

ARTICLE III. Committees

1. The Coordinating Committee shall govern policies and activities of the CGC. It shall consist of six members elected in order to represent areas of interest and importance in the field. The Coordinating Committee shall select its Chairman, who shall serve as a spokesman of the CGC, as well as its Secretary and Treasurer.
2. The Gene List Committee, consisting of at least 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 for fulfilling other functions arises.

ARTICLE IV. Election and Appointment of Committees

1. The Chairman will serve an indefinite term while other members of the Coordinating Committee shall be elected for ten-year terms, replacement of a single retiring member taking place every other year. Election of a new member shall take place as follows: A Nominating Committee of three members shall be appointed by the Coordinating Committee. The aforesaid Nominating Committee shall nominate candidates for an anticipated opening on the Coordinating Committee, the number of nominees being at their discretion. The nominations shall be announced and election held by open ballot at the Annual

Meeting of the CGC. The nominee receiving the highest number of votes shall be declared elected. The newly elected member shall take office immediately.

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

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

ARTICLE V. Publications

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

ARTICLE VI. Meetings

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

ARTICLE VII. Fiscal Year

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

ARTICLE VIII. Amendments

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

ARTICLE IX. General Prohibitions

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

1. The CGC shall be organized and operated exclusively for scientific and educational purposes.
2. No part of the net earnings of the CGC shall or may under any circumstances inure to the benefit of any individual.
3. No part of the activities of the CGC shall consist of carrying on propaganda or otherwise attempting to influence legislation of any political unit.

4. The CGC shall not participate in. or intervene in (including the publishing or distribution of statements). any political campaign on behalf of a candidate for public office.
5. The CGC shall not be organized or operated for profit.
6. The CGC shall not:
   (a) lend any part of its income or corpus without the receipt of adequate security and a reasonable rate of interest to;
   (b) pay any compensation in excess of a reasonable allowance for salaries or other compensation for personal services rendered to;
   (c) make any part of its services available on a preferential basis to;
   (d) make any purchase of securities or any other property. for more than adequate consideration in money's worth from;
   (e) sell any securities or other property for less than adequate consideration in money or money's worth; or
   (f) engage in any other transactions which result in a substantial diversion of income or corpus to any officer. member of the Coordinating Committee, or substantial contributor to the CGC.

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

ARTICLE X. Distribution on Dissolution

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

Approvals:

W. Bemis

J. D. Norton

R. W. Robinson

W. R. Henderson

M. L. Robbins

R. L. Lower

Cucurbit Genetics Cooperative

Financial Statement

31 December 1994

Balance (31 December 1993)			**$4,258.65**
Receipts:			
	Dues & CGC back issue orders	$2,769.00	
	Interest on savings	$117.58	
	Total receipts		$2,886.58
Expenditures:			
	CGC Report No. 17 (1994)		
	Printing	$2,733.86	
	Mailing	$540.41	
	Call for papers (Report No. 18)	$71.94	
	Miscellaneous (envelopes, postage, etc.)	$61.89	
	U.S. FDIC bank fees	$11.80	
	Total expenses		$3,419.90
Balance (31 December 1994)			**$3,725.33**