WATERMELON

Updated 1996

Watermelon Sub-Committee

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WATERMELON

[*Citrullus lanatus* (Thunb.) Matsum. & Nakai]

I. INTRODUCTION

Watermelon is native to central Africa where it was domesticated as a source of water, a staple, and an animal feed. There are 4 million acres of watermelons in the world with China and the middle Eastern countries the major consumers. In the United States, watermelon is utilized in fresh desserts and salads. Total domestic acreage is approximately 200,000 acres and is concentrated in Florida, California, Texas, and Georgia. Over 30 million hundredweight of commercial-sized melons are produced annually. Per capita consumption is about 15.4 pounds.

II. PRESENT GERMPLASM ACTIVITIES

The public and private research programs which are actively involved in germplasm activities are listed below:

PUBLIC RESEARCH

ALABAMA

Auburn University

Investigator: George Boyhan
Dept. of Horticulture
101 Funchess Hall
Auburn University, AL 36849
(334)844-3041 FAX (334)844-3131
email: gboyhan@ag.auburn.edu

Investigator: Fenny Dane
Dept. of Horticulture, AU
101 Funchess Hall
Auburn University, AL 36849
(334)844-3046 FAX (334)844-3131
email: fdane@ag.auburn.edu

Activities: Development of comprehensive linkage map.

ARIZONA

University of Arizona

Investigator: Dennis T. Ray
Dept. of Plant Sciences, UA
Tucson, AZ 85721
(602)621-7612 FAX(602)621-7186
email: DTRAY@ccit.arizona.edu

Activities: Cytogenetics

FLORIDA

University of Florida

Investigator: Donald N. Maynard
Gulf Coast Research & Education Center, UF
5007 60th Street East
Bradenton, FL 34203
(941)751-7636 FAX(941)751-7639
email: BRA@gnv.ifas.ufl.edu

Activities: Variety evaluation, pollination, production practices, and hollowheart.

Investigator: George Hochmuth
Horticultural Sciences Dept., UF
1143 Fifield Hall
PO Box 110690
Gainesville, FL 32611-0690
(904)392-2134 FAX(904)392-5653
email: GJH@gnv.ifas.ufl.edu

Activities: Watermelon fertilzation and culture.

Investigator: Dennis J. Gray
Central Florida Research & Education Center, UF
5336 University Ave.
Leesburg, FL 34748
(904)360-6686 FAX(904)360-6691
email: djg@gnv.ifas.ufl.edu

Activities: Use of biotechnology, including genetic transformation and regenerative cell and tissue culture to improve watermelon.

Investigator: Susan E. Webb
Central Florida Research & Education Center, UF
5336 University Ave.
Leesburg, FL 34748
(904)360-6686 FAX(904)360-6691
email: SEWE@gnv.ifas.ufl.edu

GEORGIA

Investigator: D. Scott NeSmith
Horticulture Department, UG
Georgia Experiment Station
1109 Experiment Station Road
Griffin, GA 30223-1797
(770)228-7358 FAX(770)412-4764
email: SNesmit@gaes.griffin.peachnet.edu

Activities: Crop ecology and environmental physiology. Research improved cultural practices for production efficiency. Explore environmental influence on growth and development of vegetables.

Investigator: Melvin R. Hall
Horticulture Department, UG
Coastal Plain Experiment Station
PO Box 748
Tifton, GA 31793
(912)386-3357 FAX(912)386-3356
email: hall@tifton.cpes.peachnet.edu

Activities: Investigations of environmental stress which limit watermelon production and development or modification of practices to reduce these stresses.

Investigator: Bob Jarret
USDA, ARS
Plant Genetic Resources Conservation Unit
1109 Experiment Street, Redding Bldg.
Griffin, GA 30223-1797
(770)229-3297 FAX(770)229-3324
email: BJarret@gaes.griffin.peachnet.edu

Activities: Plant germplasm maintenance, and distribution; Maintains U.S. collection of watermelon.

INDIANA

Purdue University

Investigator: Richard Latin
Professor of Plant Pathology, PU
1155 Lilly Hall
West Lafayette, IN 47907-1155
(317)494-4639 FAX(317)494-0363
email: latin@btny.purdue.edu

Activities: Research, extension responsibilities for diseases of vegetable crops, including watermelons. Current research projects involve bacterial fruit blotch, anthracnose, and gummy stem blight of watermelon.

Southwest-Purdue Agricultural Center

Investigator: Dan S. Egel
SW-PAP, PU
RR 6, Box 139A
Vincennes, IN 47591
(812)886-1098 FAX(812)886-6693
email: Dan_Egel@aes.purdue.edu

Activities: Research on diseases of watermelon especially Fusarium wilt and alternaria leaf blight.

Investigator: Diana Lange
SW-PAP, PU
RR 6, Box 139A
Vincennes, IN 47591
(812)886-0198 FAX(812)886-6693
email: Diana_Lange@aes.purdue.edu

Activities: Trials and quality.

KANSAS

Kansas State University

Investigator: Charles Marr

Department of Horticulture, KSU
Waters Hall
Manhattan, KS 66506
(913)532-6170 FAX(913)532-6949
email: cmarr@oz.oznet.ksu.edu

Activities: Field trials with watermelon varieties and cultural practices.

LOUISIANA

Louisiana State University

Investigator: Carl E. Motsenbocker
Department of Horticulture, LSU
137 J.C. Miller Hall
Baton Rouge, LA 70903
(504)388-1040 FAX(504)388-1068

Activities: Cultural practices research and variety evaluation.

Investigator: Charles J. Graham
Calhoun Research Station, LSU
PO Box 539
(321 Highway 80 East)
Calhoun, LA 71225
(318)644-2662 FAX(318)644-7244
email: Agexp78@lsuvm.sncc.lsu.edu

Activities: Diploid breeding for multiple disease resistance, variety evaluations, and establishment of watermelon plants in subtropical conditions.
Research environmental influence on growth and physiology of watermelon.

MARYLAND

University of Maryland

Investigator: Timothy Ng
Department of Horticulture, UM
1122 Holzapfel Hall
College Park, MD 20742-5611
(301)405-4175 FAX(301)314-9305
email: TNg@deans.umd.edu

Activities: Cucurbit genetics and breeding for disease resistance, seed germinability, and postharvest quality.

MISSISSIPPI

Mississippi State University

Investigator: Boyett Graves
Miss. Ag. Expt. Sta.., MSU
478 Hwy. 15
Beaumont, MS 39423
(601)788-6616
email: boyett@acc.MsState.edu

Activities: Watermelon cultural practices, variety evaluations for Fusarium resistance and control.

Investigator: Richard G. Snyder
Truck Crops Branch Expt. Sta.., MSU
PO Box 231
Crystal Springs, MS 39059
(601)892-3731 FAX(601)892-2056

Activities: Variety trials and cultural practices.

Investigator: Paul G. Thompson
Department of Horticulture, MSU
PO Drawer T
Mississippi State, MS 39762
(601)325-3223 FAX(601)325-8742
email:thompson@ra.msstate.edu

Activities: Breeding and genetics.

NORTH CAROLINA

North Carolina State University

Investigator: Jonathon R. Schultheis
Dept. of Horticultural Sciences, NCSU
PO Box 7609
Raleigh, NC 27695-7609
(919)515-3283 FAX(919)515-7747
email: Jonathan_Schulteis@NCSU.edu

Activities: Cultural management including plant establishment, fertility, plasticulture, and irrigation.

Investigator: Todd C. Wehner
Dept. of Horticultural Sciences, NCSU
PO Box 7609
Raleigh, NC 27695-7609
(919)515-5363 FAX(919)515-2505
email: Todd_Wehner@NCSU.edu

Activities: Breeding and genetics with emphasis on yellow and orange flesh types.

OKLAHOMA

Oklahoma State University

Investigator: Warren Roberts
Wes Watkins Ag. Res. & Extn. Ctr., OSU
PO Box 128
Lane, OK 74555
(405)889-7343 FAX(405)889-7347
email: 102615,157@compuserve.com

Activities: Cultural practices and soil fertility.
Integrated production practices.

Investigator: Benny Bruton
USDA-ARS, Southern Pines Area
PO Box 159 (Hwy. 3 West)
Lane, OK 74555
(405)889-7395 FAX(405)889-5783
email: bbruton@ag.gov

Activities: Research on etiology and epidemiology of soil-borne pathogens involved in vine decline complex.

SOUTH CAROLINA

Clemson University

Investigator: Bill B. Rhodes
Horticulture Department, CU
Poole Agricultural Center
Box 340375
Clemson, SC 29634-0375

(803)656-0410 FAX(803)656-4960
email: BRhodes@quickmail.clemson.edu

Activities: C.G.C. Co-Curator, watermelon; S-9 member, Southern PI Station; breeding genetics tissue culture with emphasis on triploid hybrids, disease resistance, germplasm of C*itrullus*.

USDA/ARS

Investigator: Claude E. Thomas
U.S. Vegetable Breeding Laboratory, USDA/ARS
2875 Savannah Highway
Charleston, SC 29414
(803)556-0840
email: Cthomas@awod.com

Activities: Identification, quantification, and genetics of disease resistance.

TEXAS

Texas A & M University

Investigator: Frank J. Dainello
Extension Horticulture, TAMU
Hort. & Forest Science Building
College Station, TX 77843
(409)845-7341 FAX(409)845-8906
email: fdainell@tamu.edu

Activities: Water use efficiency; variety adaptability; disease resistance screening.

Investigator: Jerral D. Johnson
Texas Agric. Extn. Service, TAMU
L.F. Peterson Bldg., Room 118
College Station, TX 77840-2132
(409)845-8032 FAX(409)845-6499
email: jd-johnson@tamu.edu

Activities: Field trials to determine resistance levels in melons.

Investigator: Ray D. Martyn
Dept. of Plant Path. & Microbiology, TAMU
College Station, TX 77843
(409)845-7311 FAX(409)845-6483
email: R-Martyn@tamu.edu

Activities: Soilborne diseases, germplasm evaluation, pathogen population characterization and dynamics.

Investigator: Marvin E. Miller
Texas Agric. Experiment Sta., TAMU
2415 East Highway 83
Weslaco, TX 78596
(210)968-5585 FAX(210)968-0641
email: m-miller@tamu.edu

Activities: Disease control.

VIRGINIA

Virginia Polytechnic Institute and State University

Investigator: Herman E. Hohlt
Extension Horticulturist, Va Tech.
Eastern Shore Branch Agric. Expt. Sta.
33446 Research Drive
Painter, VA 23420
(804)442-6411 FAX(804)787-5824
email: Painter@mail.vt.edu

Activities: Variety and cultural practices research.

WISCONSIN

Investigator Mike Compton
College of Business, Industry, Life Sciences, & Agriculture
1 University Plaza
University of Wisconsin
Platteville, WI 53818-3099
(608)342-1393 FAX(608)342-1395
email: Compton@uwplatt.edu

Activities: Genetic engineering/virus resistance, 4N induction.

PRIVATE RESEARCH

Investigator: Warren S. Barham (President)
Robert W. Barham (Executive Vice President)
Barham Seeds, Inc.(BSI)
7401 Crawford Drive
Gilroy, CA 95020
(408)847-3056 FAX(408)847-3056

Activities: Disease resistant, defect resistant diploid and triploid hybrids, red and yellow flesh with various fruit shapes and rind patterns. Interest in cucumber beetle resistance and will provide information on 1 or 2 susceptible checks to those interested.

Investigator: Nancy Childers
National Watermelon Association
406 Railroad Street (PO Box 38)
Morven, GA 31638
(912)775-2130 FAX(912)775-2344

Activities: Executive Secretary-Treasurer of the National Watermelon Association (a non-profit corporation for promotion and other concerns of the watermelon industry).

Investigator: Paul Chung
Seminis Vegetable Genetics
37437 State Highway 16
Woodland, CA 95695
(916)666-0931 FAX(916)666-0219

Activities: Variety development, gummy stem blight and virus resistance.

Investigator: Lee C. Coffey
Coffey Seed Company
Route 1, Box 253B
Plainview, TX 79072
(806)293-5304 FAX(806)293-5305

Activities: Inbred and hybrid variety development.

Investigator: Bill Copes
Harris Moran Seed Company
9241 Mace Blvd.
Davis, CA 95616
(916)756-1382 FAX(916)756-1016

Activities: Breeding

Investigator: Eric De Groot
Centro Ricerche
Via Ghiarone, 2
40019 - S. AGATA BOL. (BO)
ITALY
(051) 956550 FAX(051)957916

Activities: Breeding

Investigator: Don Dobbs
Willhite Seed Company
PO Box 23
Poolville, TX 76487
(817)599-8656 FAX(817)599-5843

Activities:

Investigator: David Drews
Seminis Vegetable Genetics
PO Box 720094
McAllen, TX 78504
(210)687-5725

Activities: Screening and field evaluations of diploid and triploid hybrids.

Investigator: Gary Elmstrom
Sunseeds
7087 E. Peltier Road
Acampo, CA 95220
(209)367-1064 FAX(209)367-1066

Activities: Variety development.

Investigator: Jim Hollar

Hollar and Company, Inc.
PO Box 204
Colusa, CA 95932
(916)458-5151

Activities: Breeding and evaluation.

Investigator: Larry Hollar
Hollar and Company, Inc.
PO Box 106
Rocky Ford, CO 81067
(719)254-7411 FAX(719)254-3539
email: Larry.Hollar@uspsa.com

Activities: Research Director. Development of watermelon and other cucurbit varieties.

Investigator: Hasib S. Humaydan
Ag. Consulting International
317 Red Maple Drive
Danville, CA 94506
(510)736-9054 FAX(510)736-1241

Activities: International consulting.

Investigator: Susan Huslig
American Sunmelon
PO Box 153
Hinton, OK 73047
(405)542-3456 FAX(405)542-3457

Activities: Research technician.

Investigator: Bronko Lovic
American Sunmelon
PO Box 153
Hinton, OK 73047
(405)542-3456 FAX(405)542-3457
email: Branko_lovic@msn.com

Activities: Seed health testing and disease resistance.

Investigator: Brian Moraghan
Seminis Vegetable Genetics
PO Box 667
Arvin, CA 93203-0667
(805)854-2390 FAX(805)854-4379

Activities: Breeding diploids and triploids.

Investigator: Roger Muren
Sunseeds
8850 59th Ave., NE
Brooks, OR 97305
(503)393-3243 FAX(503)390-0982
email: rmuren%sunseeds@mcimail.com

Activities: Tissue culture, genetic marker analysis, commercial variety development.

Investigator: John Nance
Robyn Coffey Nance
Willhite Seed Company, Inc.
PO Box 23
Poolville, TX 76487
(817)599-8656 FAX(817)599-5843

Activities:

Investigator: E. Glen Price
American Sunmelon
PO Box 153
Hinton, OK 73047
(405)542-3456 FAX(405)542-3457

Activities: Direct research on triploids.

Investigator: John Schoenecker
Harris Moran Seed Company
4511 Willow Road, Suite 3
Pleasanton, CA 94588
(510)416-8440 FAX(510)416-8499

Activities: Product manager.

Investigator: Satoro Takeda
Sakata Seed America, Inc.
PO Box 1103
Lehigh, FL 33970
(941)369-0032 FAX(941)369-7528

Activities: Breeding.

Investigator: Greg Toler
Seminis Vegetble Genetics
RR 1, Box 1907
Tifton, GA 31794
(912)386-8701 FAX9912)386-8805

Activities: Diploid breeding.

Investigator: Jon Watterson
Seminis Vegetable Genetics
Mas Rouzel
Chemin des Canaux
30900 Nimes
FRANCE

Activities: Pathology

Investigator: Wayne Wiebe
Seminis Vegetable Genetics
37437 State Highway 16
Woodland, CA 95695
(916)666-0931 FAX(916)666-0219

Activities: Disease resistance and seed transmitted diseases.

Investigator: Tom Williams
Rogers Seed Company
10292 Greenway Road
Naples, FL 33961
(941)775-4090 FAX(941)774-6852

Activities: Variety development

III. Status of Crop Vulnerability

A. Status and Risks

Relatively little has been done regarding surveying and reporting on the level of diversity among plant introductions and currently available cultivars. Some material has been evaluated for specific characteristics by individual breeders. However, if the lines are unsuitable in terms of their goals, the material is set aside and not evaluated for additional traits or publicly described.

Breeding new cultivars with resistance to Fusarium wilt (*Fusarium oxysporum* f. sp. *niveum*) has been a major, long-term objective of many watermelon improvement programs. The causal fungus occurs throughout the world with three known races expressing differential virulence. There are presently several cultivars (Calhoun Gray, Smokylee, and Dixielee) which carry sufficient resistance to Fusarium wilt races 0 and 1. A breeding line from Texas has been released which has resistance to all three races but has very poor horticultural characteristics. With the probable loss of methyl bromide for use as a soil fumigant to control wilt, genetic resistance becomes even more important.

Anthracnose (*Colletotrichum lagenarium*) resistance to races 1 and 3 has been found in lines obtained from Africa and is now in a number of commercial cultivars (Congo, Fairfax, Charleston Gray, Dixielee, Sugarlee). High yields in the presence of race 2 anthracnose have been obtained from lines derived from PI189225.

Resistance to gummy stem blight (*Didymella bryoniae*) has been found in some plant introductions with citron background including PI189225. This resistance has not yet been incorporated into horticulturally acceptable cultivars.
Downy mildew (*Pseudoperonospora cubensis*) resistance has not been reported. Downy mildew also is a problem principally in high-humidity areas and sporadically results in severe economic loss.

Several virus diseases, including papaya ringspot virus (watermelon strain), watermelon mosaic virus, and zucchini yellow mosaic virus occasionally inflict economic losses. Resistance to WMV and ZYMV has been reported in some citron types.

Watermelon fruit blotch (*Acidovorax avenae* Subsp. *citrulli)*, a fruit rot disease first observed in commercial fields in the U.S. in 1989, has inflicted near total losses of marketable fruit in southeastern, mid-Atlantic, and midwestern states. The disease requires high humidity. for development. Some tolerant PI lines are being studied. There is evidence for resistance in selections of Congo, PI295843 and PI299318. In general, triploid varieties are more tolerant of WFB than are diploid varieties.

Powdery mildew (*Erisiphe cichoracearum*) occurs only rarely under field conditions in the U.S. although recently it has been noted more frequently. Outbreaks do occur in greenhouses and in India. The Indian variety Arka Manik is reported to have resistance.

B. Future Outlook and Needs to Reduce Genetic Vulnerability

Most of the leading watermelon cultivars produce fruit of 20 pounds or more. The per capita consumption of watermelon in the U.S. increased by approximately 28% between 1977 and 1995. The market trend may be toward smaller-fruited cultivars due to demographic changes in the population (smaller family size, a higher proportion of older citizens). Seedless (triploid) watermelons have taken over the market in Israel and they continue to take a larger share of the U.S. market. New triploid varieties have been introduced with improved disease resistance and better quality than diploid varieties.

The germplasm base in watermelon is actually quite narrow. Sources of resistance to diseases and must be identified and the germplasm enhanced before incorporating these traits into horticulturally acceptable cultivars. Interviews with growers indicate the top two germplasm evaluation priorities should be sources of resistance to aphid transmitted viruses and watermelon fruit blotch.
these and other priorities are listed in Table 1.

IV. GERMPLASM

A. Collection

The watermelon germplasm collection at the Plant Genetic Resources Unit in Griffin, Georgia is given in Table 2. In addition to these, more than 300 cultivars are stored at the National Seed Storage Laboratory in Colorado. Many previous increases at the Griffin unit were from open pollinations and purity of these lines is suspect. In rare instances, PIs were increased in isolation.

Between 1988 and 1993 a limited number of PIs were increased through a cooperative agreement with Auburn university. During this six year period 371 PIs were increased at a cost of approximately $250/PI. In 1992, a plan was proposed to increase the seed in the People's Republic of China. Although the cost per accession to increase seed in the PRC was low, the agreement was not formalized for various reasons including concerns for the phytosanitary status of the materials on their return to the U.S. A general review of the collection is in Table 3.

A small watermelon genetic stock collection is maintained at Clemson University. This collection is not backed up in Griffin. In 1993, 1000 previously open-pollinated *C. lanatus* PIs were tested for germination. Average germination was >85%. More than 50% of the collection requires NSSL backup. NSSL maintains a collection of approximately 300 heirloom varieties not duplicated at Griffin, many of which require increase.

About 9% of the *Citrullus* collection exists as original seed only, although viability and germination of these seeds is not known (Table 4). Approximately 1/2 (461) of the watermelon original seed samples are more than 20 years old! Original seed of 916 watermelon is maintained in Griffin.

The descriptors used by the Genetic Resources Conservation Unit are shown in Table 5. To date, limited information is available in GRIN, with almost no information on disease evaluation (there is probably information on disease resistance that has not been submitted) . Thus, the researcher has limited information from which to choose accessions to meet a specific demand.

At the present time, new collection trips appear unwarranted. The germplasm collection can expand greatly if extant collections from other countries are obtained through request and /or exchange, and plant breeders place their undocumented lines, which were obtained through personal contacts, into the system. Finally, until the present accessions are evaluated, specific watermelon germplasm needs are unknown.

B. Evaluation

Simply more effort is needed in evaluation of the present collection. Data for horticulturally important characteristics or sources of different resistance is incomplete. These can be evaluated much more efficiently by specific researchers than by the Plant Genetic Resources Unit staff.

The lack of information from sources, plus the lack of a CCGC approved format for placing information in the system, has perhaps led to the rather low request rate for watermelon germplasm. From 1980 to 1988, 2,459 seed samples of watermelon PIs have been distributed (1,155 domestic requests, 1,304 international requests). This is low compared to other major collections, and no doubt more requests would be received if more disease evaluation data were available and in the system. To this end, the watermelon disease and nematode descriptor list Table 6, compiled by workers from South Carolina, Texas, Florida, California, and Alabama should be evaluated for possible inclusion in GRIN.

C. Enhancement

Evaluation and enhancement go hand-in-hand. Once desirable traits are identified, they should be bred into horticulturally acceptable breeding lines adapted to the various production areas.

D. Preservation

The seed storage facilities are good but personnel are limited for the evaluation and maintenance. However, the status of the seed is difficult to evaluate since few requests are received. In addition, it should be emphasized that seed should be increased by controlled sib pollinations within isolated plots.

At the present time, watermelon genetic stocks, with the exception of a few tetraploids, are not included in the Plant Genetic Resources system. These should be added to the collections. and should include mutants, aneuploids, and polyploids. These will have special requirements for seed increase which must be noted and followed.

V. RECOMMENDATIONS

1. Provide funds for the evaluation of the PIs, for both non-economic and economic traits.

2. Evaluate the descriptor lists and submit a re-evaluated CCGC approved list to GRIN.

3. Obtain undocumented lines from U.S. and world collections.

4. Add genetic stocks to the PI collections.

5. Seed increase should be by controlled sib pollinations only.

6. The NSSL should not include hybrids if the parent material is already in the system.

7. GRIN should provide the CCGC with an annual evaluation of the status of the watermelon plant introductions.

Table 1. Priorities for watermelon germplasm evaluation proposals.

Rank	Priority area
1	Watermelon fruit blotch
2	Fusarium wilt
3	Gummy stem blight
4	Anthracnose, race 2
5	Downy mildew
6	Herbicides
7	Ozone/pollution injury
8	Squash bugs
9	Ice box watermelons
10	Nematodes

Table 2. Accessions at the Plant Genetic Resources Conservation Unit, Griffin, GA.

Species	Country of origin	Number of accessions
Citrullus colocynthis		
	Afghanistan	2
	Algeria	1
	Cyprus	1
	Egypt	4
	Ethiopia	1
	Iran	9
	Morocco	1
	Namibia	1
Citrullus ecirrhosus	Swaziland	1
Citrullus lanatus	Afghanistan	2
	Algeria	2
	Argentina	1
	Australia	1
	Belize	6
	Bolivia	1
	Botswanna	20
	Brazil	2
	Bulgaria	1
	Cameroon	2
	Chad	4
	Chile	2
	China	28
	Cuba	1
	Egypt	5
	continued	
	El Salvador	1
	Ethiopia	10
	Former Soviet Union	27
	Ghana	14
	Guatemala	4

(continued)

Table 2. Continued

Species	Country of origin	Number of accessions
	Honduras	1
	Hungary	13
	India	124
	Indonesia	4
	Iran	31
	Iraq	3
	Israel	7
	Italy	3
	Japan	16
	Jordan	2
	Kenya	3
	Korea, South	7
	Lebanon	9
	Liberia	3
	Maldives	18
	Mali	2
	Mauritania	1
	Mexico	8
	Moldova	1
	Namibia	1
	New Zealand	1
	Nigeria	51
	Oman	1
	Pakistan	22
	Paraquay	3
	Philippines	8
	Portugal	2
	Russian Federation	1
	Senegal	11
	Singapore	1
	Somalia	8
	South Africa	35
	Spain	76
	Sudan	7
	Swaziland	4

(continued)

Table 2. Continued

Species	Country of origin	Number of accessions
	Syria	6
	Taiwan	1
	Tunisia	2
	Turkey	309
	Ukraine	2
	United States	9
	Uruguay	1
	Uzbekistan	5
	Venezuela	7
	Yugoslavia	191
	Zaire	15
	Zambia	68
	Zimbabwe	147
Citrullus lanatus var. *citroides*	China	3
Citrullus lanatus var. *lanatus*	Egypt	13
	Mexico	1
	Syria	22
	Uzbekistan	1
Citrullus sp.	Bolivia	3
	China	1
	Former Soviet Union	1
	Mali	10
	Pakistan	1
	Russian Federation	1
	South Africa	7
	Turkmenistan	1
	United States	4

Sum		1506
Praecitrullus fistulosus	India	27
	Pakistan	3
	Unknown	2

Sum		32

Table 3. Watermelon Collection Specifics

Total *Citrullus* spp.	1852
Number of related genera	1
Total number of species	3
C. lanatus	1,444/1,274a
Unidentified	28 (<2%)b
Original seed only (*C. Lanatus*)	114 (7.5%)b
Original seed only (crop group)	141 (9%)b
Distributions	644c
PIs increased/yr. Griffin	1d
PIs backed-up at NSSL	719
PIs not backed-up at NSSL	812
% of PIs backed-up at NSSL	47
PIs held at NSSL only	352

a Total no. per no. available, Griffin only
b % of total
c Total since 11/92
d 1988 to 1993, open pollination

Table 4. Age distribution of original seed samples of watermelon that are more than 20 years old, stored in Griffin.

Date of entry	#PIs
1934	1
1935	1
1948	3
1949	11
1950	5
1951	1
1954	1
1955	1
1958	12
1959	12
1960	13
1961	49
1962	91
1963	4
1964	14
1965	9
1966	4
1967	1
1968	2
1969	11
1970	90
1971	37
1972	35
1973	40
1974	13

Table 5. The current descriptor format used by the Plant Genetic Resources conservation Unit for *Citrullus* introductions.

Descriptor	Interpretation and abbreviations
Genus	CTRL, *Citrullus*
Species	COLCYN, *Colocynthis*. LANTUS, *lanatus*. SP, unspecified species.
Source	AFGH, Afghanistan. ALGE, Algeria. ARGN, Argentina. CH C, China. CH T, Taiwan. CO LE, Zaire. ELSAL, El Salvador. FWAFR, Senegal. ETHI, Ethiopia. GRECE, Greece. GUAT,Guatemala. HOND, Honduras. ISRL, Israel. JORDN, Jordan. LEBN, Lebanon. LIBR, Liberia. MEX, Mexico. NIGIA, Nigeria. N Z, New Zealand. PAK W, Pakistan. PHIL, Philippines. PORT, Portugal. RHOD, Rhodesia. S AFR, South Africa. SENGL, Senegal. SOMAL, Somalia. SWAFR, Southwest Africa. THAI, Thailand. TURKY, Turkey. UAR, United Arab Republic. URUG, Uruguay. VENEZ, Venezuela. YUGO, Yugoslavia.
Maturity	1, early. 5, mid-season. 8, late.
Fruit shape	1, round. 2, oblate. 3, oblong. 4, elongate. 9, variable.
Rind color pattern	1, solid. 2, striped. 3, variable.
Rind stripe color	1, light green. 2, medium green. 3, dark green. 4, white. 5, yellow. 6, brown. 9, variable.
Rind background color	Same as above.
Flesh color	1, red; 2, pink; 3, yellow; 4, white; 9, variable.

(continued)

Table 5. Continued.

Descriptor	Interpretation and abbreviations
Antrhacnosez	1, resistant to 9, susceptible.
Powdery mildewy	1, resistant to 9, susceptible.
Downy mildewx	1, resistant to 9, susceptible.
Downy mildeww	2, moderately resistant; 3, susceptible; 4, severely diseased.
Cercospora leaf spotv	1, resistant to 9, susceptible.
Gummy Stem Blightu	1, resistant to 9, susceptible.
Anthracnose R-2t	1, resistant to 9, susceptible.
Verticillium wilts	1, resistant to 9, susceptible.
Seedling blightr	1, resistant. 9, susceptible.

z Incited by *Colletotrichum lagenarium* (Pass.) Ell. & Halst.; race unknown.
y Incited by *Odium* sp.
x Preliminary results of screening for resistance to *Pseudoperonospora cubensis* (Berk. & Curt.) Rostow. in the greenhouse or field at Experiment, GA.
w Winstead et al. 1975. Plant Disease Reporter 41:620-622.
v Incited by *Cercospora citrullina* Cke.
u Incited by *Mycosphaerella citrullina* (C.O. Sm.) Gross. Reaction reported by Sowell and Pointer (Plant Disease Reporter 46:883-885. 1962) and Sowell (Plant Disease Reporter 59:413-415. 1975).
t Reaction to *Colletotrichum lagenarium* (Pass.) Ell. & Halst. Race 2 in North Carolina through PI No. 222714 (Winstead et al. 1959. Plant Disease Reporter 43:570-577 and at Experiment, GA (Grover Sowell, Jr.).
s Incited by *Verticillium dahliae* Kleb. Reported by C.B. Skotland, Washington State University, Prosser, WA.
r Incited by *Pseudomonas pseudoalkaligenes* ssp. *cirulli* . Schaad et al. Determined in greenhouse screening tests at Experiment, GA (Grover Sowell, Jr.)

Table 6. Proposed watermelon disease and nematode descriptor list.

Category	Organism
Fungi	*Alternaria cucumerina* (Ell. & Ev.) J.A. Elliot: Alternaria leaf blight
	Botryosphaeria quercum (Schw.) Sacc.:Stem-end rot
	Cercospora citrullina Cke.: Cercospora leaf spot
	Cladosporium lagenarium All. & Arth.: scab
	Colletotrichum obiculare (Berk. & Mont.) Arx. = *C. lagenarium*: Anthracnose Race not specified for data without race designation Race I, Race II, Race III
	Corynespora cassicola (Berk. & Curt.) Wei: Target leaf spot, blotch
	Cylindricladium scoparium Morgan: Fruit rot
	Didymella bryoniae (Anersw.) Rehm = *Mycosphaerella citrullina* (C.O. Smith) Gross: Gummy stem blight
	Lasiodiplodia theobromae (Pat.) Griffon & Manbl. = *Diplodia natalensis* P. Evans: Stem-end rot, gray spot
	Erisiphe cichoracearum DC.: Powdery mildew [? *Sphaerotheca fuliginea* Schlect.) Poll.]
	Fusarium oxysporum (Schlect.) f. sp. *niveum* (E.F. Sm.) Snyd. & Hans.: Fusarium wilt. Race not specified for data without race designation. Race 0 - common U.S. race; Race 1 - more aggressive U.S. race--maybe a geographic strain of Race 0. Race 2 - originally restricted to the Mediterranean basin
	Fusarium sp.: market rind rots
	Macrophomia phaseolina (Maubl.) Ashby: Charcoal stem rot
	Phymatotrichum omnivorum (Shear) Dug: Root rot
	Phytophthora sp.: fruit and stem rot
	Pseudoperonospora cubensis (Berk. & Curt.) Rostow: Downy mildew
	Pythium spp.: Damping off, fruit rot, seedling blight
	Rhizoctonia solani Kuhn: Damping off, seedling blights, fruit rot

(continued)

Table 6. Continued.

Category	Organism
	Sclerotium rolfsii Sacc.: Southern blight
	Thielaviopsis basicola: Root rot
	Verticillium albo-atrum Reinke & Berth.: Verticillium wilt
Bacteria	*Acidovorax avenae* subsp. *citrulli* (Schaad et al.) Willems et al. = *Pseudomonas pseudoalcoligenes* subsp. *citrulli*: Bacterial fruit blotch
	Erwinia carotovora subsp. *carotovora* (Jones) Bergey et al.: Soft rot
	Erwinia sp.: Bacterial rind necrosis (identity and pathogenicity not fully determined)
	Erwinia tracheiphila (E.F. Sm.) Holland: Bacterial wilt. This has been reported but watermelon is generally considered resistant.
	Pseudomonas syringae (E.F. Sm.) pv *lachrymans*: Angular leaf spot
Viruses	Beet curly top virus
	Cucumber mosaic virus
	Squash mosaic virus
	Tobacco ringspot virus
	Papaya ringspot virus, watermelon strain (WMV I)
	Watermelon mosaic virus (WMV II)
	Zucchini yellow mosaic virus
Nematodes	*Meloidogyne incognita* (Kofoid & White) Chitwood: Root knot
	Meloidogyne javanica (Treub) Chitwoo: Root knot
	Meloidogyne arenaria (Neal) Chitwood: Root knot
	Pratylenchus spp.: Lesion
	Rotylenchus reniformis Linford & Oliveira: Reniform
Unknown	Yellow vine disease