Melon

Cucumis melo L.

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I Introduction

Melons are a diverse group of fresh, dessert fruits that includes the orange flesh cantaloupes, the green flesh honeydew, and the mixed melons (Casaba, Crenshaw, Persian, Santa Claus, Juan Canari). In 1984, there were approximately 97,673 acres of cantaloupes reported in the U.S. California, Texas and Arizona accounted for approximately 71%, 20% and 9% of the reported cantaloupe acreage, respectively. The remaining portion of the reported cantaloupe acreage was distributed in Colorado, Georgia, Indiana, Michigan, New York, and South Carolina. California, Texas and Arizona accounted for 100% of the reported honeydew acreage in 1984. California accounted for most of the acreage of the mixed melons grown in the U.S. Total value of the 1981 melon crop excluding the mixed melons was 239.1 million dollars. Some cantaloupe and honeydew melons are exported from California to the Far East, but volume estimates are not available.

Melons add flavor, aroma, color and variety to the American diet. Melon fruit are not important dietary sources of calories (carbohydrates, fats) or protein. They are, however, high in Vitamin C (ascorbic acid) and Vitamin A. One quarter of a cantaloupe provides approximately 100% of the U.S. Recommended Daily Dietary Allowance (RDA) of Vit. C for infants, children and adults. The same amount of cantaloupe also provides from 77% (for lactating women) to 330% (for infants) of the U.S. RDA for Vit. A. The oil content of melon seeds is approximately 50% by weight which compares favorably with conventional oilseed crops. Protein content of oil-free seed kernels ranges from 60 to 70%.

II. Present Germplasm Activities

Each State and Federal project actively engaged in germplasm activities is included in the following alphabetical listing. Commercial melon breeders, in general, use germplasm that has been enhanced by public scientists and are, therefore, not included in this listing. Melon germplasm is maintained at the USDA, ARS, Regional Plant Introduction Station, Ames, Iowa.

Alabama

Auburn University

Joseph D. Norton
Department of Horticulture, Auburn University, Auburn, AL 36849
(205) 826-4862. Activities: Breeding for horticultural type and adaptability to southeastern U.S., and resistance to alternaria, anthracnose, gummy stem blight, Fusarium wilt, root knot nematode. Some biotechnological activities.

Arizona

University of Arizona

Dennis Ray
Department of Plant Sciences, University of Arizona, Tucson, AZ 85721
(520) 621-7612 . Activities: basic genetics and cytogenetics.

California

USDA, ARS, Salinas

James D. McCreight
USDA, ARS, Vegetable Production Research Unit, 1636 East Alisal St., Salinas, CA

93905. (408) 755-2864. Activities: Breeding for horticultural type and adaptability , and resistance to lettuce infectious yellows virus, cucumber mosaic virus, papaya ringspot virus, watermelon mosaic virus, zucchini yellow mosaic virus, powdery mildew, and insects. Genetic and linkage studies of novel vegetative and reproductive characters.

Florida

University of Florida, Leesburg

Vacant

University of Florida, Agricultural Research Center, P.O. Box 388, Leesburg, FL 32749. (904) 787-3423. Activities: Breeding for horticultural quality and adaptability to Florida, disease and insect resistance.

Kentucky

University of Kentucky

Dean E. Knavel

Horticulture Department, University of Kentucky, Lexington, KY 40546. (606) 257-8900. Activities: Analyses of growth and yield potential of short-internode plant types.

Maryland

University of Maryland, College Park

Timothy J Ng

Department of Horticulture, University of Maryland, College Park 20742. (301) 454-2463. Activities: Breeding for horticultural type and adaptability to Mid-Atlantic area, and resistance to Fusarium wilt. Ripening physiology; seed viability and vigor.

New York

Cornell University

Molly M. Kyle

Department of Plant Breeding and Biometry, Cornell University, Ithaca, NY 14853. (607) 255-8147. Activities: Breeding for horticultural type and adaptability to New York, resistance to cucumber mosaic virus, papaya ringspot virus, watermelon mosaic virus, zucchini yellow mosaic virus, powdery mildew, Fusarium wilt, sudden wilt, and monoecious sex expression.

Cornell University

Henry M. Munger

Department of Plant Breeding and Biometry, Cornell University, Ithaca, NY 14853. (607) 255-1661. Activities: Breeding for horticultural type and adaptability to New York, resistance to cucumber mosaic virus, papaya ringspot virus, watermelon mosaic virus, zucchini yellow mosaic virus, powdery mildew, Fusarium wilt, sudden wilt, and monoecious sex expression.

New York State Agricultural Experiment Station

Rosario Provvidenti (Retired)

Department of Plant Pathology, New York State Agricultural Experiment Station, Geneva, NY 14456. (315) 787-3216. Activities: Find sources and determine the nature of resistance to virus diseases.

South Carolina

USDA, ARS

Perry E. Nugent

U. S. Vegetable Laboratory, 2875 Savannah Highway, Charleston, SC 29407. (803) 556-0840. Activities: Breeding for horticultural type and adaptability to southeastern U.S., resistance to downy mildew, powdery mildew, anthracnose, gummy stem blight, Fusarium wilt, Verticillium wilt, root knot nematode, pickleworm, cucumber beetles, melon aphid, and genetic studies of marker genes and male sterility.

USDA, ARS

Claude E. Thomas

U. S. Vegetable Laboratory, 2875 Savannah Highway,Charleston, SC 29407. (803) 556-0840. Activities: Nature, mechanisms, and inheritance of resistance to downy mildew, powdery mildew, and Alternaria leaf blight.

Texas

Texas A&M University

David L. Wolff

Texas Agricultural Experiment Station, 2415 Highway 83, Weslaco, TX 78596. (512) 968-5585. Activities: Breeding for horticultural type and adaptability to Texas, and resistance to downymildew, powdery mildew,alternaria, anthracnose, gummy stem blight, charcoal rot, Fusarium wilt

III. Vulnerability

A. Status and Risks

It is impossible to provide a definitive statement regarding the genetic vulnerability of melon and its relationship to genetic diversity (as indicated by different types of cantaloupes, honeydew, and the mixed melons) of melon cultivars grown in the U.S. The 1972 National Academy of Sciences report Genetic Vulnerability of Major Crops suggested that a potential vulnerability exists in the orange flesh cantaloupes grown in the western U.S. because "All cytoplasm in western United States varieties of cantaloupe trace back to the variety 'Hales Best'." This statement is misleading for two reasons.

First, the two major varieties grown in California and Arizona are 'PMR 45' and 'Topmark'. 'Hale's Best' was one of the two parents of 'PMR 45'. Because it was developed by a commercial seed company, the pedigree of 'Topmark' is not known although it is likely that 'Hale's Best' is in its pedigree. With two exceptions, both of these cultivars are susceptible to every major disease of melon. 'PMR 45' is resistant to powdery mildew race 1 and 'Topmark' is "tolerant" of papaya ringspot virus and watermelon mosaic virus. Thus, the major western cultivars have been, are, and will be vulnerable. Second, the term 'cytoplasm' suggests that the supposed potential vulnerability of the western U.S. cantaloupe cultivars is analogous to the Texas male-sterile cytoplasm situation in corn. There is a fundamental difference between the contribution of a single progenitor to the pedigree of widely used cultivars and the methodical incorporation of the cytoplasm from a single progenitor into every available cultivar.

Temporal and spatial isolation of melon production areas around the U.S. minimizes the probability of complete loss of melon production in any given year. Local or regional epidemics may, however, be severe and may result in serious financial losses. Because the major melon production areas are isolated from each other, the disease and insect complex in each area is unique. There are not any cultivars that are resistant to the entire disease and insect complex in the areas in which they are grown.

Two, possibly three, diseases of melon occur in every production area. These are powdery mildew, and zucchini yellow mosaic virus. Three races of the powdery mildew pathogen are known, and one or more of the races may be present in a given area. Powdery mildew is, however, rarely yield-limiting in the U.S. Zucchini yellow mosaic virus can completely destroy melon fields. Losses to zucchini yellow mosaic virus vary yearly.

Cucumber mosaic virus is a potentially widespread pathogen that may be unrecognized at present in areas were papaya ringspot virus, watermelon mosaic virus and zucchini yellow mosaic virus occur. In cucumber, the introduction of cucumber mosaic virus resistant cultivars revealed the extent of the damage done by this virus. Since cucumber mosaic virus resistance has become almost a requirement for new cucumber varieties in most of the U.S., it is logical to think that this virus is a problem on melons as well.

B. Future Outlook and Needs to Reduce Genetic Vulnerability

Sources of resistance to most diseases of melon are known, except for watermelon mosaic virus and squash mosaic, the latter important because of being seedborne. For these diseases, it will take time for breeders to incorporate known resistance into adapted, horticulturally acceptable cultivars. These efforts may first require emphasis on germplasm enhancement prior to incorporation into horticulturally acceptable cultivars. For some diseases, the available resistance may not provide sufficient protection in all situations. For these diseases, additional sources of resistance are needed. Resistance to watermelon mosaic virus and additional sources of resistance to zucchini yellow mosaic virus are of the utmost priority. Sources of lettuce infectious yellow virus,nematode and air pollution injury resistances and salt tolerance are needed.

IV Germplasm Needs

A. Collection

The U.S. Regional Plant Introduction Station, Ames, Iowa. currently lists 2,339 accessions in its melon inventory. Not all of these accessions are, however, *C. melo* (see Table 1); 20 other species are also listed. In addition, the collection has 74 accessions labeled *Cucumis* sp. which may include some *C. melo* or *C. metuliferous* accessions.

In terms of seed stocks, the status of the *C. melo* accessions is uncertain. Stocks of 6% of the accessions consist solely of the originally received seeds. Stocks of another 92% of the accessions consist of the originally received seeds and seeds from one or more open-pollinated increases by the Plant Introduction Station. Andromonoecious melons are probably fairly representative of the original collection after one open-pollinated generation, but monoecious ones will have largely lost their identity. It is extremely urgent that increases of originally received seeds be made with controlled pollination. Less than 1% of the accessions consist solely of increased seed. Approximately 1% of the accessions are reduced to one last seed packet. Significantly, seed stocks of less than 0.5% of the accessions are completely exhausted.

Africa has been generally regarded as the center of origin of *C. melo*, while India has been considered an important center of diversification. Strong viewpoints and arguments on African versus Indian origin are moot in light of continental drift. Southeastern Africa and peninsular India were likely continuous or contiguous. Regardless, 18% of the *C. melo* germplasm collection is from India while less than 5% is from Africa (Table 2). It should be noted that 67% of the collection is from the Asian sub-continent. Examinations of the accessions from Africa show that approximately 60% (approximately 3% of the total collection) of them are from eastern and southeastern Africa; the remainder are from northern and western Africa.

Future explorations for *C. melo* germplasm should be directed towards eastern and southeastern Africa. Additional collections from India are, however, also desired because germplasm from India is diverse, and has been an important source of genes for disease and insect resistance, as well as other traits. Opportunities for germplasm exploration in all parts of Asia are desirable. The rapid rate of modernization in India warrants collections there in the near future. India does have a functional germplasm system. Thus, it may be possible to acquire new collections from India via exchange.

B. Evaluation

The descriptors of vegetative and fruit characteristics used at present do not adequately fulfill the requirements of currently conceived ideas for their function: to characterize easily evaluated traits which are stable over a range of environments. The information recorded for each trait is from a standard set of alternatives and indicates whether the accession is homogeneous. Thus, the currently used set of nine descriptors must be changed; the revised set will likely ignore five of the nine in current use (Table 3).

Beyond the basic six descriptors, *C. melo* germplasm is evaluated for other traits on a project basis as determined by the interests of the research scientists conducting the research. With a few exceptions, an intensive program for evaluation of the entire collection for resistance to one or more of the important pests is not warranted for two reasons. First, sources of resistance to virtually every major disease are known. This does not mean that scientists will not or should not look for additional sources of resistance. Second, the collection is large enough so that such an evaluation would hinder research and breeding necessary to incorporate currently available sources of resistance into adapted cultivars and breeding lines.

Resistance to watermelon mosaic virus is needed for production in Florida, Arizona, and southern California. Resistance to lettuce infectious yellows virus and squash leaf curl virus are needed for production in Arizona and southern California.

C. Enhancement

With the exception of watermelon mosaic virus, lettuce infectious yellows and squash leaf curl, resistance to most important diseases is available, but the the sources in which they occur are horticulturally undesirable. Effort is, therefore, needed to transfer these genes into horticulturally acceptable breeding lines and cultivars that are adapted to the different production areas of the U. S.

The relationship between evaluation and enhancement is dynamic. These two areas of germplasm activities are complementary to each other in research programs to determine the genetic, biochemical, pathological, and physiological bases for the traits of interest. The research programs are the cornerstone of melon improvement. Together, evaluation, research, and enhancement activities comprise the processes of crop improvement and knowledge development.

D. Preservation (storage)

Melon accessions are held by numerous collections around the world (Table 4). Some, such as those at the Regional Plant Introduction Stations and the National Seed Storage Laboratory, are highly structured and documented. Others are less formal collections for research purposes and consist of samples acquired from national or international collections, and through personal exchange with scientists throughout the world. Samples acquired through personal contact are often important and are used in crop improvement, but they are often not documented or represented in the NPGS base collection or RPIS working collection.

The number of unique, undocumented accessions from Africa or the Asian sub-continent in the U.S. could be equivalent to 10-20% of the collection at Ames, Iowa. There is not any system for soliciting submission of undocumented collections to the melon collection at Ames, Iowa.

It is of interest to note that according to the IBPGR report Genetic Resources of the Cucurbitaceae there are three melon collections in the NPGS: the two Regional Plant Introduction Stations at Experiment, Georgia and Geneva, New York, and the NSSL. It is prudent to have redundancy in case of catastrophic loss at the primary repository. The extent of duplication at these three repositories is not known. Current NPGS policy requires NSSL to fully duplicate collections RPIS collections.

Facilities at the Regional Plant Introduction Stations are suitable for long-term storage of Cucurbit seeds. Storage conditions are 38°F (3.3°C) and 40% relative humidity.

V. Recommendations

A. Priority of Actions

1. Acquisition of all undocumented germplasm from foreign sources that is presently held by U.S. public and private scientists. Solicitation can partly be accomplished via the annual Cucurbit Genetics Cooperative Report.
2. Preservation of the identity and integrity of germplasm in the NPGS as it is increased and maintained over the years. This is the responsibility of the NPGS with advice from the CAC.
3. Collection of additional germplasm from Africa and India.

4. Insure a reliable GRIN database for retrieving information about the best, known sources of important characters. The information in the database must be reliable, comprehensive and frequently updated so that the full potential of the database can be realized.
5. Correct species identification for all PI's.

B. Level of Support

Permanent support for the Regional Plant Introduction Station, Ames, Iowa and the National Seed Storage Laboratory for maintenance and testing. The total amount necessary for both locations is approximately $95,000 per annum· The responsibilities of these positions would likely include other cucurbits and/or other crops, thus the amount directly attributable to melon would be reduced accordingly.

1. Ames
   a. One, GS-9 Agricultural Research Technician, including benefits 29,2000
   b. One, GS-4 Agricultural Research Technician, including benefits 17,300
   c. Four, GS-1 Biological Aids, temporary (3 months during the summer), including benefits 12,600
   d. Equipment and supplies 11,800

   sub-total 70,900

2. National Seed Storage Laboratory
   a. One, GS-4 Agricultural Research Technician, including benefits17,300
   b. Equipment and supplies 7,000

   sub-total 24,300

Total 95,200

Table 1. Summary of the status of seed stocks of Cucumis melo, C. metuliferous and Cucumis sp. accessions at the U.S. Regional Plant Introduction Station, Experiment, Georgia.

Species	Number of accessions	Status[z]					
		1	2	3	4	5	6
melo	2121	17	116	1963	7	17	1
metuliferous	33	1	21	3	0	9	0
Cucumis sp.	74	3	65	2	1	1	0
21 other sp.	111						

[z]Status:
1 = increased seed only;
2 = original seed only;
3 = original and increased seed;
4 = seed supply exhausted;
5 = original seed only - last packet;
6 = increased seed only - last packet.

Table 2. Origin of Cucumis melo accessions at the U. S. Regional Plant Introduction Station, Ames, Iowa.

Continent	Number of accessions	Country	Number of accessions
Africa	100	Algeria	10
		Egypt	14
		Ethiopia	1
		Kenya	2
		Mali	2
		Morocco	1
		Niger	1
		Senegal	7
		Sierre Leone	1
		South Africa	5
		Zambia	14
		Zimbabwe	42
Asia	1556	Afghanistan	361
		Burma	6
		India	391
		Indonesia	2
		Iran	279
		Iraq	7
		Israel	33
		Japan	34
		Korea	3
		Lebanon	2
		Pakistan	20
		China (PRC)	33
		Saudia Arabia	3
		Syria	12
		Thailand	1
		Turkey	312
		USSR	57
Australia	2	Australia	2
Europe	295	Belgium	2
		Czechoslovakia	2
		Cyprus	3
		Finland	1
		France	6

Germany	3
Great Britain	1

(continued on next page)

Table 2. (cont.)

Continent	Number of accessions	Country	Number of accessions
		Greece	19
		Hungary	1
		Netherlands	2
		Poland	1
		Portugal	1
		Spain	134
		Switzerland	1
		Yugoslavia	118
North America	137	Canada	49
		Cuba	2
		Dominican Republic	1
		El Salvador	6
		Haiti	1
		Mexico	18
		USA	60
South America	12	Argentina	1
		Brazil	2
		Colombia	3
		Ecuador	3
		Paraguay	1
		Peru	2

Table 3. Melon descriptors previously developed and currently used by the U.S. Plant Introduction Station, Ames, Iowa, and the set proposed by the Vine Crops Crop Advisory Committee in 1986 for future use

Current	Future
	sex type
	slip or non-slip at maturity
days to maturity	
fruit shape	
fruit length	fruit length
fruit diameter	fruit diameter
fruit surface	fruit surface
mature fruit color	
flesh thickness	
flesh color	flesh color
flesh taste	
	100 seed weight

Table 4. Germplasm collections of Cucumis melo.[z]

Continent	Number of collections	Country	Number of collections
Africa	31	South Africa	31
Asia	4433	India	433
		Japan	122
		Pakistan	10[x]
		Turkey	92
		USSR	3776
Europe	1580[y]	Bulgaria	156
		Czechoslovakia	2
		France	240
		Germany	133
		Hungary	148
		Netherlands	325
		Poland	U[w]
		Spain	568
North America	3493[y]	USA	3491[v]
		Costa Rica	2
South America	Peru	22	

[z]From Table 8 in IBPGR. 1983. Genetic Resources of Cucurbitaceae.
[y]Does not include those from collections of unknown size.
[x]Wild species.
[w]U = Unknown number of accessions.
[v]Includes collections having an unknown number of accessions, wild species, or mutants.