NCRPIS Annual Report-2003
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**NORTH CENTRAL REGIONAL PLANT INTRODUCTION STATION**
**NC-7 ANNUAL REPORT, JANUARY 1 - DECEMBER 31, 2003**

**I. PROJECT TITLE: NC-7 "Plant Germplasm and Information Management and Utilization"**

**II. COOPERATING AGENCIES AND PRINCIPAL LEADERS:**

**A.** **Administrative Advisor** *C.E.O. Woteki, Iowa
**B.** **Regional Coordinator** *C.A. Gardner, Iowa
**C.** **State Experiment Stations Representatives**

| | | | | | |
|---|---|---|---|---|---|
| 1. | Illinois | *T. Hymowitz | 7. Missouri | *D. Sleper |
| 2. | Indiana | *J. Janick | 8. Nebraska | *D. Baltensperger |
| 3. | Iowa | *C. Brummer | 9. N. Dakota | *B. Johnson |
| 4. | Kansas | *C. Rife | 10. Ohio | *D. Francis |
| 5. | Michigan | *A. Iezzoni | 11. S. Dakota | *A. Boe, Chmn. |
| 6. | Minnesota | *S. Hokanson | 12. Wisconsin | *W. Tracy |

*Voting members

**D.** **U. S. Department of Agriculture**

| | | |
|---|---|---|
| 1. | ARS National Program Staff, Germplasm | *P. Bretting |
| 2. | ARS Plant Exchange Office | *E. Garvey |
| 3. | ARS Area Director, Midwest Area | A. Hewings |
| 4. | Cooperative State Research, Education, and Extension Service | A. Thro |
| 5. | Natural Resources Conservation Service | |
| 6. | National Center for Agric. Util. Research | *T. Isbell |
| 7. | National Center for Genetic Resources Preservation | *H. Shands |

**E.** **North Central Regional Plant Introduction Station, Ames, Iowa**
See organizational chart, Appendix 1.

## III. PROGRESS OF WORK AND PRINCIPAL ACCOMPLISHMENTS:

Our mission focus continues to focus on acquisition, regeneration, characterization, evaluation, distribution, and documentation of associated information in a world where biological diversity is threatened by climatic, social, political and environmental pressures. Demand for genetic diversity continues to increase, as does the development of supporting technologies to increase the availability of plant genetic resources and associated information.

The year 2004 marks the 50th anniversary of the NC-7 Ornamental Trials, which will be celebrated at the METRIA conference. This represents significant, long-term contributions on the part of all NC-7 participants, past and present, which is worthy of appreciation and note.

Available resources are devoted to accomplishment of this mission, to securing the plant genetic resources entrusted to us and the safety of our staff, to modifying the processes which support their efforts, and to research designed to provide information which improves the value and utility of the collections and their quality. Work was initiated to bring the entire Operations Manual up to date, which is challenging due to rapidly advancing change driven by new learning and technologies. This is a key part of providing relevant reference and/or training materials that serve to guide our staff in daily decision-making and procedures, ensuring high standards and quality of operations.

***Personnel changes:***

Departures: Staff members who departed between January, 2003 and May, 2004 and do not appear on the chart include:
Brian Alt, USDA-ARS Agr. Res. Science Technician, GEM Project
Mary Arnold, USDA-ARS Biological Science Lab Technician
Mary Brothers, USDA-ARS Geneticist/Helianthus Curator
Rick Luhman. ISU Brassica Curator II and network administrator
Linda Minor, ISU Clerk for seed distribution (retired)
Jerry Scheuermann, ISU Field-Lab Technician II (retired)

Brent Werner, USDA-ARS LA Biological Science Laboratory Technician (Insects)
Lori Wilson-Voss, USDA-ARS Supervisory Program Assistant

Promotions:
Brian Alt, USDA-ARS GEM Agr. Res. Science Tech., from GS-7 to GS-8.
Larry Lockhart, from Farm Superintendent II to Program Manager II, a P18 level in ISU's Professional and Scientific System.
Cris Nass, USDA-ARS Office Automation Asst., from GS3 to GS4.
Dr. Mark Widrlechner, USDA-ARS Horticulturist, from GS13 to GS14 scientist.

New Hires (January, 2003 to May, 2004):
Barbara Bingaman, ISU Agricultural Research Specialist I, supporting the Cruciferae
Jeff Carstens, USDA-ARS Agri. Research Science Technician, Horticulture
Peter Cyr, USDA-ARS IT Specialist
Sam Flomo, ISU Agricultural Research Specialist I, supporting the Amaranth, umbel and other crops curation project.
Dr. Laura Marek, ISU Oilseeds Curator III
Dr. Joe-Ann McCoy, USDA-ARS Cat III Horticulturist, Medicinal/Nutriceuticals

Transition:
Lisa Pfiffner, previously USDA-ARS Agri. Res. Science Technician (Maize), now a Biological Science Technician position with the NCRPIS Seed Storage group.

Management of Federal STEP (Student Temporary Employees):
Significant progress was made in developing, establishing and refining protocols for hiring, training, and management student employees under this system. Credit for streamlining this goes to the supervisors of these students, to the administrative team including Larry Lockhart, Cris Nass, Stacey Winter, Lori Wilson-Voss, and to their ability to work effectively as a team.

***Construction and Facilities:***

Highlights include development of a new archival records room with a double density filing system, renovation of office spaces, installation of a keycard access security system. A tank delivery system was developed for storing syrup used to feed honeybee pollinators which eliminated storing and handling a large number of barrels and saving considerable space. Significant improvements were made to the entomology greenhouse's electrical systems, and to the dust collection systems used in seed processing areas.

The ISU Foundation sold 40 acres previously used by the NCRPIS. Adjacent land to the north of Mortensen Road has been provided for our use. South of Highway 30, the West Curtis farm has been designated for our future use. This land was previously used by weed science researchers, and ISU staff are working to reduce weed pressure in 2004.

***Equipment:***

New equipment acquisitions included two new JD 50 hp tractors, four vehicles, a cultivator and a seed treater. New IT systems acquired and implemented included a clustered server system and software, Altiris software for effective network management, and a new back up system called a JBOD (Just a Bunch of Discs). These acquisitions have significantly enhanced the success and security of our IT network operations, and the productivity and efficiency of general operations.

## IV. Progress in Germplasm and Information Management, Research and Education (C. Gardner)

(Part IV summarizes the accomplishments and progress presented in greater detail in the individual staff reports later in the document.)

***Acquisition:***

Over 450 accessions were newly acquired in 2003, including 231 maize accessions comprises of newly expired PVP and CSR-registered inbred lines, GEM lines, 172 lines from Major Goodman used in molecular marker studies, and sweet corn lines from Bill Tracy.

Woody ornamental acquisitions consisted of 119 accessions which included transfers from the National Arboretum, materials from Harold Pellet of Minnesota, and 44 newly collected native Iowa materials. The latter group's collection was funded by an NPGS exploration grant.

Over 30 accessions were acquired within Curator Dave Brenner's crop group, including new umbels and *Dalea* from Central Iowa, superior *Melilotus* material, and the first accession of *Eryngium foetidum*, a tropical spice species.

Within the oilseeds collections, most notable were 27 *Helianthus bolanderi* populations collected in California during 2002 by Gerald Seiler and Tom Gulya, and received by NPGS in 2003

Thirteen new vegetable accessions were received, including eleven accessions of old *Daucus* varieties from the National Center for Genetic Resources Preservation in Ft. Collins, CO following regeneration by cooperators. One accession of wild *Cichorium* from Poland and one accession of wild *Pastinaca* from Finland were acquired from seed indices.

***Regeneration and Maintenance:***
Over 1,500 accessions were grown for regeneration, with 1,376 harvested including 125 perennial ornamentals and wild sunflowers. Approximately 1,400 accessions were made available to the public. In addition to the traditional use of the Ames location, efforts were conducted at Parlier, CA, Davis, CA (Sakata Seeds), Puerto Rico and Hawaii (Monsanto, Syngenta, Pioneer Hi-Bred and Golden Harvest), Idaho (Seminis Seeds), and Oregon (Sunseeds). Use of contracted Golden Harvest nurseries in Puerto Rico enabled the maize curator to increase the number of regenerations in tropical locations while retaining his staff in Ames to achieve program objectives; this has been a very useful and productive partnership.

Our Entomology group continues to focus on improving methods for utilization of non-stinging pollinators such as *Osmia* and alfalfa leaf cutter bees. Their work has helped develop strategies for utilizing insect pollinators in greenhouse cage environments on crops such as *Cucumis* and *Pimpinella*, and provides a useful knowledge base for designing greenhouse facilities for controlled pollination regenerations. The number of field cages requiring pollinators in 2003 was lower than in past years due to the Brassica curation transition and spring losses due to weather and disease, requiring a total of approximately 680 caged pollinator units. *Cucurbita* regenerations were lost due to Squash Mosaic Virus infection, which is a major phytosanitary challenge.

NCGRP researchers in collaboration with our horticulturist successfully developed a system to store stem segments of *Salix* (willow) clones under cryogenic conditions. This will work has been accepted for publication.

Taxonomic re-identification was accomplished for 73 accessions; 442 accessions were assigned PI numbers. Over 760 accessions were backed up at the NCGRP in Ft. Collins, CO; currently, 76% of the accessions are backed up. Over 3,905 accessions were tested for viability, representing 8% of our holdings. In 2003, seed storage personnel stored 2,225 seed lots, including 232 original seed lots for long-term freezer storage.

***Distribution:***
Approximately 17,150 seed packets or plants were distributed in 740 orders to requestors. Approximately 75% of these were to U.S. requestors, and 25% to international requestors. The seed storage group continues to develop the

prepacking program which has been very successful in improving efficiency and speed for fulfilling requests. Research user requests continue to be targeted for specific accessions, traits and characteristics, and/or objectives.

***Evaluation and Characterization:***
Over 3,000 accessions were observed and characterized for a wide array of descriptor information; over 12,300 observations were transferred to GRIN from NCRPIS in 2003. Digital image capture continued to be a major area of focus, resulting in capture over 2,140 images.

The CGC-approved descriptor list for *Echinacea* was formatted for inclusion in the GRIN database. An extensive amount of information on ornamentals from the NC-7 Trials was received. Evaluations by public, private, and in-house researchers for maize disease and insect resistance included aflatoxin production and A. flavus growth, Diplodia ear rot, European Corn Borer, Western Corn Rootworm, Northern Corn leaf blight, Stewart's wilt, Eyespot, and Southern Rust (Brazil, Pioneer Hi-Bred). Data on 17 descriptors for *Cucumis* and *Cucurbita* were loaded to GRIN, as well as data for the first descriptors of Spinach (10 traits).

***Information management and computers:***
Noteworthy developments included implementation of a clustered server system (MS 2003 Server), a new JBOD backup system, and use of management software to facilitate network administration and system security. Staff involved in development work currently are using Oracle 9i, JDeveloper, and .NET systems to provide database tools and other enhancements. Protocols were developed for mass loading of data and images to GRIN; it is anticipated that in 2004 the mass-loading protocol will become automated, enabling a large amount of information to be posted to GRIN. Oracle Files software has been purchased for management of digital images, and will be implemented in 2004.

Efforts continue at the national level to link GRIN accessions to searchable PI accession numbers cited in literature; this would greatly enhance our curators' ability to associate useful information with the accessions, thus increasing their value to researchers.

***Testing germplasm's germination, viability and health:***
Over 3,900 accessions were tested for viability, representing approximately 8% of collection holdings. The viability testing group has made great strides in covering the backlog of needed testing, and has a systematic process of addressing this in the future. It is critical that resources remain adequate to ensure continued not only testing, but methods development for crops that lack testing protocols, and to update the lab itself. This will help ensure the security of the plant genetic resources for the future.

Our plant pathologist continues to conduct exciting, innovative research in the area of IMC-PCR, immuno-capture PCR, to improve our ability to detect seed infestation and provide materials which meet phytosanitary criteria and reduce the risk of spreading disease. Elisa testing for cucurbit viruses is a critical part of the regeneration process, as is treatment of Cucumis seed for Bacterial Fruit Blotch pathogens.

***Insect management:***
Efforts are focused primarily on improving our ability to utilize Osmia and alfalfa leaf cutter pollinators, to develop systems for use of insect pollinators in greenhouse environments, and to eliminate chalcid infestation of seed prior to distribution.

***Outreach and scholarship:***
Over 320 visitors toured the NCRPIS during 2003. Our staff participated in teching students, providing outreach events to civic and other organizations about

germplasm conservation and management, and the word done at the NCRPIS. The scientific and technical staff continue to publish scholarly journal articles and make presentations at scientific meetings, and to supervise graduate research programs.

**Current and future foci**:
Research foci include invasive species research, development of phytosanitary detection methods, insect pollinator programs, insect and pathogen control programs, and germplasm enhancement. In 2004, development of automated procedures for mass loading of digital and other information to GRIN is expected to be complete. Development of improved germination procedures and viability testing procedures will enhance the security of the plant genetic resources we hold.

## VII. SUPPORT TEAM REPORTS

### a. Farm (L. Lockhart, L. Crim, B. Buzzell,

We supervised and coordinated daily operations at the NCRPIS farm, including management of all facilities, fields, and greenhouse space. We supervised or conducted pesticide applications in the field and campus greenhouses. We responded to maintenance requests from staff members at the farm and the campus location. We selected, coordinated and scheduled the student labor force of 25.0 FTE's. We coordinated and completed facility construction and upgrades.

**Labor**:

During 2003, 156 applications for hourly employment were received and reviewed. There were 77 interviews, resulting in 66 hourly employees hired. Currently there are 42 Biological Science Aides (17.7 FTE) working at the NCRPIS. This year was the first full year of hiring temporary help as USDA employees. Protocols for hiring, training, and managing this process have been established and refined this year.

**NCRPIS Farm Crew:**

Larry Lockhart (Program manager II) has been on staff since 1985.
Larry was successfully promoted from Ag Station Superintendent to Program Manager II this year.

Lloyd Crim (Equipment Operator III) has been on staff since March 1998.

Brian Buzzell (Farm Mechanic) joined the staff in May 2002. Brian was successfully promoted from a Field Lab Tech II to a Farm Mechanic this past year.

**Maintenance projects:**

During the past year the farm staff initiated and completed several projects which enhanced the efficiency and safety of the station operations:

1) Completed remodeling of GEM tech office and work space.
2) Completed remodeling of the IT Specialist, Oilseeds Curator and Program Manager offices.
3) Planned, reviewed and coordinated key card access system installation. At this time the card access system is 75% complete.
4) Replaced headhouse windows and painted headhouse and storage garage.
5) Replaced main electrical panel in GH-1.
6) Installed set-back thermostats on all furnaces that did not already have them.
7) Completed installation of Archive Room files.
8) Prepared Emergency Disaster Kits and supplies.
9) Installed flexible dust collector arms in threshing room.

10) Designed and installed corn syrup tank delivery system.

**Purchasing:**

Larry Lockhart coordinated all purchasing for the NCRPIS farm: this task included gathering and summarizing requests, writing specifications, and obtaining supplies for the farm. Major purchases included the following:

1) Four vehicles.
2) A Polaris utility vehicle for general farm use.
3) Two 50 hp tractors to replace to 50 year old models.
4) Two row cultivator
5) Office furniture for remodeled areas
6) Seed Treater for GEM
7) Arc Welder
8) Commercial Dishwasher for washing corn syrup buckets
9) De-ionized water still for Entomology group
10) Cages for sunflower regeneration project in Parlier, CA
11) High Pressure Washer for shop

**Tours:**

This past year, we organized and conducted 21 tours. There were 320 visitors to the NCRPIS during 2003.

**Staff Training:**

We conducted two Tractor Safety training sessions and several Worker Protection Standard training sessions for the new student employees and existing staff.

**Future Plans:**

1) Lay out plots in new land area obtained from ISU
2) Add office area to shop/machinery building
3) Remodel and upgrade germination counting lab/curators office

**b. Computers and Telecommunications**

In July, 2003, Mark Millard (maize curator) assumed the duties of the acting NCRPIS IT Administrator following Rick Luhman's departure. During the 2003 period, he supervised a student intern, Jaryd Sunstrom. Mr. Sunstrom designed a clustered server system for our program; together with Mr. Millard, this system was implemented using MS Server 2003. They also converted to a JBOD backup system in order to resolve the technical issues with the previous tape drive system. Several computer systems were upgraded, and the first ruggedized tablet PC was purchased for use by Steve Hanlin, Entomologist. Other issues are discussed in Mark Millard's maize curation section and in Dave Kovach's following section.

**c. Seed Research and Computer Application Development (D. Kovach and M. Erickson)**

**Seed Research:**

During 2003, D. Kovach conducted additional experiments to develop effective methods for killing chalcid wasps that infest coriander seed without harming the seed. Infested seeds were subjected to a $CO_2/N_2$ modified atmosphere for 3 and 7 days or were stored above $LN_2$ for 18 hours. Germination tests were then conducted to verify that seed was not harmed by the various treatments. An experiment was also conducted to evaluate chalcid emergence from the seed.

This work has a two-fold purpose: 1) controlling the chalcid insect infestation that often occurs in coriander seed, and 2) finding a method that can be applied to other crops, as some seed cannot tolerate cryogenic treatments. Two years of study have shown that $LN_2$ treatments work very well with coriander. The modified atmosphere treatments did not provide effective control under the conditions tested. Further work using different atmospheres is being considered.

In another experiment, D. Kovach conducted a $GA_3$ rate study to test its effectiveness in breaking seed dormancy without harming germination of non-dormant seed in *Angelica*, *Cuphea*, and *Helianthus*. In all cases, a two-day treatment of $GA_3$ did not appear to be injurious. In those cases where seed dormancy was evident, very high $GA_3$ levels [10 to 13 mM] promoted seed germination. This may not be practical or affordable. Acceptable levels of germination may be attained by using $GA_3$ concentrations of 3 to 5 mM. Figure 1 summarizes the results.

**Computer Application Development:**

During 2003, D. Kovach investigated Oracle Forms9i and Reports9i for possible station use, by assessing ease of development, ease of use, and relative cost. He looked into future directions for Oracle's line of products and concluded that the Forms9i and Reports9i might only be short-term solutions. If new-product releases from other vendors (discussed later) come too slowly, this may require the use of Forms9i and Reports9i as an intermediate step toward a more long-term solution.

Mr. Kovach investigated Information Builders report-writing and data-entry software. The report writing was very good, but too expensive. Their data-entry forms were not robust enough for the station's needs.

Other alternatives were also considered. JBuilder (Borland) and NetBeans (Sun) products are alternative Integrated Development Environments (IDE). D. Kovach met with USDA computer personnel in Ft. Collins (Object Modeling System) regarding their use of NetBeans. No real advantage of these products over JDeveloper was seen; some disadvantages, such as difficulty in connecting to the Data Base Management Unit's (DBMU) database, were detected.

Lastly, D. Kovach examined Oracle's JDeveloper IDE for possible use for client-side and web-enabled forms. He attended the 2003 Oracle Developer Tools User Group (ODTUG) Conference and obtaining additional information on its use. Preliminary work indicates that although JDeveloper is not yet a 'mature' product, the direction of its planned development is appropriate to our applications. Mr. Kovach ordered a JDeveloper license, began learning and using it, developed some test applications for the web, and then worked with Quinn Sinnott of the DBMU to troubleshooting errors on the Beltsville, MD server. A test Java Server Page (web-enabled form) was then successfully deployed.

Using the established Forms and Reports software, D. Kovach created or modified forms and reports, as requested by users, including the creation of a new planting label for a Ph.D. student evaluating our coriander germplasm. He also ran the annual statistics for the station.

**Internet website related*:***

During 2003, D. Kovach developed and maintained the Amaranth 2003 Annual Meeting Website, made one of the Horticulturist's PowerPoint presentations available on the NC7 Woody Ornamentals Evaluation Trials Website, and posted a draft version of a Web-based Accession Performance Report form that would allow germplasm users to transmit data to the station electronically.

**Imaging and document management related:**

During 2003, D. Kovach evaluated several imaging management programs and attended two presentations by software representatives. Luna Imaging appeared to be the best available, but it is probably too expensive for our station. Content DM had many limitations, and Lead Technologies was designed for medical applications. We purchased one copy of Cumulus for Mark Millard to evaluate, but after testing he concluded that the product is not suitable for our needs.

Mr. Kovach and M. Millard also evaluated document management software that could possibly be used for image management, and, on that basis, the station purchased Oracle Files. The new server was not yet ready in 2003 to install this software, but its installation is planned in 2004.

**Inter-Site and GRIN Database related:**

Mr. Kovach continued correspondence with Q. Sinnott, E. Abadie, G. Emberland, and J. Mowder of the DBMU to keep up-to-date regarding their software plans. This is very important in order for us to stay current with our software licensing.

**Equipment and facilities related:**

This past year D. Kovach ordered and set up a new Zebra printer for cage labels. Mr. Kovach also ordered additional bar-code readers for the station.

Mr. Kovach developed or modified AutoCAD floor plans and selected furniture layout plans for the Information Technology room, created equipment layout plans for the threshing room, updated or created field plot plans as needed, made drawings for the door security system currently being installed, created plans for bee nuc construction, and made plans for cage construction for the small and large cages.

In 2003, D. Kovach's AutoCAD drawings for the layout of facilities for the door-security system, ordering foil-lined bags from the supplier in conjunction with another purchaser (i.e. piggy-backing the order), and preventing a 'dump' of the special Inergen gas fire suppression system saved the station an estimated $37,000.

**Supervision:**

This past year, M. Erickson, Agricultural Biological Science Technician, continued to oversee and conduct germination tests. D. Kovach trained M. Erickson to use additional NC7 Oracle Forms. We requested and received from the computer committee new flat-panel monitors for Maria and her crew (freeing up valuable desktop space for scoring the germ tests). Maria and her crew made good progress in 2003. The germination crew took on more responsibilities, by filling seed orders, helping curators germinate seeds for their regeneration efforts. TZ testing requests increased, as well as those for specialized help to get the best germination from seeds with a poor germination history.

**Germination Testing*:***

During 2003, most of the germination crew’s time was divided between filling germination orders created by curatorial projects or by M. Erickson. The germination crew also initiated the germination process for all seeds used for transplanting by the Amaranth crew.

M. Erickson modified the Maize germination protocol method in order to accommodate slower-germinating accessions; the method change was approved by M. Millard (Maize curator) and D. Kovach. First counts are conducted on the 7th day after setup, second counts on the 10th day and final counts on the 14th day.

M. Erickson's training of the germination crew resulted in a higher level of proficiency by each individual. This allowed M. Erickson time to conduct experimental tests for the purpose of finding new methods for improved germination of dormant seeds. She was able to conduct more tetrazolium tests, used to determine the seed viability of questionable accessions. One experiment was conducted on behalf of M. Brothers (former Sunflower curator), who was working in conjunction with T. Gulya, Scientist, USDA, Fargo, ND. Results were forwarded to M. Brothers and T. Gulya without analysis.

**Plans for 2004**

Plans for 2004 include attending a conference this summer on application development tools. This will aid Mr. Kovach in creating forms and reports using the latest version of application development software.

This coming year includes plans for writing up the results of work on the seed dis-infestation project, continued development of specialized forms and reports to meet station needs, learning the new Oracle development tools and staying current with software licensing, continued maintenance of the station’s Website, and providing computer-aided drawings for facility improvement as needed.

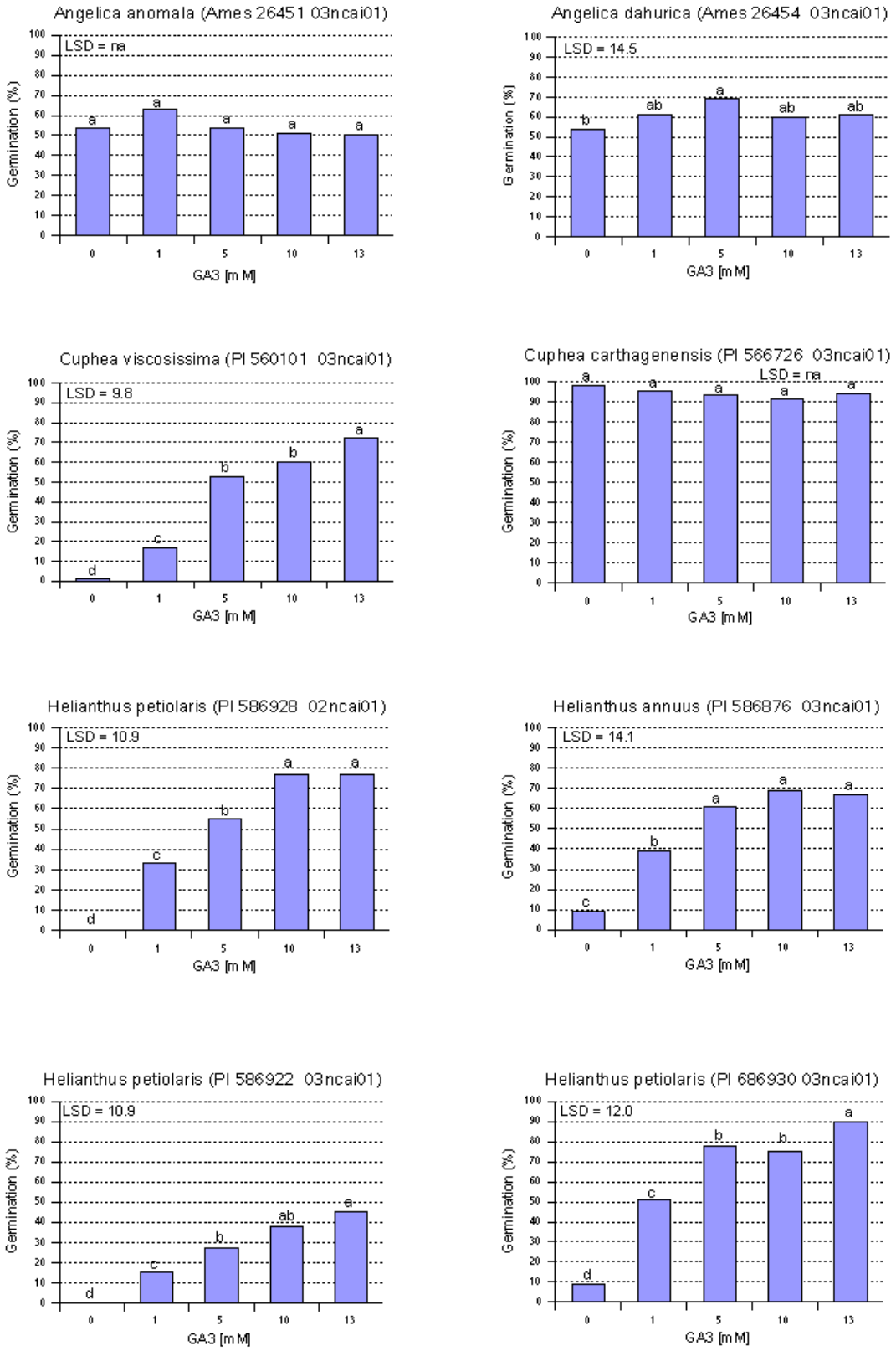


Figure 1. *Angelica*, *Cuphea* & Wild Sunflower Seeds. $GA_3$ Rate Study

**d. Information Management: Germplasm Program Assistant (R. Stebbins)**
**Germplasm Collections**

**Acquisition:**

The North Central Regional Plant Introduction Station (NCRPIS) acquired 453 new accessions in 2003. Of these new accessions, 97 were received from within the National Plant Germplasm System (NPGS). The majority of these came from the National Center for Genetic Resources Preservation (NCGRP) in Fort Collins, Colorado; among these were 21 accessions of *Zea mays* subsp. *mays*.

The remaining 356 accessions, received from outside the NPGS, included 187 accessions of *Zea mays* subsp. *mays*, 97 accessions of ornamentals, and 27 accessions of *Helianthus bolanderi* from an exploration to California. As new accessions are recorded in the Germplasm Resources Information Network (GRIN), an effort is made to include as much passport information as possible. Typical passport information would include a source history, cooperator records, collection-site description, pedigree, secondary identifiers, and any other pertinent information provided by the donor.

**Maintenance:**

Assistance with curatorial management was provided by processing requests for taxonomic re-identifications and nominations of accessions to the inactive file. In total, 73 accessions received taxonomic re-identifications. Among these were 32 accessions of *Amaranthus* and 20 accessions of umbels. Also, 7 accessions were nominated for inactivation, including 5 accessions of umbels.

Additionally, 442 accessions were assigned PI numbers. Included in this group were 254 accessions of crucifers and 110 accessions of *Brassica*.

**Projects:**

One of the first steps in obtaining a PI number for an accession is to proof the passport information for accuracy and completeness. Proofing passport information is an ongoing project that is secondary to logging in new material. Proofing involves locating paper files of accession information, corresponding with collectors and donors, Internet searches, and researching maps and GIS databases.

One of my projects involved working with Mark Widrlechner to prepare 41 accessions of ornamentals for PI number assignment. Any errors in GRIN were corrected, and reports were printed for a final check before requesting PI numbers. In addition, I have continued to enter old passport information from logbooks for early Ames-numbered accessions. During the course of this project, I have encountered duplicate accessions and missing GRIN records, which have been corrected once identified.

I continued work with the Medicinal and Nutraceutical Plants Subcommittee of PGOC on a draft list of species with medicinal and/or nutraceutical uses. This list was completed and made available for distribution in 2003.

I coordinated communications with 9 foreign and domestic seed banks to request seed of a wide range of genera.

I worked with Mark Widrlechner to draft a protocol for accessioning germplasm as it is received at the NCRPIS. This document has replaced the key for accessioning germplasm that had been a part of the Station’s Operations Manual.
I also worked with Mark Widrlechner to revise the procedures and form used by curators to nominate accessions for PI number assignment. The new procedures include minimum standards for passport data which must be met prior to PI number assignment.

I served as a member of the Computer Committee. The committee is responsible for maintaining a modern and efficient computer system which includes budgeting, planning, repairing, and purchasing.

I served on the selection committee for the newly formed position of seed storage technician.

I received training in the use of DIVA-GIS. This is a powerful software package which not only allows mapping of past germplasm collection sites, but will predict the best locations to attempt new collections based on ideal climate, elevation, rainfall, temperature, etc.

Cooperative activities included staffing an ARS booth in the Agriculture Building of the Iowa State Fair where we interacted with the public and ARS personnel from other units, helping roll cage screens in the fall in preparation for winter storage, and filling in as farm receptionist during times of vacation or illness

**Conclusions:**

Compared to 2002, new accessions received at NCRPIS were down by 182 in 2003, a decrease of 29%. In maintenance areas, re-identifications were down by 26%, nominations to the inactive file were down by 93%, PI number assignments were up by 49%, and duplications were down by 100% compared to their 2002 levels.

All figures for acquisitions and maintenance were below the eight-year average, with the exception of PI number assignments which were 15% above average.

**e. Order processing (R. Stebbins and C. Nass)**

I (R. Stebbins) began processing outgoing seed orders after the retirement of Linda Minor. The original plan was for me to fill this role only until a replacement was hired. However, the combination of my original duties with those of Linda Minor worked so well, it was decided to make the arrangement permanent. I then attended a workshop entitled “Working with Postal and Parcel Service" where I learned to more efficiently prepare materials for shipment via the Iowa State University Postal and Parcel Service. I also prepared and mailed several ornamental seed lists to various cooperators around the world to assist in them in the selection of accessions to support their research.

During 2003, there were 946 orders entered into GRIN, resulting in the distribution of 17,147 items to requestors and evaluators throughout the world. Of the total items distributed, 27% were sent to foreign requestors.

The number of orders entered into GRIN in 2003 was 15% less than that of 2002; however, the number of items was up by 356 or 2%. The number of requests received electronically this year was 626, an increase of 21% over 2002.
Cris Nass and I distributed 451 Initial Accession Performance Report forms in 2003. By the end of the year, 320 (71%) had been returned. The Summary Accession Performance Reports and Final Reports that were mailed out in 2003 totaled 291. Of these, 183 (63%) have been returned. The return rate on the Initial Accession Performance Report forms was slightly higher than that for 2003.

**f. Seed Storage (L. Burke, M. Arnold, M. Block)**

In 2003, 2225 lots were stored, including both newly received lots and those regenerated at Ames or at remote sites. During storage, 315 lots were bulked to create 148 new lots, and 29 original samples were split to create distribution lots due to adequate seed numbers received. Inventory records for 1395 lots were reviewed to ensure accuracy of seed amounts, and new labels were printed for lots with outdated labels. We prepared 232 original lots for long-term freezer storage.

Seed orders prepared in 2003 included those for distribution, observation, germination, transfer and backup. Seed storage personnel filled 740 orders. This statistic can now

be tracked with the use of an ORDFILLED action in the order action field of GRIN. There were 822 lots (761 accessions) sent to the National Center for Genetic Resources Preservation (NCGRP) for backup, including both accessions new to NCGRP and supplemental lots for previously supplied accessions. We distributed 17,147 packets to meet distribution and observation requests. Of these, 12,435 were distributed domestically and 4712 outside the US. We transferred 16 inventory lots to other NPGS sites.

Major projects for 2003 included the continuation of the prepacking program for NCRPIS crops (to date, 2198 distribution lots have been prepacked, insuring inventory accuracy and efficiency); continued work on the new web-based GRIN database to train NCRPIS employees and assist the Database Management Unit (DBMU) with continued testing and improvement of GRIN processes; and creation of a station poster for display at the Agronomy Society meetings in Denver, Co.

Training for 2003 included CPR/First Aid re-certification (Lisa Burke); Blood Borne Pathogen re-certification (Lisa Burke); CPR/First Aide certification (Mary Arnold) and IT Security Awareness training for all seed storage personnel.

Travel for 2003 included trips by Lisa Burke to the Missouri Botanic Garden in St. Louis, MO to image original maize collections of material maintained at the station and to the Agronomy Society meeting in Denver, CO to present a poster in the C8 session on the Native American Southwestern Maize collection maintained at the station. Poster title: The North Central Regional Plant Introduction Station's Southwestern Maize Collection – An Historical Perspective. Authors: M.J. Millard, L.A. Burke and M.P Widrlechner.

In 2003, 73 accessions received taxonomic re-identification. All affected seed samples were re-labeled by seed storage personnel. In addition, seed samples of 7 inactivated accessions were removed from the active collection and placed in inactive storage. New labels were made and cold-storage locations and GRIN records were adjusted to reflect changes resulting from the assignment of 442 PI numbers. Four accessions were identified as duplicates, and appropriate changes were made to those packets, to their locations and to GRIN.

One full-time, permanent federal employee (Lisa Burke), one full-time, temporary federal employee (Mary Arnold) and one part-time, temporary federal employee (Mary Block, 20 hours/week) staffed the seed storage department in 2003. During 2003, a full-time, permanent biological science technician GS 5-7 position was created to replace the two, temporary seed-storage positions. A person was selected to fill this new position in December, with a January 2004 starting date.

## VIII. Curatorial and Scientific Team Reports

### a. Entomology (S. McClurg)

**Progress:**

**Field**

Maize – At the request of curator M. Millard, completed statistical analysis of three hundred thirty-five accessions included in the 2002 retest to evaluate for leaf-feeding resistance to first-generation European corn borer in the field in Ames; these accessions had been previously tested from 1992 through 2001 in Ames field plots. Although check ratings varied somewhat from year to year, average ratings for the susceptible ("WF9") and resistant ("CI31A") checks showed no statistically significant difference between years tested. Variability of ratings from year to year is probably due to weather; in cool, rainy years larvae do not establish as well and more intermediate to resistant ratings may be reported. Analysis of accessions retested in 2002 showed no significant difference between replications and highly significant

differences between accessions. The overall accession rating obtained in 2002 was then compared to the original rating obtained the first year each accession was tested. There was a highly significant difference between years tested, which is probably due to different weather conditions in different years. There was no significant difference between accessions which indicates the reporting of resistance in the original evaluation was valid in those accessions.

A replicated test of previously untested maize accessions (two hundred sixty-seven inbred accessions and three hundred sixty-nine population accessions) were evaluated for leaf-feeding resistance to first-generation European corn borer in the field in Ames in 2003 for curator M. Millard. Forty-four accessions (twenty inbreds and twenty-four populations) were rated as resistant in two replications.

Sunflower – Finished data collection on thirty-eight accessions of cultivated sunflower from the core collection evaluated for sunflower moth resistance in the field in Ames in 2002. Data analysis is in progress.

Eleven accessions of the core collection of cultivated sunflowers remain untested for sunflower moth resistance in Ames field tests to date. Seven of the untested core collection accessions have maturities that allow for field testing in Ames, but six of these accessions were not available for distribution in spring, 2003.

Forty-four accessions of cultivated sunflowers from two of the three core collection clusters that appeared to have more resistance to sunflower moth larval feeding than the other seven clusters, were tested in the field in Ames in 2003. Data collection is in progress.

In cooperation with S. Hanlin, M. Brothers, and I. Larsen, three accessions of sunflower were again evaluated for effectiveness of pollination by three bee species, including one species of sunflower leafcutter bee, in a replicated cage field test in Ames, summer, 2003. Results are discussed in the "Controlled Polination" section of this report.

The sunflower curatorial project utilizes a large number of honeybees in controlled pollination field cages; ca. 100 cages are utilized per summer field season. It would be practical to have an alternate pollinator available for sunflowers in times of peak demand for honeybee nucleus hives in field regeneration cages. In cooperation with S. Hanlin, M. Brothers, and I. Larsen, several open plots of cultivated sunflowers, wild annual and perennial sunflowers at Ames were observed for native bee species, summer, 2003. The most common bees were collected and given to S. Hanlin for identification.

Cucumis/curcubita – In an ongoing attempt to determine if cucumber and rootworm beetles are capable of spreading one or more plant viruses by feeding on plant parts pressed against field cage screens, assisted the vegetable project personnel with field collection and species separation of these beetles from the exterior of field cage screens and maize plots, summer, 2003. Beetle counts per area were determined with the assistance of K. Reitsma in fall, 2003. Beetles will be tested for presence of viruses via ELISA under the direction of C. Block.

Daucus – In cooperation with S. Hanlin, devised and assisted in the construction of a field cage "fly pupae holder" from a 0.95 liter plastic carton weighted at the bottom with plaster. This pupae holder was created to reduce fly mortality which resulted with the previous distribution technique of placing pupae under newspaper mulch near the field cage opening. After instituting the use of the pupae holders, it was noted that flies often congregated in the containers during times of cooler temperatures and precipitation which may have extended their life span.

Assisted in the twice weekly placement of houseflies and blue bottle flies into summer, 2003 vegetable project field regeneration cages; eight hundred eighty-seven cartons of flies were placed in forty-seven field cages containing six different *daucus* species and one *peucedanum alsaticum* from 6 June to 12 September, 2003.

**Greenhouse**

Cucumis – In cooperation with K. Reitsma, L. Clark, and S. Hanlin, completed summarizing environmental data collected during the summer 2002 trial of insect pollination of *Cucumis* in greenhouse cages. We also assisted in a second trial conducted during the winter/spring 2003 using newly designed cages in two greenhouses at Ames; we conducted hourly observations on four pollinators in these cages in addition to collecting environmental data. In general, it seemed that insect activity in the winter 2003 test was the same as the summer 2002 test and the new cage design was satisfactory. It appears that several bees are suitable to use in this situation; there may not be one "perfect pollinator" for greenhouse *Cucumis* regenerations due to the variability in these accessions. The test protocol and conclusions are discussed completely in the "Controlled Pollination" section of this report.

Curatorial staff utilizing flies in greenhouse cages during winter, 2002/3 expressed concern about poor fly emergence and low numbers of flies in regeneration cages. Prior to 2003, flies utilized as plant pollinators in field and greenhouse regeneration cages were introduced in the pupal stage as collected directly from the rearing media (houseflies) or as stored in an incubation chamber (blue bottle flies). Since fly pupae from the same source appeared to emerge adequately in rearing room conditions (temperature ca 25 C and relative humidity ca. 20%) we concluded that the high humidity (average ca 40 % in one greenhouse) and low temperature (ca 15 C at night in another greenhouse) reduced fly emergence when pupae were put directly into greenhouse cages. We found that "pre-conditioning" the fly pupae in the rearing room for several days prior to placement in cages resulted in a larger number of active healthy flies for plant pollinations; this was made a standard part of the protocol of putting flies into regeneration cages as of March, 2003.

*Pimpinella* – In cooperation with S. Hanlin, K. Reitsma, and L. Clark, assisted with test to determine the most effective number of fly pupae per small mesh greenhouse cage, the frequency pupae should be introduced to cages (once vs. twice per week), and species of fly (houseflies, blue bottle flies, or a combination of both) which resulted in best seed set; the test was begun fall, 2003 and is still in progress.

Mixed genera - Assisted in the twice weekly placement of houseflies and blue bottle flies into greenhouse regeneration cages in Ames in 2003. Seven hundred twenty-six cartons of flies were delivered to four plant genera (six *Daucus* species, *Torilis*, *Ampelopsis*, and one unidentified umbel) in greenhouse cages from 6 January to 14 July, 2003; one hundred-seventeen cartons of flies were delivered to four different plant genera (two *Dalea* species, *Torilis*, *Pimpinella*, and one unidentified umbel) from 20 October to 29 December, 2003.

**Laboratory**

Coriander – In cooperation with D. Brenner and D. Kovach, we continued investigation of the seed chalcid (*Systole* sp.) infesting coriander maintained by D. Brenner with the goal of determining the most effective method for producing large quantities of high quality seed without viable insect pests, so that harmful insects are not introduced to the user community and there is minimal delay in distributing seed after regeneration. We conducted several tests. Seed from both 2001 and 2002 harvest lots was blown in an air separation column to determine if chalcids were only present at certain fractions; insects were found in all fractions so this method would not provide a satisfactory way to eliminate infested seed with current equipment on hand. Coriander seed was x-rayed with a cabinet system to determine if percent infestation could be determined quickly and non-destructively. Due to the nature of the coriander fruit (it is small, round, and contains multiple seeds), it is difficult to interpret the radiographs accurately. Four seed samples were sent from 2002 Ames field plots with known % infestations determined by dissection (44, 32, 10, and 6%) to G. Simmons (Seattle University, Seattle, WA) for photographic evaluation of chalcid-infested coriander. Assessed the infestation level of twelve 2003 Ames field grown accessions for D. Kovach's follow up chemical testing; see his section of this report for further discussion.

Maize – In cooperation with maize curator M. Millard, and J. Robbins and L. Pollak of CICG (USDA-ARS, Ames, IA), finished data collection and analysis and discussed the results of three insects (Angumois grain moth, Indian meal moth, and maize weevil) feeding on eight accessions of maize with and without multiple aleurone layers begun in 2002. It has been suggested that multiple aleurone layers contain phytosterols which may have insecticidal properties (J.P. Santos, Purdue M.S. Thesis, 1977). Since sterols reduce cholesterol, these properties would be a significant health benefit in producing food from maize. It appeared that insect days to emergence and male insect data was most likely to be of statistically significant difference in the feeding studies. It was concluded that the information obtained to date could be published in a non-peer reviewed arena; L. Pollak was appointed to begin writing, spring, 2003.

Rearing – We continued to rear three insect colonies; weekly rearing schedules were flexed to accommodate student workers' class schedules when feasible. We purchased a new Barnstead® water distiller in April, 2003 to enable us to continue making artificial insect laboratory diets; our old Wheaton® distiller became unreliable in operation, and we found that brand of still was no longer manufactured and replacement parts were difficult to obtain.

Flies - Houseflies and blue bottle flies were reared for use as pollinators in field and greenhouse regeneration cages containing primarily umbel type plants.

Due to difficulties technician Brent Werner was experiencing with longevity in housefly colonies, new rearing cages which could be more easily cleaned were designed and constructed from large plastic storage containers. These cages are also more easily accessed than the old wooden cages.

Fly rearing protocols and work tracking forms were reviewed and standardized in April, 2003.

Sunflower moth - We maintained a laboratory colony of sunflower moths for use in the field resistance evaluation of cultivated sunflowers at Ames.

We provided several stages of sunflower moths, rearing procedures, and reference on sexing this insect to R. Howard (USDA-ARS, Manhattan, KS) for his lipid analysis of cuticular chemicals in comparison to other Pyralidae which are pests of stored grain products.

Provided sunflower moth eggs and rearing advice on several occasions to S. Foster (NDSU, Fargo, ND). NDSU personnel intended to use the insects for host selection behavior, specifically to identify chemical attractants to female sunflower moths.

We provided late instar sunflower moth larvae to A. Labreque (Laurentian Forestry Centre, Quebec, Canada) for colony establishment for use by J. McNeil in testing the effect of sunflower pollen on female moth oviposition and reproduction.

**Crew:**

Brent Werner continued his limited appointment as a Biological Science Laboratory Technician (Insects), GS-5 through April, 2003 when his appointment expired. S. McClurg is now assisted in her work by student employees.

**Other Activities:**

We began capturing digital images of the photographic slides the entomology project had accumulated over the last twenty-plus years in fall, 2003. The images are being burned to DVD; work is ongoing.

**Plans for 2004:**

We will continue host-plant resistance evaluations in the field, laboratory, and greenhouse with the collaboration of NCRPIS curators and appropriate cooperating scientists from other ARS units. These evaluations will include reaction to first-generation European corn borer in maize and sunflower moth in cultivated sunflower. We plan to complete evaluation of all available core collection cultivated sunflowers that are of proper maturity for Ames field growing season when the untested accessions are available for distribution.

Support activities for the NCRPIS insect pollinator program will continue, assisting in the rearing and placement of bees and flies, as well as providing cooperation in pollinator studies proposed by S. Hanlin and NCRPIS curators. Implementing new or modifying existing procedures to improve our ability to effectively use alfalfa leaf cutter bees and Osmia bees is a high priority. Research to improve our ability to provide chalcid-free seed will continue, using coriander as a test crop.

S. McClurg will continue to offer support to all NCRPIS and GEM project personnel when insect pest identification/information is needed, and to process, archive and make data publicly available from past host plant resistance evaluations, and to serve on internal committees dedicated to advancing our efforts.

**b. Controlled insect pollination program (S. Hanlin)**

**Progress:**

Cage pollination: Pollinators were supplied to 551 cages for controlled pollination of 559 accessions. Honey bees were used to pollinate 531 accessions in the field and 11 accessions in the greenhouse. *Osmia* spp. was used to pollinate 61 accessions of Brassicaceae, 1 accession of *Aronia melanocarpa* and *Staphlea trifolia*, and 1 accession in the greenhouse of *Scaligeria tripartita*. *Bombus* colonies were used in 10 accessions of ornamentals and 2 accessions of *Helianthus annuus*

The accessions which were pollinated by flies this year are reported by S. McClurg under the “field - *Daucus*” and “greenhouse – mixed genera” headings in the entomology section of this report.

Beekeeping: Honey bees were over-wintered in the indoor wintering facility with a survival rate of 85% for the parent colonies and 31% for the nucleus colonies. The survival rate for the nucleus hives was lower than last years 69% and for the hives moderately higher than last years 65%. This winter, we placed 78 two-story parent colonies, 15 three story parent colonies, 157 double-story nucleus colonies and 21 single story nucleus colonies into the over-wintering facility. All queens to be used for queen rearing will be selected in the spring of 2004 from resilient parent colonies.

In spring 2003, 60 two-pound packages of bees were purchased. These bees were used to increase the winter losses of parent colony numbers from 2002. Our queen rearing continued to improve throughout the summer with an average of 65 queens per week being produced. This number is comparable to the number of cells produced last year. To prevent swarming in our queen rearing colonies, we removed frames of honey on a weekly basis and replaced them with foundation or empty combs throughout the summer. We also removed any swarm queen cells and frames of bees and brood to produce nucleus hives to be used for pollination.

By the end of the summer we had an additional 63 nucleus hives which did not get used for cage pollination. These hives were made into doubled story nucleus hives and over-wintered; they hopefully will be strong nucs in the spring and possible made into parent colonies.

We collected 3 swarms which were made into colonies and an established colony from a “bee tree”. These colonies were included in our nucleus production once they became established and all were over-wintered in the fall.

Because of low mite counts in the spring and fall, no miticide was used this year for the control of *Varroa* mites. We determined mite populations using three separate methods of sampling. We used the "powder sugar roll" in which 1 tablespoon of powdered sugar is placed into a jar with 100 bees that are randomly sampled from the hive as our main sampling technique. A second sampling method used this year involved the uncapping approximately 25 drone cells per hive, removal of the larvae and examination of the larvae and cell for mites. We also sampled 63 colonies using sticky boards and Checkmite© mite strips in order to observe a 24 hour mite drop. On 10 hives, screened bottom boards were used for the entire summer. We made weekly observations of the "sample boards" for mites, however because of the low mite populations very few mites were observed.

All parent colonies and nucleus hives to be over-wintered were fed a total of four feedings of fumidal-B syrup during the fall. This treatment is for prevention of dysentery in the bees while in the over-wintering room.

For wax moth control during the winter of 2003, we used environmental control methods by opening up the outside doors on colder days and allowing the room to drop in temperature and to freeze the moth larvae. During the summer months, we treated stacks of supers containing empty frames with paradichlorobenzene (para-moth©) crystals on a bimonthly basis to fumigate for moth larvae.

To make feeding of high fructose sugar syrup to caged nucleus hives less labor intensive, a new system for filling feed containers was installed. The system consisted of two 1000 gallon polypropylene tanks (one inside the shop and one outside), a 30 gallon "mixing" tank and a dish washer. This allowed a single person to fill feed containers and clean containers and less mess to be present in the shop from mixing.

Bombus: Nine "research" colonies of *Bombus impatiens* were ordered from commercial suppliers. The bumble bee colonies were used for controlled pollination of 12 field cages. The colonies were checked in the fall to determine if they were strong enough to be over-wintered, however, in all cases they found to be weak or no longer alive.

A new supplier was used for half of the colonies purchased this year; this decision was based on a lower cost per colony. However, it was found that the quality of the lower priced colonies was poorer than what we received from the former supplier, so the supplier of higher quality materials will be used in the future.

Two drone colonies of *B. impatiens* were purchased to use in the "greenhouse pollination study". The colonies worked very well as pollinators in the small cages in the greenhouse. The blossoms in the drone colony cages showed less damage than the blooms in cages containing the regular queen colonies.

*Megachile rotundata*: Two domiciles of alfalfa leaf-cutting bees were used this year in the "greenhouse pollination study". They were found to be beneficial greenhouse pollinators; however, they showed a delayed emergence which was after the major flowering was completed and thus showed less fruit production. Nine domiciles of alfalfa leaf-cutters were used in the "sunflower pollination comparison study" as we used in the summer of 2002 as replacement bees. Fifty two domiciles of alfalfa leaf-cutter bees were used for a cooperative research project with R. Palmer in his study of "attractiveness of male sterile lines of soybeans to pollinators".

*Osmia cornifrons/O. lignaria*: *Osmia* spp. were used to pollinate all *Brassicaceae* seed increase plots and a single greenhouse cage of *Aronia melanocarpa* and *Staphlea trifolia.*

Approximately 4846 bees were used to fill 818 straws in 2003. The spring and summer were drier than 2002, so that our increases were lower than last year. We collected approximately 105 straws or 846 bees last year. Because of the low number of bees produced, we will have to purchase additional bees in 2004. We will use a new supplier, because of the inability of contact our past supplier. We will also be

testing a new type of insert straw for improved increase numbers; the straw has a plug at the back end which is more favorable to the bee to lay eggs into.

*Musca domestica & Cochliomyia macellaria:* All rearing of both species of flies and their introduction into cages for pollination was completed by S. McClurg and the entomology staff. This information is listed in the entomology section under "laboratory" of this report.

**Research:**

For a fourth and final year, a comparison study was conducted using honeybees, a species of sunflower leaf-cutter bee (*Megachile pugnata)* and alfalfa leaf-cutter bees (*M. rotundata*). For a second year, the alfalfa leaf-cutter bees were used in replacement for the Washington sunflower leaf-cutter bee (*M.* apicalis) which was used the first two years of this study. The three pollinator species were randomly placed into small cages containing either a cultivated species of sunflower or one of two types of wild species. Several *Oenothera* plants were placed in the cages containing *M. pugnata* to assist in the formation of the egg cases. For the first time, we did have an increase of sunflower leaf-cutter bees with approximately 471 pupae collected in the fall. This indicated that the bees emerged close to when plants were showing the greatest flowering and best conditions.

A native pollinator study was continued for the third year. The pollination staff assisted S. McClurg with making field observations and collections of pollinators and identified all of the collected specimens during the winter. To assist in identifying of Hymenoptera pollinators, S. Hanlin attended "The Bee Course" in August, which improved the ability to identify bee species. Because the greatest number of honey bee nucleus hives are presently being used for sunflower pollination and a large variety of pollinators use sunflowers as a pollen and nectar source, the focus of this year's observations were made on wild accessions of sunflowers. The staff continued to make observations of native pollinators on biannual accessions which have been observed for the past two years. Climatic conditions such as temperature, precipitation, wind, time of day and cloud cover were observed and recorded to assist in determining if these conditions limited the type of pollinator present. A future goal dealing with the native pollinators is to visit the Bee Biology and Systematic lab in Logan Utah and observe their research and lab rearing techniques used with new pollinators. We continued to see a numerous population of *Bombus* and *Megachile* on both the sunflowers and the biennials.

A comparison study of greenhouse pollinators was conducted in February through March of 2003 in cooperation with K. Reitsma, L. Clark and S. McClurg. The insects used in this study consisted of honey bees, *Bombus* (drone), *Bombus* (queen), alfalfa leaf-cutter bees and mixed blue bottle flies and house flies. The insects were placed into 10' X 3' X 6.5' cages containing *Cucumis sp.* (PI 505608). Two locations were used this year with similar temperatures but differing humid conditions. Cages were set in a similar manner with one set of cages was placed in the entomology greenhouse and a comparable set of cages was placed in greenhouse 3. Environmental data was collected in both greenhouses using a "HOBO" and hourly insect position observations were collected by the pollination staff and S. McClurg over a period of three weeks. Pollinator success was based on the number of fruits produced and the number of seeds per fruit. The highest amount of seed/fruit was produced in the honey bee cage in the entomology greenhouse followed closely by the alfalfa leaf-cutter bees in the same location. It was found that the *Bombus* (queen) were more aggressive than the other pollinators by forcing themselves into the blossoms after they had closed and may have caused some damage to the blossoms and possible aborting.

To determine the amount of freezing or crystallization of high fructose corn syrup stored outside during the winter months, two 50 gallon barrels were placed outside the bee shop during the months of January and February. One of the barrels was straight 95% high fructose corn syrup and one barrel was a 1/3:2/3 mix of syrup and water. This work was done as preliminary work for the construction of the syrup tank system and to determine the amount of freezing/crystallization which would occur in the outside tank.

It was found that in the straight syrup, the freezing of the syrup promoted crystallization. In the barrel of diluted syrup, there was some ice crystal formation, but on warmer sunny days the contents were generally liquid. The conclusion from this study was if storing syrup outside in tanks, it must be diluted prior to cooler temperatures or the tank should be emptied prior to winter.

**Cooperation:**

A cooperative study was carried out in July and August with Dr. Reid Palmer. The objective of the study was to observe the attractiveness of soybean flowers to alfalfa leaf cutter bees and honey bees and to try and determine the nectar makeup in the accessions most attractive to pollinators. Twelve leaf-cutter domiciles were placed around the sides and down the center of a soybean test plot and twelve double nucleus hives were placed around the sides of a comparable sized plot. An additional forty alfalfa leaf-cutter domiciles were placed in an adjacent field for pollination of soybean accessions. Dr. Palmer and his assistants made all plot data observations and nectar makeup analysis. The NCRPIS pollination staff supplied all insects needed in the project and the expertise for determining needed domicile numbers. The pollination entomologist supplied Dr. Palmer with an accurate identification of Hymenopteran specimens which were collected in 2002 from Texas soybean sites.

The pollination staff worked in cooperation with S. McClurg to design a “fly introduction dish” for the greenhouse and field cages. In the past, fly pupae were placed on the ground or in paper cups in which there was a chance of desiccation, drowning or the possibility of the pupae being stepped on. The new design consisted of a quart plastic container with a lid. A two inch section was cut from the top of the container and an inch of Plaster of Paris was poured into the bottom. This container allows for easier introduction of flies into the cage, prevents moisture from filling the container, the pupae from drying because of direct sunlight and prevents the pupae from being stepped on when individuals entered the cage.

In November, the pollination staff with cooperation of the maintenance crew and S. McClurg placed heat lamps on the north side of cages containing flies and bees in the bubble-house. It was observed that on cool cloudy days that the pollinators would set on the cage or plants with little activity. With the use of the lamps, it did appear to increase the pollination activity slightly, but had less effect than if the insects had direct sunlight on a warmer day.

In January, the pollination entomologist was contacted by D. Henry a local orchard owner about the use of “squash bees”. Because of the possibility of use of this bee as a pollinator for the vegetable project, extensive literature research and contacting other entomologists was done. However, it was found that the bee was not native of Iowa, could not be purchased and was not recommended for use in cooler northern locations.

The pollination entomologist was contacted by C. Waits of the USDA in Georgia about pollinators to use for *Ipomoea* sp. in greenhouses. The entomologist recommended the use of *Bombus* or alfalfa leaf-cutter bees for greenhouse pollination. C. Waits contacted the introduction station the end of 2003 and requested further information of additional pollinators which could be used in the greenhouse because of aggressive pollination observed by the *Bombus* and a lack of pollination by the solitary bees. It was recommended at that time to try weak honey bee nucleus hives as pollinators and to contact the apiarist who was supplying bees for their project for assistance.

In September, R. Hellmich of the USDA corn project in Ames and J. Villa of the USDA bee lab in Baton Rouge contacted C. Gardner, M. Widrlechner and the pollination entomologist about cooperating with a research project to determine mite resistance in “Russian bees”. The bee lab was also interested in the capabilities of the Russian bee as a pollinator and it’s abilities in honey production in northern states. Additional research was discussed about the possibility of testing several other strains of bees which are presently being reared and tested at the bee lab for mite resistance under northern conditions. In January 2004, J. Villa informed us that all research was being

delayed at this time because of an outbreak of “small hive beetles” found in the hives in Louisiana. Contacts will be maintained so that research can be conducted in the future.

The pollination entomologist was contacted by S. Bruner, an author of a local gardening magazine. Mrs. Bruner had several photos of Hymenoptera which had been taken for an article to be published and wished to identify bees identified and obtain additional information provided for her article, which I provided.

Cooperation continues with S. Stieve and Dr. Tay of Ohio State University’s OPGC and her cooperators on the use of various pollinators. In the past we have built and supplied domiciles which are presently used at NCRPIS for housing the pollinators used. We continue to instruct and assist all individuals on this project on insect care and cage pollination.

**Presentations:**

On February 23, the pollination entomologist spoke at Reiman Gardens in Ames on the use of honey bees and bumble bees as pollinators. The display consisted of the domiciles used at NCRPIS, the bee equipment used for protection and an observation hive. Approximately 200 children and adults visited the booth and asked questions about bees.

On May 8, the pollination entomologist was invited to present to approximately 200 sixth graders at the Squirrel Hollow Nature Center “outdoor classroom” in Jefferson IA. The hands on presentation was based on general honey bee facts, the equipment used in beekeeping and a short introduction to the other pollinators used at NCRPIS. On the day of the field day, the weather forced a cancellation of this program; however an invitation was extended to participate in 2004.

On May 10, the pollination entomologist conducted an invited queen rearing class at the Indian Creek Nature Center in Cedar Rapids IA. The course was attended by 20 individuals who listened to a lecture on queen rearing and then had the opportunity to practice grafting queens using real bee larvae. A tour was provided of the beekeeping facilities found at the center. An invitation was extended to teach a course in the future which would focus on actually producing queens at the center. Attendees would have the opportunity to graft queens and use the queens they produce either at the center or in their own bee operations.

On May 28, the pollination entomologist went to Abbie Sawyer elementary school and talked to Mrs. Shilling’s first grade class about insects. The children discussed what an insect is, differences between insects, and the benefits/damages that they cause. The children could observe insect specimens, an observation bee hive and several live specimens which could be held.

On September 28, the pollination entomologist gave a similar presentation at a booth at the BSA “Broken Arrow” district Cub-N-Around to approximately 150 scouts and their parents. In addition to the observation opportunities, the scouts could try on beekeeping equipment and try to catch insects and identify them using sweep nets, specimen vials and field guides.

**2003 Research plans:**

We will continue research with greenhouse pollinators. A study will begin in March using an accession of *Cucumis* and pollinators consisting of honey bees, Bumble bees (drone colony), alfalfa leaf-cutter bees and combined house flies and blue bottle flies. We will again use “HOBO” portable weather stations both in and out of the cages to collect temperature, humidity and light intensity data, this work will be done by the vegetable project. Observations on pollinator location and activity will be made and recorded the same as 2003 by the entomology staff, in which observations will be made on an hourly basis for approximately two weeks.

A comparison study between house flies (*Musca domestica)* and blue bottle flies *(Cochliomyia macellaria*) will be conducted in the greenhouse using two accessions of *Pimpinella* sp. (Ames 25735 & Ames 25737). A total of two replications will be done using each fly species separate and a combination of the two species. Results will be compared from adding flies to cages once versus twice a week. A total of 100 diptera will be placed in each cage at the defined times or in the case of the combined diptera, 50 of each species. Success will be determined by the amount of seed collected at the end of the trial based on fly species and the number of times flies were introduced to the cage.

We plan to continue cooperating with Dr. Reid Palmer and assist in determining the attraction of *Megachile rotundata* and honey bees to the male sterile lines of soybeans which he is researching. We also hope to derive benefit from observation of pollinators observed in Texas and in Chile by Dr. Palmer and his graduate students. The transport and placement of pollinators and the identification of collected samples will be done by NCRPIS entomology personnel; all field observations and research will be made by Dr. Palmer’s personnel.

We plan to continue the native pollinator study, focusing on observations of pollinators of wild and cultivated sunflower accessions throughout the summer. Presently sunflowers are the largest users of honey bees in the caged fields, so a less work intensive pollinator would be of benefit to this program. We hope to set a time to tour the Bee Biology and Systematic lab in Logan UT and discuss with employees the methods used to lab rear several of the hymenoptera species which have observed on biennials and sunflowers in the last three years.

For the past two years the entomology staff has observed large numbers of syrphid flies on both the biennials and the sunflowers in the later summer months. It was thought based on literature searches that these flies could not be lab reared however in the past summer it was found that at UC Davis a protocol was created and rearing of these flies did occur. The protocol for fly rearing will be obtained by the pollination entomologist and determined if it is economical and beneficial to the program to rear this insect at our facilities. If it is determined to be of benefit to lab rear this fly, the offspring will be tested both in lab and field conditions to determine its pollination potential.

During the 2004 pollination season, a new method of obtaining data from caged nucleus hives and colonies will be tested. The data will be collected using a notebook computer with a bar code reader attached. Bar codes will be attached to colonies in two selected bee yards and the nucleus hives placed in the vegetable accession cages. Information collected from the nucs in the vegetable fields will consist of cage number and accession, the nucleus number and the date the nuc is put in and taken out. In the bee yards, information such as the colony number, the number of nucs a colony produces, disease problems and general observations will be recorded. This information will be used to determine if this method is more time efficient than prior methods used for and if found to be of benefit, will become the excepted method used for data collection.

## Total Bee Use

| Total cages per year<br>Crop | Pollinator | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Horticulture** | Honey bee | | | | | | 39 | 102 | 74 | 43 | 33 |
| | Osmia | | 2 | 1 | 2 | | | 36 | | | 1 |
| | Bombus | | 5 | | 1 | 1 | | | 5 | 11 | 10 |
| **Sunflower** | Honey bee | | | | | | 55 | 131 | 129 | 107 | 103 |
| | Osmia | | | 1 | | | | | | | |
| | Bombus | | | | | | | | | | 2 |
| Flax | Honey bee | | | | | | | | 15 | | |
| **Cuphea** | Honey bee | | 1 | | | | 5 | | 3 | 4 | 9 |
| **Vegetable** | | | | | | | | | | | |
| *Cucumis* | Honey bee | | | | | | 136 | 164 | 120 | 77 | 172 |
| | Bombus | | | | | | | | | 4 | |
| *Cucurbita* | Honey bee | | | | | | 3 | 6 | | 10 | 16 |
| | Flies | | | | | | | | | | 7 |
| *Daucus* | Honey bee | | | | | | 22 | 45 | 61 | 36 | 50 |
| | Flies | | | | | | 9 | 37 | 14 | 62 | 55 |
| ***Brassica*** | Honey bee | | 14 | 14 | | | 40 | 43 | 76 | 76 | 36 |
| | Osmia | | 3 | 126 | 137 | 85 | 82 | 114 | 194 | 71 | 63 |
| | ALC | 31 | | | | | | | | | |
| | Bombus | | | | | | | | 4 | | |
| | Flies | | | | | | | | | 47 | |
| *Lepidium* | Honey bee | | | | | | | 3 | | | |
| | Osmia | | | | | | | 2 | | | |
| *Linum* | Honey bee | | | | | | | 4 | | 82 | 37 |
| | Osmia | | | | | | | 1 | | | |
| **Umbels** | Honey bee | | | | 1 | | 4 | 135 | 129 | 74 | 79 |
| | Osmia | | | | 1 | | | | | | 1 |
| | Flies | | | | | | | 44 | | 3 | |
| *Amaranthus* | Bombus | | | | 2 | | | | | | |
| | Honey bee | | | | | | 1 | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | Honey bee | 969 | 785 | 616 | 580 | 565 | 305 | 633 | 607 | 509 | 535 |
| | Osmia | | 5 | 128 | 140 | 85 | 82 | 153 | 194 | 71 | 65 |
| | Bombus | | 8 | | 1 | 3 | | | 9 | 15 | 12 |
| | Flies | 969 | | | | | 9 | 81 | 14 | 112 | 62 |
| | ALC | 31 | | | | | | | | | |

## c. Horticulture (M.P. Widrlechner, J. Carstens, A. Polsley)

**Germplasm Collections**

**Acquisition:** During 2003, we received 119 new accessions of ornamentals (Table 1). The largest groups included 16 accessions transferred from the National Arboretum, 10 accessions of woody plants collected in Minnesota by Harold Pellett, and 44 accessions, primarily of native trees and shrubs collected in Iowa as part of an NPGS-funded plant exploration. The exploration proposal was prepared by Mark Widrlechner, Robert Schutzki (Michigan State University), and Harold Pellett (Landscape Plant Development Center) and (in addition to Iowa) includes planned collections from Minnesota and Michigan in 2004.

**Maintenance:**

Note: In 2002, about 500 accessions of herbaceous ornamental germplasm representing 23 genera that had been part of this project were transferred to the Ornamental Plant Germplasm Center (OPGC) in Columbus, Ohio for maintenance. Statistics presented in the Annual Report tables at the end of the Annual Report exclude activity in transferred accessions. However, statistics reported below do include activity related to transferred accessions conducted prior to the transfer.

Mark Widrlechner collaborated with Leigh Towill at the National Center for Genetic Resources Preservation in Fort Collins, CO to conduct experiments that evaluated methods to store stem segments of *Salix* clones under cryogenic conditions. These experiments were promising, and results have been accepted for publication in the journal, CryoLetters. We hope that a practical protocol can be developed to make this storage a routine practice.

Availability:

During 2003, approximately 43% of the ornamental collections and 60% of the mint family plants were available for distribution (Table 1), figures similar to those reported in 2002 (44 and 56%).

Back-up:

Approximately 31% of the ornamental collections and 59% of the mint family plants are duplicated at NCGRP (Table 2), figures similar to those reported in 2002 (31 and 54%).

Regeneration:

Regeneration efforts continued at approximately the same levels established in 2001. The established, three-year, caged-regeneration field was harvested for its third year, and a new, three-year field for *Echinacea* and *Hypericum* was planted. The harvests listed in Table 2 include 44 successful cage increases and 30 woody-ornamental seed increases. There were also four accessions of woody plants established from seeds and 18 accessions vegetatively re-propagated.

Viability Testing:

In 2003, 85 ornamental and 21 mint-family accessions were tested for germination (Table 2).

**Distribution:**

As summarized in Table 3, during 2003, a record number of distributions of ornamental germplasm were made. The 883 “order items” included all the distributions for the NC7 Trials (described in the following section), along with 26 plants, 694 cuttings, 21

leaf samples for DNA extraction, 117 plants for chemical analysis, and 549 seed packets, which were distributed to fulfill external requests for ornamental plant germplasm. This group encompassed 47 genera; those most in demand were *Echinacea* (325 packets, 21 leaf and 117 plant samples), *Sanvitalia* (18 packets), *Malva* (17 packets), and *Tanacetum* (17 packets). In addition, 45 seed packets were distributed of mint family germplasm.

**Historical Summary of Distribution Activity:**

| Crop | Year | No. of Orders | No. of Recipients | No. of Items Distributed | No. of Accessions Distributed |
|---|---|---|---|---|---|
| Ornamentals[1] | 99 | 92 | 83 | 658 | 272 |
| | 00 | 84 | 79 | 596 | 282 |
| | 01 | 94 | 85 | 671 | 365 |
| | 02 | 103 | 89 | 779 | 361 |
| | 03 | 108 | 91 | 883 | 320 |
| Mint Family | 99 | 3 | 3 | 8 | 8 |
| | 00 | 3 | 3 | 37 | 35 |
| | 01 | 5 | 5 | 42 | 42 |
| | 02 | 4 | 4 | 22 | 19 |
| | 03 | 9 | 9 | 45 | 39 |

[1] Includes genera transferred to OPGC in 2002.

**Characterization/taxonomy:**

During 2003, the CGC-approved descriptor list for *Echinacea* was formatted for inclusion in the GRIN database. Morphological descriptions were completed for *Echinacea* in the old, three-year cage field to help verify taxonomic identifications. These evaluation data will be loaded into GRIN in 2004, once a curator for this collection has been hired. This will allow the research community to gain a better understanding of our collections and increase the efficiency of their use in research.

All the other herbaceous ornamentals in the same cage field, and many of the tree and shrub accessions being regenerated, were checked to verify identifications. In all, nine ornamental accessions were re-identified. During 2003, with assistance from Jeff Carstens, 19 images of ornamentals were added to our local database (Table 4). These will also be loaded to GRIN in the coming year.

**Evaluation:**

An extensive collection of evaluation data was received from NC-7 Trial Site Cooperators and has been loaded into our Access database. These data will also be summarized and loaded to our Internet database (described further in the section “Coordination of the NC-7 Regional Ornamental Trials”) in 2004.

**Enhancement:**

There was no major progress to report with enhancement activities in 2003.

**Coordination of the NC-7 Regional Ornamental Trials:**

Plant Distribution - In 2003, Mark Widrlechner and Alicia Polsley distributed 497 plants of 11 accessions (plus six replacement plants) to 21 sites for long-term evaluation, with an additional 293 plants of those 11 accessions provided to 15 public gardens. As part of that process, during the spring, Mark Widrlechner delivered plants and met with cooperators in Iowa, Nebraska, Kansas, and Missouri.

Many of the tree and shrub seed collections from Ukraine have been germinated and distributed for long-term testing in the NC-7 Trials (eight accessions in 2003 and two more accessions scheduled for distribution in 2004). These materials have been evaluated with two overall goals: finding well-adapted, new landscape plants for the North Central Region and testing scientific hypotheses about the relationships between soils, climates, vegetation patterns and woody plant adaptation. A follow-up report on the collection trip was published in the Ukrainian journal, Agrarna Nauka i Osvita.

Computer-generated, "One-, Five-, and Ten-year Performance Report" forms were distributed to trial-site cooperators this summer. Five updates were emailed or sent to trial cooperators in 2003 to inform them about recent developments in the testing program. One of the major developments that connect us more closely to trial sites is our NCRPIS home page on the Internet. The only significant change to the website in 2003 was made by David Kovach, who loaded Mark Widrlechner’s PowerPoint presentation on "Geographic Analysis and Exploration in the South Central United States," presented to the Annual Meeting of the Midwest Plant Collecting Collaborative in Saint Louis in April. Evaluation data from the Trial sites that are being managed in Access will be uploaded to the website in 2004.

An extensive collection of reports on the evaluation of NC7 Trial Plants was published from the 1960s until about 1980. These reports are not widely available. During 2002, Kyle Cavanaugh scanned these reports and created .pdf files. These reports will also be placed on our website in 2004.

2004 marks the 50$^{th}$ anniversary for the Trials. A half-day symposium marking this event is being planned for June 2004, in conjunction with a meeting of the Metropolitan Tree Improvement Alliance sponsored by the Morton Arboretum, Lisle, IL.

**Germplasm activities in crops other than those curated:**

Fourteen requests for accessions with special horticultural or agronomic characteristics (most for oilseeds, as a consequence of the departures of Mary Brothers and Rick Luhman) were handled by Mark Widrlechner, resulting in the distribution of 347 packets of seed.

With the help of Robert Stebbins, Germplasm Program Assistant, the Station’s acquisition of new germplasm from Indices Seminum was coordinated.

Work continued on a project by Mark Widrlechner, Lisa Burke, and David Kovach that assembled data on historical seed distribution rates and seed longevity under NCRPIS storage conditions to develop target seed-regeneration quantities for rapeseed, corn, domestic sunflowers, and cucumbers. This information is being prepared for publication in Genetic Resources and Crop Evolution.

Mark Widrlechner continued to work with Amalio Santacruz-Varela on a paper, describing patterns of genetic and morphological variation among New World popcorn germplasm, which was submitted to Crop Science in 2003 and is undergoing final revisions.

Throughout 2003, Mark Widrlechner actively participated in a university-industry-ARS collaboration to establish the Ornamental Plant Germplasm Center (OPGC), a new National Plant Germplasm System site in Columbus, Ohio, that focuses on the conservation of herbaceous ornamentals. He serves as the Agency's representative to administer a Specific Cooperative Agreement between ARS and The Ohio State University to fund the OPGC and has been assisting the new OPGC Director and Curator in its operations and integration within the NPGS. In February, Mark attended a National Floriculture Forum researchers' meeting sponsored by the OPGC and participated in their strategic planning process.

Mark Widrlechner chaired an in-house committee on medicinal/nutriceutical plants, and assembled (with Robert Stebbins' assistance) a spreadsheet that lists species used in traditional medicine and as nutriceuticals and displays NPGS's holdings for these species. During 2003, a draft of the spreadsheet was distributed to members of a Plant Germplasm Operations Committee (PGOC) subcommittee on Medicinal and Nutriceutical Plants charged with developing an NPGS-wide plan for enhancing the conservation and utilization of such germplasm.

In 2002, Iowa State University and the University of Iowa were awarded a five-year grant from the National Institutes of Health establishing a Center for Research on Botanical Dietary Supplements to study variation and bioactivity in *Echinacea* and *Hypericum*. Mark Widrlechner continued his involvement the Center through a subcontract to ARS. The subcontract supports the curation of *Echinacea* and *Hypericum* germplasm collections at the Station and the distribution of that germplasm so it can be evaluated for chemical composition, genetic diversity, and bioactivity. Two national searches were conducted in 2003 to hire a medicinal-plant curator. At the end of 2003, negotiations were underway with a promising candidate.

During 2003, Mark Widrlechner was involved with a number of other collaborative germplasm activities including a *Coriandrum* germplasm evaluation project being conducted by Pedro Lopez, a doctoral candidate at Iowa State University, who focused on morphological and phenological traits and essential oil composition during the 2003 field season, and Terry Isbell, National Center for Agricultural Utilization Research, Peoria, IL, who evaluated fatty acid composition in its seed oils; a project to capture digital images of historical Native American maize collections at the Missouri Botanical Gardens with Mark Millard and Lisa Burke; and studies investigating interactions between cucurbits and downy-mildew pathotypes with Aleš Lebeda, Palacký University, Czech Republic.

**Mark Widrlechner's other research and training activities:**

Collaborations continue with Welby Smith of the Minnesota Department of Natural Resources in preparing a treatment of *Rubus* for a new book on the woody plants of Minnesota and with the staffs of herbaria at the University of Wisconsin, National Arboretum, Missouri Botanical Gardens, and Ohio State University to identify and document their *Rubus* collections.

Collaborations also continue on the development of models to predict the risk of naturalization of non-native woody plants in Iowa. In 2003, Mark Widrlechner, Jeff Iles (ISU Horticulture Department), Jan Thompson (ISU Natural Resource Ecology and Management Department), and Phil Dixon (ISU Statistics Department) developed three predictive models that combine the geographic risk-analysis approach with biological attributes and tested an existing risk-assessment model. Results have been accepted for publication in Journal of Environmental Horticulture.

**Other Horticultural project training and staff development activities:**

In 2003, Mark Widrlechner and Jeff Carstens attended training sessions to satisfy continuing education requirements for tractor safety and state pesticide applicator certification. Jeff also traveled to Prosser, Washington in September to attend a DIVA-GIS training workshop. DIVA-GIS is a software package that serves as a geographic-information system for the management of biological resources.

**Communications Activities:**

**Manuscript and Proposal Review:**

Mark Widrlechner reviewed manuscripts through service on the Editorial Review Boards of Genetic Resources and Crop Evolution and the Journal of the American Rhododendron Society. He also served as a peer reviewer for manuscripts submitted to HortScience, Journal of Heredity, and Biochemical Systematics and Ecology, Czech Journal of Genetics and Plant Breeding. He reviewed grant proposals for the American Rhododendron Society, the Eastern Region of the International Plant Propagators' Society, the Landscape Plant Development Center, and the Center for Research on Botanical Dietary Supplements.

**Posters, Presentations and Seminars:**

Lebeda, A. and M.P. Widrlechner. 2003. Differentiation of *Pseudoperonospora cubensis* (cucurbit downy mildew) pathogenicity. Abstracts of the 8th International Congress of Plant Pathology, Christchurch, New Zealand, 2-7 February. Abstract 634, Host/pathogen Interaction Session.

Lebeda, A. and M.P. Widrlechner. 2003. Response of wild and weedy *Cucurbita* L. to pathotypes of *Pseudoperonospora cubensis* (cucurbit downy mildew). Abstracts of the 8th International Congress of Plant Pathology, Christchurch, New Zealand, 2-7 February. Downy Mildews Session, E3.7.

Millard, M.J., L.A. Burke, and M.P. Widrlechner. 2003. The North Central Regional Plant Introduction Station's southwestern maize collection - an historical perspective. ASA-CSSA-SSSA Annual Meetings Abstracts, November 2-6, 2003, Denver, CO on CD (Abstract of poster C08-burke847843 presented on 3 November).

Towill, L. and M. Widrlechner. 2003. Cryopreservation of willow species using winter vegetative buds. HortScience 38: 735-736 (Abstract of poster presented at the 2003 ASHS Centennial Conference, Providence, Rhode Island, 4 October).

Widrlechner, M.P. 2003. Geographic Analysis and Exploration in the South Central United States. Presentation made to the Annual Meeting of the Midwest Plant Collecting Collaborative in Saint Louis, 9 April.

Widrlechner, M.P., J.K. Iles, and J.R. Thompson. 2003. Developing a comprehensive strategy to assess the risk of naturalization of non-native woody plants in Iowa. Presentation to the Iowa Shade Tree Short Course, Ames, IA, 23 March.

Wurtele, E.S., L. Wu, J. Wendel, I. Alvarez, R. Rapp, B. Nikolau, M.A. Perera, G. Kraus, and M.P. Widrlechner. 2003. Genetic and phytochemical diversity in *Echinacea.* Poster presented to the NIH Botanicals Conference, UCLA, Los Angeles, CA, 28 June.

**Publications which appeared in print in 2003:**

Lebeda A. and M.P. Widrlechner. 2003. A set of Cucurbitaceae taxa for differentiation of *Pseudoperonospora cubensis* pathotypes. Journal of Plant Diseases and Protection 110: 337-349.

Widrlechner, M.P. and L.A. Burke. 2003. Analysis of germplasm distribution patterns for collections held at the North Central Regional Plant Introduction Station, Ames, Iowa, USA. Genetic Resources & Crop Evolution 50:329-337.

Yukhnovskiy, V. Yu., V.V. Svyatetskiy, M.P. Widrlechner, and R.E. Schutzki. 2003. Biodiversity of the forest component of the forest-agricultural landscape. (•••••••••••••• ••••••• ••••••••• •••••••••••• ••••••••• // ••••••• ••••• • •••••••.) Agrarna Nauka i Osvita UANNP "Feniks" 4(1-2): 70-75. (In Ukrainian).

**Departmental Activities:**

Mark Widrlechner continued as an active member of the Crop Seed Committee and the Plant Breeding and Genetics Advisory Panel of the Agronomy Department at Iowa State University. He also served on the Written Preliminary Exam Committee for the Plant Breeding and Genetics Advisory Panel and the Greenhouse and Growth Chamber Committee. He continued to serve as Co-major Professor for Pedro Lopez, a Ph.D. candidate in Plant Breeding, and on the Program of Study Committees for two Ph.D. candidates in Plant Breeding and an M.S. candidate in Sustainable Agriculture. He assisted Laura Merrick in teaching a 0.5 credit module of Agronomy 565D, Ethics in Professional Practice, dealing with plant genetic resources.

**Conclusions and Plans for 2004:**

**Curation**

Thanks to continuity gained through the retention of Alicia Polsley through the 2003 field season and the arrival of Jeff Carstens in June, we were able to sustain our active regeneration program at levels established during the last three years and were able to meet increased levels of demand for our collections (especially for *Echinacea*). The hiring and mentoring of a curator for medicinal plants will be among the top priorities for 2004.

Collection transfers to the OPGC have allowed us to focus more closely on a smaller set of herbaceous ornamental genera, especially on those genera that also have medicinal, aromatic or industrial uses, and on woody landscape plants, which were augmented through new collections made in Iowa as part of an NPGS-funded exploration in September, 2003.

**Research**

Considerable progress was made on the following three research projects during the past year: the development of three new models that combine location-based information with biological attributes to predict risk of woody-plant naturalization; the selection of an improved set of differentials to study interactions between cucurbits and downy-mildew pathotypes (with Aleš Lebeda, Palacký University, Czech Republic); and the completion of a draft key for the *Rubus* of Minnesota as part of a new book on the woody plants of Minnesota authored by Welby Smith, Minnesota DNR.

Research efforts during 2004 will include validating new comprehensive risk-assessment models for the invasiveness of non-native woody plants in the Midwest, completing a study that examines long-term germplasm records and distribution history to estimate target quantities for seed regeneration for publication, work with Leigh Towill to develop practical protocols for routine cryogenic storage and plant recovery of *Salix* clones, and collaborative projects to evaluate our collections of medicinal and aromatic plants, emphasizing collaborations through the Center for Research on Botanical Dietary Supplements. Mark Widrlechner will also participate in the completion of ongoing studies on the genetic diversity of the Station's germplasm collections, including research on popcorn by Amalio Santacruz-Varela and *Coriandrum* by Pedro Lopez. Studies will also continue on the biosystematics of *Rubus* and the dynamics of the local flora, with special attention paid to the role of exotic species.

**Staff Development**

Plans for staff development for 2004 will focus on training for Jeff Carstens and for the new medicinal-plant curator, funded in part by the Center for Research on Botanical Dietary Supplements. Training experiences for Jeff are likely to include attendance at the Eastern Region Annual Meeting of the International Plant Propagators' Society, the

Iowa Shade Tree Short Course, visits to local nurseries, and Microsoft Access coursework.

**d. Plant Pathology (C. Block, B. Van Roekel)**

**Research Notes:**

**Maize (*Zea mays*):**

The national maize germplasm evaluation program moved into its fourth year, with 1500 accessions sent to cooperating pathologists. Diseases evaluated included gray leaf spot, southern corn leaf blight, maize dwarf mosaic virus, and Fusarium and Diplodia ear rots. At Ames, we evaluated 650 accessions in 3 replications for Stewart's wilt resistance.

Charles Block co-authored a manuscript entitled 'Ability of an ELISA-based seed health test to detect *Erwinia stewartii* in maize seed treated with fungicides and insecticides' by J. K. Pataky, Univ. of Illinois; C. C. Block, USDA-ARS, P. M. Michener, Univ. of Illinois; L. M. Shepherd and D. C. McGee, Iowa State Univ; and D. G. White, Univ. of Illinois. The manuscript was accepted by Plant Disease.

**Sunflower:**

Charles Block prepared for release two wild *Helianthus annuus* germplasm populations selected for resistance to Alternaria leaf blight, Septoria leaf blight and powdery mildew. These populations exhibit a hypersensitive type of leaf spot resistance that is not found in cultivated sunflowers.

Three sunflower disease nurseries were planted, the first to evaluate wild *H. annuus* accessions for Alternaria leaf blight resistance, the second to evaluate accessions from several species for Septoria leaf blight resistance, and the third to test a geo-statistical model for Septoria-resistant wild *H. annuus*.

In the *Alternaria* nursery, 35 of the 44 PIs had average disease scores of $\leq$2.0 on a 1-5 scale, indicating very little disease. Low rainfall may have been partly responsible for the low disease scores, but the resistance in this material has been quite good. The top ten (most resistant) PIs were PI 435418 (TX), PI 435428 (TX), PI 435424 (TX), PI 435427 (TX), PI 435594 (AZ), PI 468514 (TX), PI 468519 (TX), PI 468451 (TX), PI 547167 (IL), and PI 586861 (KS). Seven of the 10 made last year's top ten list as well - PIs 435418 (TX), 435424 (TX), 435428 (TX), 468514 (TX), 468519 (TX), 468451 (TX), and 547167 (IL).

In the *Septoria* nursery, data was collected on 61 of the 85 accessions; the others died early due to drought. Thirty-nine accessions had average disease scores of $\leq$2.0 on a 1-5 scale. As in 2002, the most Septoria resistant species included *H. argophyllus*, *H. atrorubens*, *H. debilis*, H. *giganteus*, *H. praecox*, *H. mollis*, and *H. occidentalis*. Resistance in *H. annuus* and *H. petiolaris* accessions was more variable.

The third nursery was the first test of a statistical model developed to predict geographic areas in the U.S. where Septoria-resistant wild sunflowers might be found. Sixty-nine accessions and three checks were planted in four replications and rated for disease development. Differences in resistance were observed among groups, but the experiment was hindered due to drought and wind damage. The experiment will be repeated in 2004.

**Amaranthus (various species):**

Amaranth research goals have focused on resistance to Pythium stem canker, particularly in the grain type accessions. The weedy species such as *A. palmeri, A. tuberculatus*, *A. retroflexus*, and A*. spinosus* have consistently showed superior resistance. The grain-types have shown more variable responses, both between and within accessions. We continue to evaluate more plants in an attempt to better characterize the resistance.

**Cucurbits:**

We conducted a small survey of beetles collected from cucurbits to assess their potential as virus vectors. Northern, southern and western rootworm beetles plus striped cucumber beetles (184 beetles of each type) were tested by ELISA for the presence of five viruses, squash mosaic, cucumber mosaic, papaya ringspot, zucchini yellow mosaic, and watermelon mosaic virus. No beetles were infected with cucumber mosaic, papaya ringspot or zucchini yellow mosaic viruses. A few beetles were weakly positive for watermelon mosaic virus, but more than 40 tested strongly positive for squash mosaic virus.

**Disease observations on seed increase crops:**

Field observations for plant diseases were made in the seed increase plots of *Brassica*, cucurbits, sunflower, amaranth and maize. Accessions were inspected to verify the presence or absence of diseases of phytosanitary interest.

***Brassica* and related *Brassicaceae* genera:**

Regeneration plots were inspected on 13-June-2002. Forty-one of the 52 accessions were completely free from diseases. The other 11 accessions had some black rot infection, a bacterial disease caused by *Xanthomonas campestris* pv. *campestris.* Black rot infection was low except for two accessions; PI 388731 (Isatis lusitanica) and PI 426698 (Eruca sativa). Those accessions had >25% of the leaves infected on June 13 and about 75% infected leaves three weeks later.

**Cucumber and melon (*Cucumis sativus* and *C. melo*)**:

Disease notes were taken on the *Cucumis sativus* and *C. melo* seed-increase accessions on 17-Jul-2003 and again on 09-Sep-2003. Bacterial fruit blotch (BFB) symptoms, caused by *Acidovorax avenae* ssp. *citrulli*, were observed on leaves of 98 of 141 melon accessions in mid-July and on 113 of 141 melon accessions on 09-Sep-2003. BFB symptoms were absent from all *C. sativus* accessions. Leaf samples were collected from all infected accessions to confirm bacterial infection. All harvested *C. melo* seed was soaked for 15 minutes in 1% hydrochloric acid as a disinfectant against BFB infection.

Powdery mildew (*Sphaerotheca fuliginea*) was barely detectable by mid-July, but reached damaging levels on several cucumber accessions by late August. The melons were generally less affected. Some resistance was shown in the cucumbers as four accessions had powdery mildew during the entire season: PI 500372, PI 511817, and PI 618961 and four developed only trace levels of mildew: Ames 1763, PI 267747, PI 390255, and PI 426169.

Anthracnose (*Colletotrichum orbiculare*) was found on six cucumber and three melon accessions in early September, but reached moderately severe levels (>25% of the leaves infected) in only two cucumber accessions, Ames 26049 and Ames 26916, and two melon accessions, PI 234607 and PI 401610.

Bacterial wilt (*Erwinia tracheiphila*) was observed in a few cages. As noted in 2002, plants probably became infected by cucumber beetle vectors feeding on leaves pressed against the sides of the cages. Beetle populations were extremely high in 2003, as they were in 2002.

**Cucurbit virus-testing:**

All cucumber, melon, squash and pumpkin seedlings were tested for squash mosaic virus (SqMV) by ELISA before transplanting (235 PIs, 6316 plants). No infected seedlings were found among any of the cucumbers (747 plants). Four plants were discarded from the melons (4766 plants), and 14 plants were discarded from the squash and pumpkins (803 plants). Insecticides were applied weekly to the non-caged pumpkin and squash plantings, but SqMV was widespread by late June, due to tremendous cucumber beetle pressure. Symptoms were observed in every hill in the field (23 accessions with 6-8 hills each) and a decision was made to destroy the planting on 7/3/2003.

**Sunflower (*Helianthus annuus*):**

The main phytosanitary disease for U.S.-grown sunflowers is downy mildew, caused by *Plasmopara halstedii*. All seeds were treated before planting with Allegiance (metalaxyl) fungicide. No DM-infected seedlings were found in field NF4 in either the cultivated or the wild accessions. Few other disease problems were noted except for three virusy-looking seedlings that were pulled.

**Corn (*Zea mays*):**

We inspected 530 maize seed increase plots during August and early September and rated disease incidence (and sometimes severity) for Stewart's wilt, common rust, common smut, gray leaf spot, and northern leaf blight. Only two diseases were found at a high incidence, Stewart's wilt and common rust.

***Amaranthus tricolor*:**

We evaluated the *Amaranthus tricolor* plots for reaction to infection by *Phomopsis amaranthicola*. The *Phomopsis* impact was reduced by strong presence from stem weevils and dry weather during July and August. Weevils, along with the root and crown rot, caused the early death of many plants. Phomopsis leaf and stem blight did not develop into much of a problem. Some of the crosses showed less disease than other entries in the field in the field, but it was difficult to judge resistance because of the confounding factors.

**Laboratory seed health testing:**

We conducted lab tests on 322 maize seed lots for *Erwinia stewartii*, 230 maize seed lots for *Clavibacter michiganensis* ssp. *nebraskensis*, 55 maize seed lots for *Cochliobolus carbonum*, *Cochliobolus heterostrophus*, *Diplodia maydis* and *D. macrospora*, and 230 maize seed lots for *Cercospora sorghi*, *Phyllosticta maydis*, and *Ditylenchus* nematodes. Seed testing results were entered into our local database and uploaded to GRIN.

**Meetings and workshops:**

Charles Block:

Attended the annual Seed Technology Conference at Ames;

Attended the American Phytopathological Society meeting at Charlotte, NC;

Participated in a two-day Seed Pathology Workshop at Charlotte, NC;

Participated in APS seed pathology committee meeting; recorded meeting notes; maintained and updated the committee's APS website;

Presented a talk on "Disease Evaluations in Amaranth" at the Amaranth Institute Research Conference at Ames, IA.

**Other activities:**

Charles Block:

Served as NCRPIS liaison with USDA-APHIS and with the Iowa Department of Agriculture and Land Stewardship for phytosanitary issues and regulations.

Visited Dr. Ron Walcott's lab at the Univ. of Georgia for three days to learn techniques for standard PCR, immuno-capture PCR, real-time PCR, and REP-PCR.

Participated in 5-week visit by Ron Walcott, at the ISU Seed Science Center, to continue PCR work and develop collaborative research.

Served on the M.S. committee for Blucher Menelas in Plant Pathology and on Ph.D. committee for Paul Esker in Plant Pathology and Statistics.

Gave invited talk to grad class, PlP 594 (Seed Pathology), on 'Statistically-based Sampling for Seed Health Testing'.

Hosted one-day visit and tour of NCRPIS and ISU Seed Science Center for Dr. Gary Kong, a sunflower plant pathologist from Australia.

Served as chair of NCRPIS safety committee and as the Station's contact person for implementation of ARS safety programs.

**2004 project plans:**

We plan to continue host plant resistance evaluations in the field with maize screening for Stewart's wilt resistance and sunflower screening for Septoria leaf blight resistance.

The sunflower field experiment to evaluate the geo-statistical model for Septoria-resistant wild sunflowers will be repeated.

We plan to explore immunocapture-PCR and real-time PCR for detecting bacterial plant pathogens from seed, using *Erwinia stewartii* from corn and *Acidovorax avenae* ssp. *citrulli* from melon as model organisms. The long term goal would be to develop non-destructive methods for detection of seed borne pathogens.

We will conduct additional evaluations of amaranth for resistance to Pythium canker.

Adult rootworm beetles were collected from cucurbits in summer 2003. Lab assays (ELISA) will be run for several cucurbit viruses to complete the second year of the beetle survey.

We will begin work on developing a greenhouse assay for assessing Verticillium resistance in cultivated sunflower.

We will continue our long-term tradition of providing support to the curators in the areas of disease diagnosis, disease management, and phytosanitary issues.

**e. <u>Zea Curation (M. Millard, G. Crim, L. Pfiffner)</u>**

**Construction:**

Remodeling was completed on the maize curator's office converting the old imaging room to office space. New furniture was installed consisting of work area, storage, and a meeting table. The curator moved to this new location during the summer of 2003. The new location positions the maize curator next to the main maize processing area and next to the GEM project farm office.

**Equipment:**

New smaller Pentium IV computers for eight multipurpose maize processing workstations were installed in 2003. These computers replaced hand-me-downs from other NCRPIS staff that required much support from the maize curator. Data acquisition throughput has been enhanced and the need for technical support reduced with this addition.

**Personnel:**

The maize curation project permanent staff remained essentially the same during 2003 with an ISU Curator II, ISU Field Tech II, and a GS-5 Federal term Biological Science Lab Technician making up the core maize team. At the start of 2004 Ms. L. Pfiffner, who served the maize term technical position, was hired as the seed storage technician within the NCRPIS.

Additionally Mr. M. Millard, the maize curator, acted as NCRPIS IT manager beginning in July after the departure of Mr. R. Luhman whose duties included Brassica curation and IT management. The student staff was converted from ISU employees to federal student employees, as was done with all student staff within the NCRPIS unit.

**Research Progress:**

The maize curator and two additional NCRPIS staff visited the Missouri Botanical Gardens Herbarium in March 2003 to examine the maize ear collection there. A flatbed scanner and computer were transported and used to scan original ears collected by Hugh Cutler, William Brown, and Edgar Anderson. These collections corresponded to those deposited in the NCRPIS collection in the 1950s. They were obtained from Native American tribes across the U.S. but focused on the U.S. Southwest and Oklahoma. Additionally it was confirmed that a collection donated by Dr. William Brown at Pioneer actually was collected between 1924 and 1936 by an unidentified organization and then acquired by Anderson. These are the earliest accession collection dates for NCRPIS maintained collections. A poster was composed by Millard, Burke, and Widrlechner documenting the accessions from the tribes in the Southwest using these images and displayed at the Agronomy meetings in Denver in 2003. A large number of ears collected by Cutler in South America were also discovered in the herbarium. These accessions predate the Rockefeller collections and some correspond to seed in the Galinat-Mangelsdorf collection. It is hoped that a return trip will allow scanning of these accessions. The NCRPIS is very grateful to the staff at MBG for their excellent cooperation.

The maize curator and NCRPIS research leader attended a meeting of the Latin American maize genebank curators at CIMMYT. The event was used to review the needs in maize regenerations and characterizations across the Western Hemisphere. Views were exchanged on how best to do this. CIMMYT has a World Bank grant to provide funding to banks for regenerations and other maize germplasm programs, and was developing a joint funding proposal with the Latin American researchers.

Work continued on the Races of Maize CDs. Permissions on the use of copyrighted materials were not yet forthcoming on several materials thought to be needed for a complete document. Documents will be excluded from the imaged materials and a new arrangement of the materials on the CDs will be completed in early 2004. A third and final version of the CDs will be constructed and distributed.

The new GRIN forms were completely adopted by the NCRPIS maize curatorial staff in 2003. Work began on addressing enhancements to public GRIN.

Over sixty GEM accessions were regenerated by the NCRPIS curatorial staff in

preparation for final public release. A field tour was given to the GEM Technical Steering Group of these accessions and the methods used in their regeneration. A last visual observation was made by GEM breeders prior to final disposition.

**Acquisition:**

During 2003, Table 1 shows there were 231 new accessions received, 30% less than 2002 and a third of what was obtained in 2001. These included 172 inbreds from Dr. Major Goodman from molecular marker studies, 13 expired PVPs (Plant Variety Protected), 9 new CSRs (Crop Science Registered), 6 old sweetcorn populations from Dr. Bill Tracy, 23 GEM accessions from Dr. Linda Pollak, and 1 GEM accession from Dr. Richard Pratt.

**Regeneration:**

There were 438 accession regenerations attempted in Ames in 2003 compared with 296 in 2002 and 200 in FY 2001. This number is somewhat inflated because there were 150 single row inbred increases of small quantities of new inbreds received from Major Goodman whereas the normal increase requires 10 rows. Regenerations included 154 populations and 284 inbreds. The populations included 28 Canadian synthetics and 65 possible GEM accessions. The inbreds included 19 expired PVP lines and 189 inbreds that Goodman donated.

While moisture on the whole was adequate, the end of the pollinating season was dry and for the third year in a row we irrigated the inbred lines. The populations appeared to have survived well on subsoil moisture' the NCRPIS does not have the facilities to support irrigation of the entire increase acreage. Again in 2003 we planted 50 very early populations in mid-April and the remainder in mid-May to spread pollinations. Heat units were fewer than average in May-June; we started pollinations on June 27th and finished on September 1st.

Ninety-three accessions were grown at the ICIA facility near Ponce, Puerto Rico. The maize curator and technician, with a considerable amount of help from the GEM technician, made the pollinations. The total is somewhat inflated because there were 46 single row increases of accessions with a limited amount of original seed that will require a second round of regeneration to become available. The normal increase requires 20 short rows to obtain 100 ears. Germination was excellent on these single row increases. The NCRPIS supports the entire cost of this nursery.

A second tropical regeneration nursery initiative was begun in Puerto Rico. The NCRPIS planted a second tropical planting in Puerto Rico at the Golden Harvest facilities near Ponce, Puerto Rico in the summer of 2003. Unlike previous tropical nurseries, this nursery and subsequent follow-up tropical nurseries are intended to be maintained and pollinated entirely by the organization providing the service. Nursery inspection tours will be performed irregularly by NCRPIS staff, but the NCRPIS staff will not spend weeks in Puerto Rico pollinating. Ears will be shipped back to the NCRPIS for procession and data acquisition. This effort should relieve an NCRPIS staff availability bottleneck due to time demands and limited number of staff. This should allow for multiple tropical nurseries to be grown of increasing size as resources become available thereby increasing tropical regeneration throughput. Federal regulations require that contracts in excess of $25,000 go through a procurement process that requires listing in the Federal Business register and enables companies to compete for Federal business through a bidding process.

Seeds from two accessions of *Zea perennis* were harvested from four accessions grown in the Ames greenhouse during 2002. These accessions can be maintained clonally indefinitely; as sufficient seed quantities are harvested, the clones are discarded.

Fifty-seven more accessions were sent to St. Croix for regeneration during the summer of 2003.

One Gaspe flint-like accession was attempted in isolation at the NPGS site at Palmer, Alaska in 2003. This was a repeat of an attempt made in 2002. Frost again occurred in August terminating the growing season prematurely and it was agreed that this site is not dependable enough for short season maize accessions though sweetcorn is grown in the area.

Monsanto grew 11 increases at their Hawaiian Research Station on Molokai, Hawaii. This was done in exchange for the unusually large distributions for their History of Corn demonstrations.

Fifteen maize inbreds of southeastern U.S. adaptation with very low seed quantities were sent to Hebron Smith, D&H Farms at Guthrie, Kentucky in FY '03. We have received 4 that he regenerated in his greenhouses. The remainder will be regenerated in the future.

One teosinte accession was grown by D&H Farms in their greenhouse in isolation.

**Maintenance:**

Table 1 indicates that accession availability was maintained at 64% though the number of accessions increased by 231 accessions. This indicates that the 411 accessions made available indicated in table 2 just covered the number of new accessions obtained plus the number of accessions made unavailable due to depleted supply or reduced viability. This indicates that though regenerations were increased as indicated in the above discussion, the NCRPIS must increase regenerations even more in future years to maintain availability.

Maize collection viability testing proceeded at a reduced rate in 2003. There were 899 accessions or 5% of the collection tested in 2003 compared to 4,140 accessions in 2002 and 1,567 in 2001. This reduced testing was permitted by the emphasis on maize testing in 2002 bringing the five year monitoring cycle up to date. This allowed more NCRPIS testing resources to go to other crops in 2003. Maize testing is expected to increase in 2004. Viability testing detected 33 accessions (3.7% of those tested) that were less than 50% viable for the first time compared to 49 (1.2%) in 2002. This does not represent more rapid deterioration of the collection. It reflects the fact that the curator focused testing on accessions suspected of deterioration.

**Distribution:**

North Central Regional Plant Introduction Station (NCRPIS) accessions are now available through MaizeGDB (Maize Genetics and Genomics Database) shopping cart at http://www.maizegdb.org/. Those querying the MaizeGDB can query on all stock (accession) names and accession numbers like PI, NSL and Ames numbers in GRIN. There are links to the GRIN database descriptions via these identifiers. Additionally, a request can be made from a MaizeGDB shopping cart query and forwarded to the NCRPIS for processing. A list of identifiers and available accessions are sent to MaizeGDB by the maize curator on a regular basis for updating links and to minimize requests for unavailable accessions.

The NCRPIS was able to send maize seed to mainland China for the first time in several years. The NCRPIS receives less then a handful of orders from China annually. Requestors evidently were unable to procure the necessary import permit from their government because permits required for seed exchange were not received. Thanks to the efforts Dr. Mei Tao, of the Chinese Academy of Agricultural Sciences, Institute of Crop Germplasm Resources, Division of Plant Introduction, Beijing, China; we sent 1500 to 3000 seeds of 6 shrunken endosperm types. Each shipment requires a form for each

accession. We plan on contacting past Chinese requestors and sending enough seed on accessions of interest to deposit a larger increase in the Chinese bank for more local distribution to current and future requestors. This should minimize the paperwork necessary for such exchanges. The NCRPIS has not received maize germplasm from China in several years. If this exchange proves successful, we would like to bring in materials to compliment our Chinese collection.

We distribute 5,368 packets (Table 3) in 2003 compared to 7,258 in 2002. The reduction is attributed to fewer pathology screenings in 2003. In 2003 the Monsanto "History of Corn" demo was repeated and combined into one large order. They redistributed 700 packets of seven accessions to over 100 separate demonstrations.

| CROP | Year | No. of Orders | No. of Recipients | No. of Items Distributed | No. of Accessions Distributed |
|---|---|---|---|---|---|
| Maize | 1999 | 231 | 167 | 4536 | 2805 |
| | 2000 | 257 | 193 | 18480 | 10981 |
| | 2001 | 313 | 210 | 7269 | 4637 |
| | 2002 | 426 | 285 | 7258 | 4006 |
| | 2003 | 257 | 190 | 5368 | 2938 |

**Characterization:**

There were 13,062 data points relating to 14 ear descriptors on 980 accessions loaded into GRIN in 2003. This compares with 8,834 data points on 450 accessions in 2002 and 15,623 on 847 in 2001.

We obtained 4,512 images on 1,594 accessions in 2003 compared to 6,451 images on 3,323 accessions in 2002 and 7,010 images obtained on 3,756 accessions in 2001. There was at least one digital image on 13,870 accessions or 76% of the maize collection. Additionally 685 slide images of earlier increase lots were converted to digital images via slide scanner compared to 1,789 the year before.

**Evaluation:**

The maize disease resistance-screening program continued in 2003.

Three hundred accessions were selected and sent to Dr. S. Moore at Louisiana State University for low aflatoxin production and therefore *Aspergillus* ear rot resistance. Initially he planned to obtain data on ears per se during the 2003 growing season, but after observing the diversity in the materials and the late maturity in the tropical accessions that he had hoped to see resistance in, he sent the same three hundred to Florida over the winter and made topcrosses with the susceptible check Mo17. In 2004 he will observe the material in a nursery in Louisiana that consistently shows high *Aspergillus flavus* ear infections.

Dr. W. Dolezal with Pioneer Hi-Bred International, Inc. planted 250 accessions in Johnston, Iowa to observe northern leaf blight resistance and *Diplodia* ear rot resistance. *Diplodia* infection was not high, but northern leaf blight resistance was observed. Preliminary indications are that there is resistance in the Cateto races Camelia from Chile, Cristalino Colorado from Argentina, and Cateto Sulino from Uruguay. Additionally he observed that this nursery of wide temperate diversity displayed a high percentage of damage by the herbicide Calisto (active ingredient mesotrione). While many of the accessions grew out of the damage, common corn smut infection was heavier than average due to this damage. He hosted a tour of the nursery at Pioneer for the NCRPIS maize curator, NCRPIS GEM coordinator, and NCRPIS research leader.

Dr. C. Block of the NCRPIS evaluated 635 accessions for Stewart's wilt resistance. The majority of this nursery consisted of inbred lines in the collection.

Syngenta receive 100 accessions that were screened at each of three nurseries. Southern corn leaf blight resistance was evaluated at Bloomington, Illinois. Northern corn leaf blight race 1 and 0 and eyespot resistance were screened at Stanton, Minnesota. Carbonum race 3 was screened at Hampton, Iowa.

Two hundred accessions were sent to Dr. E. Stromberg at Blacksburg, Virginia for gray leafspot screening and 100 accessions were sent for MDMV screening.

One-hundred-seventy-six accessions from the maize collection and 49 from GEM were sent to a Pioneer Hi-Bred International, Inc. location in Brazil for southern rust screening and for determining southern rust differentials for classifying resistance to specific southern rust races. This undertaking demonstrated the difficulties that can be experienced when trying to use in-kind support from overseas companies to screen the U.S. maize germplasm collection for diseases with hot spots overseas that threaten U.S. corn production. Brazil has an extensive list of pests that require a declaration that the seed supplied was either observed growing in an area free of the listed pests or that the sample has undergone laboratory tests demonstrating freedom from these pests. The majority of the NCRPIS tropical accessions have been obtained from suppliers outside of the United States and therefore a lab test must be performed on them. These tests are expensive in time, materials, and seed required.

Twenty-two accessions were sent from the regeneration nursery to Mr. Ken Zeigler for popping expansion evaluation.

Ms. S. McClurg of the NCRPIS entomology group screened 636 accessions for first generation European corn borer resistance.

**Communication:**

A demonstration planting of the maize races of the U.S. was toured twice by ISU researchers. Many graduate students working normally with maize DNA sequence diversity were provided with the opportunity to see the phenotypic diversity in the field. This planting doubled as a regeneration nursery and as a source of materials for a student thesis intended to compare methods for obtaining characterization data from images of ears to that obtained on the ears themselves. Additionally, open pollinated ears will be compared to control pollinated ears.

Many groups who tour the farm observe the maize imaging project as part of their learning experience. This has been a popular demonstration over the past few years with visitors, and has increased awareness of image availability in GRIN.

**2004 Project Plans**

**Acquisition:**

In 2004, we wish to obtain accessions held by Major Goodman at N.C. State which were used in molecular and evolutionary studies. These valuable accessions are currently not held by NCRPIS, nor can they be obtained from other genebanks. In 2002, we initiated arrangements to transfer these accessions. Major explained that population size was not a consideration when he originally regenerated these accessions, and that samples from regenerations using larger effective population sizes would be better. He also provided helpful history on the collections and their identifiers that will help ensure that only unique accessions are obtained. The NCRPIS maize project will continue to procure the core accessions (not already been incorporated into the collection) designated by CIMMYT and published in CD format from the LAMP project. The NCRPIS will try to further identify and fill gaps in maize racial populations, and to acquire more of the Caribbean accessions from CIMMYT in 2004.

There will by continued exchanges of accessions between NCGRP, CIMMYT, and NCRPIS. NCRPIS would like to obtain at least one accession from each of the type collections for each race described in the Races of Maize bulletins. CIMMYT will be the best source for obtaining these accessions. Additionally we need to procure more of the LAMP core, CIMMYT core, and Caribbean accessions. We must obtain more guidance on International exchange issues in 2004.

**Regeneration:**

Tropical regenerations will be expanded to 150 to 200 accessions per year by funding competitive projects for regenerating tropical maize to NCRPIS specifications.

Regenerations in Ames will be maintained at 250-300 accessions annually. Dr. Widrlechner, in association with other NCRPIS staff, has documented that maize accessions are consistently lasting 30-35 years under our current conditions of cold storage of 5˚ C and 20% relative humidity. Since half the collection of 18,000 accessions is temperate adapted, calculations indicate that 300 regenerations/year are required to maintain the collection. Any additional accessions regenerated would contribute to eliminating the backlog of some 6,000 accessions.

Quarantine regenerations on St. Croix will continue at the 30-50 accession level during 2002.

**Maintenance:**

The last of the Goodman tropical increases from Mexico will be backed up in 2004 at NCGRP, and 500 kernel samples will be distributed to CIMMYT. Additionally, we will send several hundred accessions to CIMMYT from other LAMP countries, which the NCRPIS holds, but CIMMYT does not.

We will send several hundred accessions of maize to CIMMYT which represent U.S. landraces. This will enhance CIMMYT’s ability to serve as an international center for maize germplasm. It also demonstrates U.S. policy of freely sharing unencumbered farmer varieties. Seed is abundant for most of these landraces since increasing them at the 100-ear population size generates large seed quantities.

The NCRPIS, NCGRP, CIMMYT, and Dr. Wilfredo Salhuana will work on a continuing project to develop and cross reference a consolidated list of the holdings of the various L.A. countries’ maize germplasm collections, the CIMMYT collection, and U.S. collections in order to identify materials that may be at imminent risk of loss.

Viability tests will be increased in 2004 to maintain the maize testing schedule to provide timely data for regeneration priorities.

**Evaluation:**

The maize curator will continue to work with the NCRPIS pathologist and interested private and public pathologists to systematically obtain data on maize pathogen resistance in the collection. Additional evaluation information will result in more effective use of accessions in the future.

The project will continue planting observation plots to obtain maturity data. Additionally, older data from field book sources will be gleaned for inclusion into GRIN. Maturity data is one of the most important pieces of data determining selection of accessions which meet researchers' objectives and allows them to plan their work.

Much of the data on the maizeDB database is being made available on a new database at Iowa State currently called MaizeGDB. We will be working with this database in 2004 to create more links to the maize data on the GRIN database. The idea is to have one stop shopping for all maize related data.

Loading of existing molecular marker information and frequencies on collections held at the NCRPIS will continue. After finishing the N.C. State isozyme data, we will add SSR data obtained here at the NCRPIS.

I will attempt to augment the collection of images for 2,000 accessions on GRIN with images of an additional 10,000 accessions in fiscal 2004.

**Other Items:**

The Races of Maize CDs should be ready for public release in 2004.

The NCRPIS will be hiring a full time permanent federal technician to replace the temporary position filled by Ms. Pfiffner.

**f. Vegetables (K. Reitsma, L. Clark)**

Collections curated by the Vegetable Project include *Cichorium* (NC7-chicory), *Cucumis sativus* (NC7-cucumis.cucs), *Cucumis melo* (NC7-cucumis.melo), *Cucumis* species (NC7-cucumis.wilds), *Cucurbita pepo* (NC7-cucurbita), *Cucumella aspera and Oreosyce africana* (NC7-cucurbits.misc), *Daucus* (NC7-daucus), *Ocimum* (NC7-ocimum), and *Pastinaca* (NC7-parsnips). Statistics for accession numbers and availability for each site crop are found in Table 1.

**Acquisition:**

Thirteen new accessions were received and are listed by site-crop in Table 1. Eleven accessions were old *Daucus* varieties from the National Center for Genetic Resources Preservation in Ft. Collins, CO incorporated into the NCRPIS collection after regeneration by cooperators. One accession of wild *Cichorium* from Poland and one accession of wild *Pastinaca* from Finland were acquired from seed indices.

**Maintenance:**

Table 2 contains 2003 data for regenerations attempted and accessions harvested.

Cucurbit regenerations focused primarily on accessions having low seed distribution quantities. Many of the *Cucumis melo* accessions were regenerated from seed lots received from the SRPIS in Griffin, GA. Seed lots from this site have been the source of Bacterial Fruit Blotch (*Acidovorax avenae*) infections. This year, the disease was very prevalent in our cage increases, so all *C. melo* seeds harvested were treated with 1% hydrochloric acid during the extraction process to clean the bacteria from the

surface of the seeds. Squash Mosaic Virus was also very prevalent this summer with nearly 100% infection in the *Cucurbita* field planted for hand pollination. A decision was made to destroy the planting to prevent possible transmission to cucurbits in the cage increase program. We have developed a prototype cage for regenerating *Cucurbita* accessions and will test 10 cages in the summer of 2004. (For additional information on these two diseases, please refer to the Plant Pathology section of this annual report.)

The *Daucus* regeneration efforts have been primarily directed towards making newly acquired accessions available. In addition to the regenerations in Ames, we received *Daucus* seed increases from R. Maxwell, Seminis Vegetable Seeds, Idaho (5 accessions), and R. Freeman, Sunseeds, Oregon (9 accessions). Accessions regenerated by Maxwell and Freeman were “at risk” old cultivars with low viability at NCGRP. These accessions will receive PI numbers and be incorporated into the NCRPIS collection.

As accessions are regenerated, seed samples are sent to NCGRP for back-up. Seven of the vegetable collections have 75% or more of their accessions backed up at NCGRP (Table 2).

In 2003, 253 germination tests (Table 2) were performed, most of which were conducted on seed increases from the 2002 regenerations.

**Distribution:**

Packet and accession distributions for the vegetable collections are summarized in Table 3. In 2003, 2771 packets (items) were distributed. Distribution history for the last five years can be found in the following table.

| Crop | Calendar Year | No. of Orders | No. of Recipients | No. of Items Distributed | No. of Accessions Distributed |
|---|---|---|---|---|---|
| *Cichorium* | 1999 | 6 | 5 | 123 | 115 |
| | 2000 | 5 | 5 | 52 | 52 |
| | 2001 | 6 | 6 | 288 | 175 |
| | 2002 | 8 | 8 | 261 | 134 |
| | 2003 | 8 | 7 | 192 | 144 |
| *Cucumis* | 1999 | 54 | 46 | 3064 | 2085 |
| | 2000 | 60 | 45 | 1555 | 1235 |
| | 2001 | 59 | 49 | 1230 | 934 |
| | 2002 | 73 | 62 | 3089 | 1938 |
| | 2003 | 48 | 37 | 1905 | 1394 |
| | | | | | |
| *Cucurbita* | 1999 | 16 | 15 | 170 | 137 |
| | 2000 | 19 | 18 | 457 | 363 |
| | 2001 | 22 | 20 | 288 | 156 |
| | 2002 | 20 | 17 | 165 | 132 |
| | 2003 | 12 | 12 | 194 | 168 |
| Cucurbits - Mics. | 1999 | 2 | 2 | 2 | 1 |
| | 2000 | 0 | 0 | 0 | 0 |
| | 2001 | 2 | 2 | 2 | 1 |
| | 2002 | 0 | 0 | 0 | 0 |
| | 2003 | 1 | 1 | 1 | 1 |
| *Daucus* | 1999 | 20 | 16 | 481 | 331 |
| | 2000 | 11 | 11 | 205 | 203 |
| | 2001 | 13 | 12 | 235 | 211 |
| | 2002 | 11 | 11 | 75 | 67 |
| | 2003 | 13 | 12 | 426 | 294 |
| *Ocimum* | 1999 | 7 | 7 | 206 | 88 |
| | 2000 | 7 | 7 | 245 | 75 |
| | 2001 | 5 | 5 | 97 | 79 |
| | 2002 | 8 | 8 | 20 | 18 |
| | 2003 | 8 | 8 | 52 | 42 |
| *Pastinaca* | 1999 | 2 | 2 | 8 | 8 |
| | 2000 | 0 | 0 | 0 | 0 |
| | 2001 | 0 | 0 | 0 | 0 |
| | 2002 | 2 | 2 | 9 | 8 |
| | 2003 | 1 | 1 | 1 | 1 |

**Characterization and Taxonomy:**

Digital images, along with basic notes for taxonomic identification and accession characterization, are recorded during regeneration (Table 4). Data for approximately 17 descriptors, primarily fruit descriptors, are recorded at harvest for *Cucumis* and *Cucurbita* accessions. Plant habit, flowering dates, and life-cycle notes are recorded for *Daucus*. Images will be made available on GRIN once the NCRPIS Imaging Committee approves guidelines for naming and loading images to the database.

With the assistance of Dr. Mark Widrlechner (Horticulturist), taxonomic identities are reviewed and confirmed as each accession is regenerated. The 2003 re-identifications included: 12 *Daucus sp.* to 1 *Daucus broteri*, 3 *Torilis*, and 8 unidentified Apiaceae.

**Evaluation/Utilization:**

Dr. Charles Block (Pathologist) continued to screen all *Cucurbita* and *Cucumis* seedlings grown for regeneration for the presence of squash mosaic virus with an ELISA protocol before seedlings can be transplanted to the field. He also visually inspected all cucurbit field plantings for disease during the 2003 growing season. Seed-borne diseases are of specific interest, with bacterial fruit blotch in *Cucumis melo* being of greatest concern since phytosanitary issues have prevented the distribution of *Cucumis* germplasm to some countries.

We are still awaiting oil analysis and DNA fingerprinting data for the NPGS *Ocimum* collection from Dr. Katerina Svoboda and her student Senga Kyle, at The Scottish Agricultural College Auchincruive, Ayr, Scotland, UK. Dr. Widrlechner and I are collaborating on a publication with Svoboda and Kyle regarding the evaluation work.

**Future Plans:**

Regenerations: We will continue to increase *Cucumis* and *Cucurbit* accessions where distribution quantities and percent germination have fallen below critical values as set on GRIN.

Thirty-nine new accessions of *Daucus* were started in the greenhouse in October 2003 for the summer 2004 field cages. Taxonomic identification and unknown life cycles are still an issue with *Daucus* regenerations, and continue to cause difficulty with planning for greenhouse and field space usage. Many of the newly acquired accessions have proven to be mixtures of annuals and biennials which require that their plant population be regenerated in both a greenhouse cage and field cage with resulting seed increases being bulked before storage. An additional 40 accessions of annual *Daucus* will be direct seeded into the field this spring for regeneration.

Regeneration of hard to handle and wild *Cucumis* species will continue in the greenhouse as time, space, and labor allocation permits. We hope to regenerate approximately 18 accessions in two regeneration cycles in the Entomology greenhouse facility.

Germinations: In April 2004, viability testing will be performed on seed lots resulting from the 2003 cucurbit regenerations. Viability testing will continue during the summer months on the 2002 and 2003 *Daucus* regeneration lots, and on 5-year germination testing to monitor the viability of the distribution lots in the vegetable collections.

Characterization: We will continue to record characterization data as regenerations occur. Hopefully Oracle forms can be developed to assist in loading newly acquired characterization data into GRIN. Characterization data collected for *Cucumis melo* since 1997 will be loaded to GRIN as soon as possible in 2004. Two USDA-ARS scientists are preparing a proposal to be submitted through the Cucurbit Crop Germplasm Committee to use these data along with the molecular and disease evaluation data to develop a

core for the NPGS melon collection. If possible, I hope to load all available characterization data for all of the NCRPIS cucurbit crops during 2004.

Evaluation: The Pollinator Program and the Vegetable Program will continue to collaborate on some small pollinator tests. One test involves evaluating whether blue-bottle flies will pollinate umbels more efficiently than houseflies in greenhouse isolation cages. A second collaborative project is planned to develop a year-round cage and pollinator program for regenerating *Cucumis* and *Cucurbita* in the greenhouse.

**g. Crucifers and Wild Flax (Mark Widrlechner, Rich Luhman and Barbara Bingaman)**

**The collection**:

The crucifer project was in transition during 2003 because of changes in personnel. Curator Rick Luhman resigned in July, and it was the first growing season for Barbara Bingaman, the crucifer Ag. Specialist. These transitions were anticipated by the curator, and a smaller than usual number of regenerations was conducted in 2003.

Three new *Brassica* accessions were added to the NC7 active collection during 2003. These accessions were acquired from the National Center for Genetic Resources Preservation (NCGRP). One new crucifer and 4 new wild flax accessions were also added to our collection (Table 1).

The percentage of available accessions increased slightly from 2002 for the *Brassica* and miscellaneous crucifers (Table 1). Percentage available accessions for the wild flax collection increased for 11% in 2002 to 30% in 2003.

**Regeneration and Maintenance**:

In 2003, 110 *Brassica* and miscellaneous crucifer and 76 wild flax accessions were stored from harvests completed in 2002. Eighty-one *Brassica* and miscellaneous crucifer accessions were made available for distribution in 2003, along with 37 wild flax accessions. The limiting factors on availability of accessions from 2002 regenerations were seed viability and quantity.

Regenerations for 10 *Brassica* and 56 miscellaneous crucifer accessions were attempted in 2003 (Table 2). Ninety percent of the *Brassica* accessions were harvested. Thirty of the miscellaneous crucifer accessions were not harvested because they either did not bloom or did not set seed. Twenty-one of these are suspected to be perennial or biennial species and are being overwintered for harvest in 2004. In addition, 38 perennial wild flax accessions were harvested in 2003 from plants established in 2002 (Table 2).

The percentage of the *Brassica* collection backed up at the NCGRP remained the same in 2003 as in 2002 (Table 2). There was a slight increase in the percentage of miscellaneous crucifers backed up. The percentage of wild flax accessions backed up rose from 8% in 2002 to 25% in 2003. Material sent to NCGRP for backup either replaced lots currently held with better quality seed or provided new material.

**Distribution**:

For the *Brassica*, miscellaneous crucifers, and wild flax, 2624 packets were distributed domestically and 363 internationally in 2003 (Table 3). These figures represent 770 accessions supplied domestically and 325 internationally.

| Crop | Year | No. Of Orders | No. of Recipients | No. of Items Distributed | No. of Accessions Distributed |
|---|---|---|---|---|---|
| *Brassica* | 1999 | 53 | 46 | 2181 | 1123 |
| | 2000 | 69 | 56 | 1245 | 862 |

| | | | | | |
|---|---|---|---|---|---|
| | 2001 | 36 | 33 | 469 | 414 |
| | 2002 | 55 | 51 | 1125 | 932 |
| | 2003 | 61 | 51 | 2878 | 884 |
| Crucifers | 1999 | 15 | 13 | 299 | 227 |
| | 2000 | 16 | 15 | 72 | 66 |
| | 2001 | 22 | 18 | 640 | 268 |
| | 2002 | 24 | 23 | 241 | 212 |
| | 2003 | 15 | 15 | 89 | 79 |
| Wild *Linum* | 1999 | 3 | 3 | 26 | 16 |
| | 2000 | 0 | 0 | 0 | 0 |
| | 2001 | 2 | 2 | 22 | 19 |
| | 2002 | 2 | 2 | 18 | 12 |
| | 2003 | 3 | 3 | 20 | 19 |

**Observations**:

Processing of both digital and scanned images proceeded in 2003. The NCRPIS Imaging Committee has continued to develop and refine standards for loading images to GRIN. Digital photographs were taken of 2003 regenerations at full flower in JPEG format, downloaded to our server, and manipulated with Adobe PhotoShop Version 7.0. Full flower and silique images were produced by collecting plant samples and scanning them in TIFF format using a flat bed scanner. These images were then converted to JPEG format and loaded to GRIN, with 457 plant images presently available in GRIN.

During 2003, 110 *Brassica* and 254 miscellaneous crucifer accessions with 'Ames' designations were assigned 'PI' numbers. To update the GRIN database, the accession numbers were changed on the seed, silique, and plant scanned images. All digital field photographs of these accessions also were modified. The process of loading these updated images and photographs into GRIN is currently in progress.

Descriptor observations were recorded during the 2003 regenerations, and plant samples were taken for later data measurements. In 2003, 662 observations for 258 accessions were transferred to GRIN (Table 4). Data for some descriptor observations and measurements of morphological parameters have not yet been loaded to GRIN for the 2003 regenerations.

**Visitors and Meetings**:

Mark W. attended the 2003 meeting of the Crucifer CGC at the American Society for Horticultural Science meetings in Providence, Rhode Island. In September 2003, Barbara participated in a workshop on the DIVA-GIS Global Information System software and its applications in mapping germplasm collections.

**Future Plans**:

The position of curator for the crucifers and wild flax was incorporated into a comprehensive oilseed curator position that includes sunflower and domesticated flax. In February, 2004, Dr. Laura Marek began her tenure as the new oilseeds curator. During 2004, Laura will become familiar with the crucifer and wild flax collections. In addition, Laura's excellent background in molecular marker research can assist in the development of molecular techniques for positive identification of accessions and assessment of regeneration protocols.

Regenerations for 2004 will include approximately 250 accessions, emphasizing *Brassica napus* and *B. rapa*. Miscellaneous crucifers, including *Crambe*, *Eruca*, *Erysimum*, *Lepidium*, *Sinapis*, and *Thlaspi*, also will be increased. In addition, 21 miscellaneous crucifer and 24 wild flax accessions are over-wintering in the field for potential harvest in 2004.

**h. *Amaranthus, Celosia, Chenopodium, Coronilla, Dalea, Echinochloa, Galega, Marina, Melilotus, Panicum, Perilla, Setaria, Spinacia* and miscellaneous Umbelliferae and Poaceae (D. Brenner)**

**Acquisition and inactivation (Table 1)**

Dr. Herman Gorz donated a *Melilotus officinalis* (PI 634019) with a fine stem trait and low coumarin content. This plant breeding product combines traits that are rare in *Melilotus*, and useful for fodder.

Pablo Morales-Payan of the University of Florida donated an accession of *Eryngium foetidum* (Ames 27073). This is our first accession of this frequently requested tropical spice species in the Umbelliferae group.

The new millet accessions are primarily segregations from older millet accessions. Most of the new umbels, and a *Dalea* are local Iowa ecotype accessions

**Maintenance and distribution (Tables 2 and 3)**

***Amaranthus* and *Chenopodium*:**

The *Chenopodium* increases included two surprisingly successful field regenerations (Ames 26923 and NSL 90209). This type of *Chenopodium* is perennial and has red drupaceous fruit. I have been growing them in the greenhouse with poor success for years. As field transplants in 2003 they grew luxuriantly, fruited heavily, and matured ample seed crops.

***Echinochloa, Panicum, Setaria,* miscellaneous Poaceae:**

Responsibility for these grass genera was transferred to me from Rick Luhman on July 15, 2004.

Three accessions that had previously failed to increase under field conditions were successfully increased in the campus greenhouse under short-day conditions using the same methods that have worked with *Amaranthus*.

***Melilotus* and other legumes**

Nine *Melilotus* accessions were regenerated in 2003 from the October 2002 planting. These included a good increase of 'Happy' (Ames 21623) a compact fine-stemmed dwarf (50 cm tall) accession with potential as a water-conserving ground cover, and forage.

Two regenerations of *Dalea foliosa* (Ames 26200 and Ames 26201) an endangered species were successfully pollinated by bees in greenhouse cages. A *Dalea purpurea* (Ames 26964) did very well in a field cage.

***Spinacia*:**

Slow-to-bolt accessions were grown successfully in Parlier, California, Palmer, Alaska, and in a greenhouse in Ames, Iowa. In 2004 accessions of wild *Spinacia* will be attempted in Ames, Iowa greenhouses.

**Miscellaneous Umbelliferae**:

After the completion of seed storage in late 2003, 40% of the miscellaneous Umbelliferae are available for distribution. Most of the seed lots stored in 2003 were grown in 2001. The delay between 2001 and 2003 was intended to exceed the life span of seed chalcid insects, so that the stored seeds would not harbor viable insects.

In fall 2003 the un-stored Umbelliferae seed lots (from 2002 and 2003) were cold treated, for 24 hours, with the vapor from liquid nitrogen to kill chalcid insects using a protocol from David Kovach's research. Following elimination of viabile chalcids, the seeds will be cleaned for storing in 2004.

Two accessions of *Angelica* (Ames 26451 and Ames 26454) yielded ample seeds in the spring of 2003. They were planted in January of 2002, grown in the field in 2002, were dug up and chill treated in late 2002, and then flowered in the spring 2003 greenhouse as large (2 meter tall plants). The maintenance crew set up temporary cages to bee-pollinate them in. Surprisingly, 85% of 67 plants chill treated in the 4 deg C growth chamber later bolted, but only 31% of 26 plants bolted after a chill treatment in the farm greenhouse #2. Even though the plants are very similar in appearance during the two treatments, the growth chamber conditions have a beneficial effect on bolting frequency.

An accession of *Oreoschimperella verrucosa* (PI 319414) was re-identified and regenerated successfully after at least three unsuccessful attempts since 1967. This regeneration was in the farm greenhouse #2 where the accession is apparently adapted to cool-short day winter conditions.

**Viability testing:**

It was a terrific year for viability testing thanks to Maria Erickson and her group. One-thousand-sixty-seven accessions (12%) of my 8,588 accessions were tested.

**Characterization/taxonomy/evaluation (Table 4)**

Bob Graybosch,(USDA-ARS, University of Nebraska) provided 651 observations on starch type in proso millet (*Panicum miliaceum*). The descriptor was established in GRIN, and the data loaded.

A new descriptor for seed weight was established for the millet genera, and observations were loaded into the descriptors; from the GRIN inventory. This data was directly useful for a seed order by Dr. David Baltensperger, a millet breeder in Nebraska.

A collaboration with Dr. Mihai Costea of the University of Guelph resulted in a re-identification of nine cultivated vegetable *Amaranthus blitum* accessions to *Amaranthus graecizans* subsp. *aschersonianus*. This work was published in Economic Botany and the new nomenclature is installed in GRIN. I am pleased that our collection has a part in these and other taxonomic revisions that are substantial progress in the understanding and use of *Amaranthus*.

A collaboration with Dr. Beiquan Mou, USDA/ARS Salinas, California resulted in the first ten spinach descriptors being entered in GRIN. The descriptors were approved by the Leafy Vegetable CGC, and Dr.Mou's data were loaded.

In 2003, 115 *Amaranthus* accessions were planted for observation, compared to only 74 for increasing. Most of these "observations" were to determine taxonomic identity, some were for a demonstration field.

There were 56 taxonomic changes in 2003 for my combined crops. With this year's 21 *Amaranthus* re-identifications I have determined identity of approximately 1,400 *Amaranthus* accessions since I began working here in 1989.

**Table: Accession distributions 1999-2003**

| Crop | Year | No. of Orders | No. of Recipients | No. of Items Distributed | No. of Accessions Distributed |
|---|---|---|---|---|---|
| *Amaranthus* | 1999 | 62 | 50 | 3682 | 2487 |
| | 2000 | 44 | 37 | 860 | 451 |
| | 2001 | 51 | 37 | 985 | 604 |
| | 2002 | 43 | 33 | 446 | 235 |
| | 2003 | 52 | 44 | 1035 | 534 |
| *Celosia* | 1999 | 3 | 3 | 24 | 17 |
| | 2000 | 6 | 6 | 11 | 8 |
| | 2001 | 2 | 2 | 12 | 11 |
| | 2002 | 7 | 7 | 9 | 7 |
| | 2003 | 3 | 3 | 17 | 14 |
| *Echinochloa* | 1999 | 2 | 2 | 9 | 8 |
| | 2000 | 5 | 4 | 166 | 149 |
| | 2001 | 4 | 4 | 36 | 33 |
| | 2002 | 4 | 4 | 5 | 5 |
| | 2003 | 5 | 5 | 26 | 26 |
| Legumes | 1999 | 4 | 4 | 32 | 32 |
| | 2000 | 7 | 7 | 16 | 13 |
| | 2001 | 4 | 4 | 7 | 7 |
| | 2002 | 7 | 5 | 69 | 50 |
| | 2003 | 5 | 5 | 31 | 26 |
| *Melilotus* | 1999 | 9 | 9 | 287 | 254 |
| | 2000 | 16 | 12 | 712 | 554 |
| | 2001 | 13 | 11 | 57 | 49 |
| | 2002 | 5 | 5 | 43 | 42 |
| | 2003 | 12 | 11 | 211 | 198 |
| Misc. Grasses | 1999 | 1 | 1 | 1 | 1 |
| | 2000 | 0 | 0 | 0 | 0 |
| | 2001 | 3 | 3 | 7 | 6 |
| | 2002 | 1 | 1 | 1 | 1 |
| | 2003 | 1 | 1 | 1 | 1 |
| *Panicum* | 1999 | 2 | 2 | 7 | 7 |
| | 2000 | 9 | 8 | 58 | 49 |
| | 2001 | 8 | 8 | 662 | 650 |
| | 2002 | 2 | 2 | 9 | 9 |
| | 2003 | 7 | 6 | 719 | 661 |
| *Perilla* | 1999 | 4 | 4 | 61 | 20 |
| | 2000 | 6 | 6 | 41 | 21 |

| | | | | | |
|---|---|---|---|---|---|
| | 2001 | 7 | 7 | 41 | 22 |
| | 2002 | 4 | 4 | 26 | 22 |
| | 2003 | 7 | 7 | 56 | 22 |
| Quinoa | 1999 | 10 | 10 | 294 | 163 |
| | 2000 | 21 | 19 | 342 | 149 |
| | 2001 | 18 | 15 | 239 | 173 |
| | 2002 | 23 | 22 | 333 | 161 |
| | 2003 | 23 | 21 | 276 | 195 |
| *Setaria* | 1999 | 7 | 6 | 27 | 26 |
| | 2000 | 13 | 12 | 795 | 757 |
| | 2001 | 6 | 6 | 20 | 19 |
| | 2002 | 9 | 8 | 48 | 43 |
| | 2003 | 7 | 7 | 58 | 53 |
| *Spinacia* | 1999 | 11 | 10 | 1061 | 332 |
| | 2000 | 7 | 7 | 670 | 348 |
| | 2001 | 12 | 11 | 1736 | 354 |
| | 2002 | 12 | 11 | 767 | 362 |
| | 2003 | 14 | 12 | 321 | 260 |
| Umbels | 1999 | 14 | 13 | 150 | 87 |
| | 2000 | 11 | 11 | 107 | 88 |
| | 2001 | 15 | 13 | 105 | 94 |
| | 2002 | 25 | 20 | 305 | 213 |
| | 2003 | 19 | 16 | 310 | 151 |

**Enhancement and/or utilization:**

***AMARANTHUS***:

Eighty-six white-seeded grain amaranth lines were segregated in the field from $F_3$ generations plantings of both *A. cruentus* and *A. hypochondriacus*. These segregates were selected for short-stature. They include shattering and non shattering types. In 2004 they will be grown in the field for additional selection. The goal is to reduce lodging in grain amaranths, by making shorter sturdier stems available. Many of the *A. cruentus* lines have a desirable all-green trait that is appreciated by many vegetable consumers in Africa, and could result in a double use for the lines.

Collaboration was continued with Charlie Block to enhance vegetable *A. tricolor* for disease resistance to *Phomopsis amaranthicola*. Some of the $F_3$ lines had substantial field resistance relative to susceptible lines dying from either the disease or from stem boring weevils. These $F_3$ lines were derived from a cross between PI 604669 disease-susceptible green vegetable, and either disease resistant PI 599683 or PI 608761. The most resistant plants were transplanted from the field to the greenhouse where they matured seeds in late 2003. The best lines will be field-tested in Ames in 2004; and I will attempt to find additional cooperators to grow them in other locations.

**Publications and presentations:**

My main project for the year was to organize an Amaranth Institute meeting here in Ames, Iowa in August. Thirty-four people attended from seven countries. The meeting was very successful for good interactions between the participants and for promoting new work. Three people came from African countries where they are promoting amaranth grain to improve human nutrition. An issue of the Legacy newsletter about the meeting will be posted on the NCRPIS www site.

I was the Amaranth Institute President for 2001-2003, and completed my term in August.

Brenner, D.M., M. Costea, and D.B. Pratt. 2003 . Taxonomic innovations in *Amaranthus* aided by a germplasm collection. In Annual Meetings Abstracts [CD-ROM]. ASA, CSSA, and SSSA, Madison, WI. (abstract and oral presentation)

Brenner, D.M. 2003. Amaranth demonstration and plant breeding field. Legacy 15:2 (abstract and tour during the Amaranth Institute meeting)

Brenner, D.M., and L. Lockhart. 2003. Seed cleaning and storage facilities at the North Central Regional Plant Introduction Station. Legacy 15:3 (abstract and tour during the Amaranth Institute meeting)

Costea, M., F.J. Tardif, and D.M. Brenner. 2003. The identity of a cultivated *Amaranthus* from Asia and a new nomenclatural combination. Economic Botany 57:646–649.

I prepared written Progress Reports for the Crop Germplasm Committees: Clover and Special Purpose Legumes, Forage and Turf Grass, Leafy Vegetable, and New Crops.

**Plans:**

The 2004 field planting will be primarily annual Umbelliferae and annual *Melilotus*.

Some Umbelliferae accessions were kept in the field over the 2003-04 winter. It will be interesting to see how well they survive into 2004.

More than 100 accessions that are currently identified as *Amaranthus* species will be grown for taxonomic determination.

In 2004 I plan to field test some *Amaranthus* breeding lines, and begin a germplasm enhancement effort with proso millet cultivars crossed with lines from exotic sources.

**Acknowledgments:**

In early 2003 Samuel Flomo was promoted to a continuing status as an Iowa State University, Professional and Scientific, Agricultural Specialist I employee. He works with me (David Brenner) full time.

Alex Fales, Brandi Huinker, Andrew Martin, and Andrew Muff worked with us as part time student help.

Lori Wilson-Voss and Stacey Winter were terrific help and guidance for the Amaranth Institute meeting held in August.

### i. Sunflower, Miscellaneous Asters, Flax, and Cuphea (M.Widrlechner, I. Larsen, M. Brothers)

The curatorial responsibilities of the *Helianthus*, misc. asters, flax, and *Cuphea* collections are in transition at this time, due to the resignation of Mary Brothers in May and reorganization in crop responsibilities We hope to have a new curator in place for this project early in 2004. In the meantime, Mark Widrlechner and Irv Larsen worked together to manage these collections. The project continued to make good progress in seed regeneration; however, many of the characterization notes collected in 2003 have not yet been entered into GRIN.

The current status of these collections is summarized in Table 1.

**Acquisition**

Thirty-nine sunflower accessions were acquired in 2003. Most notable were 19 *Helianthus bolanderi* populations collected in California during 2002 and received by NPGS in 2003. Five accessions were added to the miscellaneous asters collection as well as two accessions to the flax collection.

**Maintenance**

The availability of the flax and *Cuphea* remained the same as in 2002: 100% and 75%, respectively. Miscellaneous aster availability fell slightly to 29%. Even with the addition of 39 accessions to the sunflower collection, availability rose for a combined 4 % increase over the previous year.

Regeneration activities for 2003 are summarized in Table 2. Emphasis on obtaining seed from perennial *Helianthus* species continued. Seventy new plots have been established and are growing for next year’s caged seed increase.

Notably in 2003, successful seed regeneration was achieved for 11 *Cuphea* accessions. Sixteen *Cuphea* accessions (mostly clonal selections or sterile hybrids) remain growing vegetatively in the greenhouse, with back-up at the Ornamental Plant Germplasm Center in Columbus, Ohio.

Collaborative seed regeneration with the National Arid Land Plant Genetic Recourses Unit (NALPGRU) in Parlier, California continued in 2003. Three wild *Helianthus* accessions were successfully increased in Parlier for our project. Additional samples were sent to Parlier to expand this effort.

As accessions are regenerated, we continue to send samples to NCGRP for back up. Eleven flax accessions were sent to NCGRP for duplication, with nearly the entire cultivated flax collection now backed up. Although 111 sunflower accessions were sent to NCGRP, there was only a slight increase in the proportion of this collection currently backed up. Cultivated and wild *Helianthus* are duplicated at 93% and 61% levels, respectively.

During 2003, one thousand germination tests were conducted, including scheduled five-year tests and initial germination tests on new inventory.

A pollinator study conducted in cooperation with entomology team was repeated in 2003. We are testing the effectiveness of various insects capable of pollinating sunflowers. More details are explained in the entomology section of the annual report.

**Distribution**

The packet and accession distribution summaries for misc. asters, flax, *Cuphea*, and *Helianthus* collections are provided in Table 3.
Packet distribution for misc. asters, *Cuphea*, and flax increased significantly during the past year. *Helianthus* packet distribution decreased; however, the number of orders and requestors rose above the 5-year average. The highest percentage of items were distributed domestically, opposite from year 2002.

**Characterization/taxonomy**

Extensive plant and seed data were recorded for both *Helianthus* and flax increases. The bulk of these notes recorded in 2003 have yet to be entered into the GRIN database.

This past year, 243 digital images were captured of *Helianthus* and flax seed, and 584 digital images were captured on the nearly 200 perennial sunflower plots; documenting plant health and references for characterization. Images captured annually will help us evaluate any possible changes in their status.

**Evaluation/Utilization**

In cooperation with Dr. Tom Gulya, we grew 52 cultivated sunflower accessions. Plant data and digital images were recorded and forwarded to him. Our contributing data will help Tom in his evaluation of several ornamental sunflower accessions for disease resistance.

**Enhancement**

Charles Block prepared for release two wild *Helianthus annuus* germplasm populations that were selected for resistance to Alternaria leaf blight, Septoria leaf blight and powdery mildew. These populations exhibit a hypersensitive type of leaf-spot resistance that is not found in cultivated sunflower.

| crop | Calendar Year | No. of Orders | No of Recipients | No. of Items Distributed | No. of acc. Distributed |
|---|---|---|---|---|---|
| Misc Asters | 1999 | 8 | 8 | 15 | 14 |
| | 2000 | 8 | 8 | 87 | 40 |
| | 2001 | 6 | 5 | 10 | 7 |
| | 2002 | 8 | 6 | 15 | 11 |
| | 2003 | 7 | 7 | 25 | 21 |
| Flax | 1999 | 14 | 13 | 297 | 259 |
| | 2000 | 8 | 8 | 120 | 118 |
| | 2001 | 14 | 14 | 268 | 223 |
| | 2002 | 8 | 8 | 73 | 63 |
| | 2003 | 6 | 6 | 95 | 95 |
| Cult. *Helianthus* | 1999 | 55 | 39 | 2114 | 1095 |
| | 2000 | 28 | 27 | 884 | 740 |
| | 2001 | 46 | 33 | 1500 | 766 |
| | 2002 | 47 | 39 | 628 | 458 |
| | 2003 | 49 | 37 | 611 | 414 |
| Wild *Helianthus* | 1999 | 35 | 29 | 704 | 448 |
| | 2000 | 21 | 15 | 820 | 588 |
| | 2001 | 36 | 29 | 1322 | 879 |
| | 2002 | 34 | 21 | 808 | 652 |
| | 2003 | 43 | 25 | 874 | 593 |
| *Cuphea* | 1999 | 12 | 11 | 110 | 98 |
| | 2000 | 10 | 8 | 122 | 89 |
| | 2001 | 16 | 12 | 713 | 498 |
| | 2002 | 12 | 9 | 255 | 222 |
| | 2003 | 21 | 14 | 394 | 247 |

**Future plans:**

Emphasis will continue to be placed on obtaining seed increases from accessions in our new perennial *Helianthus* field. We will significantly increase the number of *Cuphea* caged plots in 2004. If we are successful with the 30 accessions selected, we would make every active accession of the seven “industrial” species available for distribution. The staff and crew of the Plant Introduction Station will be teaching and informing Dr. Laura Marek, the new oilseeds curator hired in February 2004, of farm operations and techniques of oilseed regeneration. At the same time, Laura will be contemplating how her extensive knowledge of, and skills in, molecular-marker research can be applied to our oilseed collections for quality assurance and for cooperative research and evaluation.

**Year 2003 Table 1 # NCRPIS Accesssions (Acc), # Acquired, # Available**

| CURATOR | GENUS CROP | Number Accs | Number Accs Acquired | Percent Acquired | Number Available | Percent Available | Percent Avail Last Yr |
|---|---|---|---|---|---|---|---|
| **Brenner** | NC7-amaranth | 3,328 | 2 | 0 | 3,055 | 92 | 91 |
| | NC7-celosia | 54 | 0 | 0 | 19 | 35 | 35 |
| | NC7-echinochloa | 269 | 0 | 0 | 190 | 71 | 71 |
| | NC7-grasses | 117 | 0 | 0 | 14 | 12 | 12 |
| | NC7-legumes | 227 | 1 | 0 | 103 | 45 | 45 |
| | NC7-melilotus | 931 | 7 | 1 | 688 | 74 | 73 |
| | NC7-panicum | 977 | 7 | 1 | 868 | 89 | 89 |
| | NC7-perilla | 22 | 0 | 0 | 22 | 100 | 100 |
| | NC7-quinoa | 232 | 1 | 0 | 191 | 82 | 71 |
| | NC7-setaria | 998 | 4 | 0 | 895 | 90 | 90 |
| | NC7-spinach | 401 | 0 | 0 | 371 | 93 | 92 |
| | NC7-umbels | 1,032 | 10 | 1 | 412 | 40 | 28 |
| | Total: | 8,588 | 32 | 0 | 6,828 | 80 | |
| **Curator** | NC7-asters | 323 | 5 | 2 | 95 | 29 | 30 |
| | NC7-brassica | 1,992 | 3 | 0 | 1,675 | 84 | 82 |
| | NC7-crucifers | 1,134 | 1 | 0 | 716 | 63 | 61 |
| | NC7-cuphea | 649 | 0 | 0 | 485 | 75 | 75 |
| | NC7-flax | 2,810 | 2 | 0 | 2,800 | 100 | 100 |
| | NC7-flax.wilds | 164 | 4 | 2 | 50 | 30 | 11 |
| | NC7-sun.cults | 1,681 | 11 | 1 | 1,463 | 87 | 84 |
| | NC7-sun.wilds | 2,179 | 28 | 1 | 1,226 | 56 | 55 |
| | Total: | 10,932 | 54 | 0 | 8,510 | 78 | |
| **Millard** | NC7-corn.kin | 34 | 0 | 0 | 7 | 21 | 21 |
| | NC7-maize | 18,255 | 231 | 1 | 11,709 | 64 | 64 |
| | Total: | 18,289 | 231 | 1 | 11,716 | 64 | |
| **Reitsma** | NC7-chicory | 249 | 1 | 0 | 203 | 82 | 68 |
| | NC7-cucumis.cucs | 1,349 | 0 | 0 | 1,261 | 93 | 93 |
| | NC7-cucumis.melo | 3,096 | 0 | 0 | 2,219 | 72 | 71 |
| | NC7-cucumis.wilds | 329 | 0 | 0 | 126 | 38 | 36 |
| | NC7-cucurbita | 991 | 0 | 0 | 798 | 81 | 80 |
| | NC7-cucurbits.misc | 2 | 0 | 0 | 2 | 100 | 50 |
| | NC7-daucus | 1,058 | 11 | 1 | 731 | 69 | 66 |
| | NC7-ocimum | 96 | 0 | 0 | 84 | 88 | 88 |
| | NC7-parsnips | 72 | 1 | 1 | 36 | 50 | 31 |
| | Total: | 7,242 | 13 | 0 | 5,460 | 75 | |
| **Van Roekel** | NC7-euphorbia | 218 | 1 | 0 | 43 | 20 | 20 |
| | Total: | 218 | 1 | 0 | 43 | 20 | |
| **Widrlechner** | NC7-mints | 123 | 2 | 2 | 74 | 60 | 56 |
| | NC7-ornamentals | 2,123 | 119 | 4 | 908 | 43 | 44 |
| | Total: | 2,246 | 121 | 5 | 982 | 44 | |
| **NCRPIS Total:** | | **47,515** | **452** | **1** | **33,539** | **71** | **70** |

**Year 2003** **Table 2** **# NCRPIS Accessions (Acc) Germinated, # Regenerated, # Made Available, # Backed Up**

| CURATOR | GENUS CROP | Number Accessions (Accs) | Number Acc Germed | Percent Acc Germed | Number Attempted Regen | Number Harvested Regen | Number Perm Perennial | Number Vegetative Harvested | Number Accs Made Available | Number Accs Growing | Number Accs Backed Up for YR | Total # Accs Backed Up | Percent Accs Backed Up |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Brenner** | NC7-amaranth | 3,328 | 302 | 9 | 74 | 64 | 0 | 0 | 39 | 0 | 28 | 3,115 | 94 |
| | NC7-celosia | 54 | 0 | 0 | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 20 | 37 |
| | NC7-echinochloa | 269 | 6 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 215 | 80 |
| | NC7-grasses | 117 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 37 | 32 |
| | NC7-legumes | 227 | 36 | 16 | 6 | 4 | 0 | 0 | 1 | 0 | 1 | 165 | 73 |
| | NC7-melilotus | 931 | 253 | 27 | 0 | 9 | 0 | 0 | 17 | 0 | 13 | 748 | 80 |
| | NC7-panicum | 977 | 184 | 19 | 1 | 0 | 0 | 0 | 3 | 0 | 2 | 886 | 91 |
| | NC7-perilla | 22 | 2 | 9 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 22 | 100 |
| | NC7-quinoa | 232 | 64 | 28 | 3 | 11 | 0 | 0 | 45 | 0 | 24 | 201 | 87 |
| | NC7-setaria | 998 | 6 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 936 | 94 |
| | NC7-spinach | 401 | 20 | 5 | 3 | 25 | 0 | 0 | 18 | 0 | 5 | 374 | 93 |
| | NC7-umbels | 1,032 | 193 | 19 | 39 | 56 | 0 | 0 | 135 | 0 | 122 | 336 | 33 |
| | Total: | 8,588 | 1,067 | 12 | 133 | 173 | 0 | 0 | 260 | 0 | 197 | 7,055 | 82 |
| **Curator** | NC7-asters | 323 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 73 | 23 |
| | NC7-brassica | 1,992 | 377 | 19 | 10 | 9 | 0 | 0 | 40 | 0 | 23 | 1,905 | 96 |
| | NC7-crucifers | 1,134 | 49 | 4 | 56 | 26 | 0 | 0 | 41 | 27 | 35 | 798 | 70 |
| | NC7-cuphea | 649 | 0 | 0 | 15 | 3 | 0 | 0 | 59 | 7 | 1 | 563 | 87 |
| | NC7-flax | 2,810 | 539 | 19 | 84 | 82 | 0 | 0 | 95 | 0 | 11 | 2,807 | 100 |
| | NC7-flax.wilds | 164 | 49 | 30 | 0 | 38 | 0 | 0 | 37 | 23 | 28 | 41 | 25 |
| | NC7-sun.cults | 1,681 | 365 | 22 | 61 | 60 | 0 | 0 | 57 | 0 | 25 | 1,566 | 93 |
| | NC7-sun.wilds | 2,179 | 95 | 4 | 217 | 1 | 82 | 0 | 95 | 200 | 86 | 1,327 | 61 |
| | Total: | 10,932 | 1,475 | 13 | 443 | 219 | 82 | 0 | 424 | 257 | 209 | 9,080 | 83 |
| **Millard** | NC7-corn.kin | 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 24 |
| | NC7-maize | 18,255 | 899 | 5 | 501 | 631 | 0 | 0 | 411 | 0 | 44 | 13,489 | 74 |
| | Total: | 18,289 | 899 | 5 | 501 | 631 | 0 | 0 | 411 | 0 | 44 | 13,497 | 74 |
| **Reitsma** | NC7-chicory | 249 | 38 | 15 | 0 | 0 | 0 | 0 | 37 | 0 | 36 | 199 | 80 |
| | NC7-cucumis.cucs | 1,349 | 24 | 2 | 35 | 31 | 0 | 0 | 25 | 0 | 13 | 1,253 | 93 |
| | NC7-cucumis.melo | 3,096 | 45 | 1 | 150 | 145 | 0 | 0 | 45 | 0 | 44 | 2,391 | 77 |
| | NC7-cucumis.wilds | 329 | 14 | 4 | 16 | 4 | 0 | 0 | 13 | 0 | 11 | 135 | 41 |
| | NC7-cucurbita | 991 | 24 | 2 | 55 | 22 | 0 | 0 | 19 | 0 | 10 | 755 | 76 |
| | NC7-cucurbits.misc | 2 | 1 | 50 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 | 100 |
| | NC7-daucus | 1,058 | 92 | 9 | 81 | 79 | 0 | 0 | 68 | 0 | 129 | 796 | 75 |
| | NC7-ocimum | 96 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 87 | 91 |
| | NC7-parsnips | 72 | 15 | 21 | 26 | 0 | 0 | 0 | 15 | 0 | 12 | 32 | 44 |
| | Total: | 7,242 | 253 | 3 | 363 | 281 | 0 | 0 | 223 | 0 | 256 | 5,650 | 78 |
| **VanRoekel** | NC7-euphorbia | 218 | 105 | 48 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 53 | 24 |
| | Total: | 218 | 105 | 48 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 53 | 24 |
| **Widrlechner** | NC7-mints | 123 | 21 | 17 | 5 | 5 | 0 | 0 | 8 | 0 | 7 | 72 | 59 |
| | NC7-ornamentals | 2,123 | 85 | 4 | 84 | 65 | 43 | 0 | 70 | 485 | 48 | 666 | 31 |
| | Total: | 2,246 | 106 | 5 | 89 | 70 | 43 | 0 | 78 | 485 | 55 | 738 | 33 |
| **NCRPIS Total:** | | **47,515** | **3,905** | **8** | **1,529** | **1,376** | **125** | **0** | **1,396** | **742** | **761** | **36,073** | **76** |

**Year 2003 Table 3 # NCRPIS Accessions (Acc) Distributed, # Orders, # Recipients**

| CURATOR | GENUS CROP | Number Accs | Number Items Dist Domestic | Number Items Dist Foreign | Number Accs Dist Domestic | Number Accs Dist Foreign | Number Accs Dist Total | Percent Accs Dist | Number Orders | Number Recipients |
|---|---|---|---|---|---|---|---|---|---|---|
| **Brenner** | NC7-amaranth | 3,328 | 588 | 447 | 401 | 304 | 534 | 16 | 53 | 44 |
| | NC7-celosia | 54 | 3 | 14 | 3 | 14 | 14 | 26 | 3 | 3 |
| | NC7-echinochloa | 269 | 16 | 10 | 16 | 10 | 26 | 10 | 5 | 5 |
| | NC7-grasses | 117 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 |
| | NC7-legumes | 227 | 26 | 5 | 21 | 5 | 26 | 11 | 5 | 5 |
| | NC7-melilotus | 931 | 55 | 156 | 55 | 153 | 198 | 21 | 12 | 11 |
| | NC7-panicum | 977 | 48 | 671 | 45 | 654 | 661 | 68 | 7 | 6 |
| | NC7-perilla | 22 | 34 | 22 | 21 | 22 | 22 | 100 | 7 | 7 |
| | NC7-quinoa | 232 | 232 | 44 | 194 | 39 | 195 | 84 | 23 | 21 |
| | NC7-setaria | 998 | 11 | 47 | 9 | 47 | 53 | 5 | 8 | 8 |
| | NC7-spinach | 401 | 95 | 226 | 86 | 221 | 260 | 65 | 14 | 12 |
| | NC7-umbels | 1,032 | 177 | 133 | 95 | 105 | 151 | 15 | 19 | 16 |
| | Total: | 8,588 | 1,286 | 1,775 | 947 | 1,574 | 2,141 | 25 | 157 | 139 |
| **Curator** | NC7-asters | 323 | 25 | 0 | 21 | 0 | 21 | 7 | 7 | 7 |
| | NC7-brassica | 1,992 | 2,566 | 312 | 719 | 276 | 884 | 44 | 61 | 51 |
| | NC7-crucifers | 1,134 | 57 | 32 | 50 | 30 | 79 | 7 | 15 | 15 |
| | NC7-cuphea | 649 | 343 | 51 | 240 | 51 | 247 | 38 | 21 | 14 |
| | NC7-flax | 2,810 | 39 | 57 | 39 | 57 | 95 | 3 | 6 | 6 |
| | NC7-flax.wilds | 164 | 1 | 19 | 1 | 19 | 19 | 12 | 3 | 3 |
| | NC7-sun.cults | 1,681 | 525 | 86 | 363 | 75 | 414 | 25 | 49 | 37 |
| | NC7-sun.wilds | 2,179 | 721 | 153 | 559 | 139 | 593 | 27 | 43 | 25 |
| | Total: | 10,932 | 4,277 | 710 | 1,992 | 647 | 2,352 | 22 | 205 | 158 |
| **Millard** | NC7-corn.kin | 34 | 20 | 3 | 8 | 3 | 8 | 24 | 8 | 8 |
| | NC7-maize | 18,255 | 4,951 | 417 | 2,781 | 394 | 2,938 | 16 | 257 | 190 |
| | Total: | 18,289 | 4,971 | 420 | 2,789 | 397 | 2,946 | 16 | 265 | 198 |
| **Reitsma** | NC7-chicory | 249 | 155 | 37 | 143 | 37 | 144 | 58 | 8 | 7 |
| | NC7-cucumis.cucs | 1,349 | 191 | 108 | 174 | 104 | 262 | 19 | 18 | 15 |
| | NC7-cucumis.melo | 3,096 | 295 | 1,058 | 264 | 869 | 1,007 | 33 | 31 | 24 |
| | NC7-cucumis.wilds | 329 | 119 | 134 | 94 | 97 | 125 | 38 | 13 | 13 |
| | NC7-cucurbita | 991 | 64 | 130 | 61 | 123 | 168 | 17 | 13 | 13 |
| | NC7-cucurbits.misc | 2 | 1 | 0 | 1 | 0 | 1 | 50 | 1 | 1 |
| | NC7-daucus | 1,058 | 283 | 143 | 230 | 133 | 294 | 28 | 13 | 12 |
| | NC7-ocimum | 96 | 26 | 26 | 24 | 26 | 42 | 44 | 8 | 8 |
| | NC7-parsnips | 72 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |
| | Total: | 7,242 | 1,134 | 1,637 | 991 | 1,390 | 2,044 | 28 | 106 | 94 |
| **VanRoekel** | NC7-euphorbia | 218 | 5 | 4 | 5 | 4 | 7 | 3 | 2 | 2 |
| | Total: | 218 | 5 | 4 | 5 | 4 | 7 | 3 | 2 | 2 |
| **Widrlechner** | NC7-mints | 123 | 27 | 18 | 23 | 18 | 39 | 32 | 9 | 9 |
| | NC7-ornamentals | 2,123 | 735 | 148 | 247 | 131 | 320 | 15 | 108 | 91 |
| | Total: | 2,246 | 762 | 166 | 270 | 149 | 359 | 16 | 117 | 100 |
| **NCRPIS Total:** | | **47,515** | **12,435** | **4,712** | **6,994** | **4,161** | **9,849** | **21** | **705** | **505** |

**Year 2003 Table 4 # NCRPIS Accessions (Accs) Obs in GRIN, # Images in GRIN**

| CURATOR | GENUS CROP | Number Accs | Number Acc Obs Trials | Number Acc Obs in Curator Notes | Number Obs in GRIN for Yr | Number Acc Obs In GRIN for Yr | Number Acc Obs in GRIN Last Yr | Number Acc Obs in GRIN (all Yrs) | Number Acc Images Recorded | Number Acc Images in GRIN for Yr | Number Acc Images in GRIN (all Yrs) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Brenner** | NC7-amaranth | 3,328 | 83 | 189 | 704 | 135 | 483 | 3,283 | 202 | 0 | 219 |
| | NC7-celosia | 54 | 0 | 5 | 0 | 0 | 1 | 3 | 3 | 0 | 3 |
| | NC7-echinochloa | 269 | 0 | 1 | 608 | 259 | 0 | 259 | 1 | 0 | 0 |
| | NC7-grasses | 117 | 0 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | NC7-legumes | 227 | 0 | 4 | 0 | 0 | 0 | 84 | 4 | 0 | 0 |
| | NC7-melilotus | 931 | 1 | 9 | 0 | 0 | 913 | 913 | 10 | 0 | 0 |
| | NC7-panicum | 977 | 0 | 1 | 3,105 | 976 | 0 | 976 | 1 | 0 | 0 |
| | NC7-perilla | 22 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | NC7-quinoa | 232 | 1 | 11 | 0 | 0 | 2 | 229 | 2 | 0 | 1 |
| | NC7-setaria | 998 | 0 | 1 | 3,647 | 993 | 0 | 993 | 1 | 0 | 0 |
| | NC7-spinach | 401 | 0 | | 1 | 1 | 401 | 401 | 2 | 0 | 0 |
| | NC7-umbels | 1,032 | 62 | 56 | 0 | 0 | 12 | 14 | 50 | 0 | 0 |
| | Total: | 8,588 | 147 | 278 | 8,065 | 2,364 | 1,812 | 7,156 | 276 | 0 | 224 |
| **Curator** | NC7-asters | 323 | 0 | | 0 | 0 | 0 | 4 | 0 | 0 | 0 |
| | NC7-brassica | 1,992 | 616 | | 286 | 65 | 152 | 1,607 | 10 | 80 | 234 |
| | NC7-crucifers | 1,134 | 0 | | 281 | 125 | 6 | 464 | 30 | 216 | 223 |
| | NC7-cuphea | 649 | 5 | | 0 | 0 | 0 | 326 | 0 | 0 | 0 |
| | NC7-flax | 2,810 | 0 | | 941 | 175 | 0 | 2,805 | 0 | 0 | 0 |
| | NC7-flax.wilds | 164 | 0 | | 95 | 68 | 0 | 70 | 1 | 0 | 0 |
| | NC7-sun.cults | 1,681 | 58 | | 5,624 | 318 | 148 | 1,616 | 0 | 0 | 0 |
| | NC7-sun.wilds | 2,179 | 375 | | 2,012 | 207 | 192 | 1,752 | 0 | 0 | 0 |
| | Total: | 10,932 | 1,054 | | 9,239 | 958 | 498 | 8,644 | 41 | 296 | 457 |
| **Millard** | NC7-corn.kin | 34 | 1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | NC7-maize | 18,255 | 2,042 | | 14,866 | 1,763 | 3,039 | 15,140 | 1,594 | 0 | 2,436 |
| | Total: | 18,289 | 2,043 | | 14,866 | 1,763 | 3,039 | 15,140 | 1,594 | 0 | 2,436 |
| **Reitsma** | NC7-chicory | 249 | 0 | | 0 | 0 | 249 | 249 | 0 | 0 | 0 |
| | NC7-cucumis.cucs | 1,349 | 0 | 403 | 0 | 0 | 1,345 | 1,345 | 36 | 0 | 0 |
| | NC7-cucumis.melo | 3,096 | 3 | 1,885 | 0 | 0 | 3,087 | 3,088 | 141 | 0 | 0 |
| | NC7-cucumis.wilds | 329 | 0 | 52 | 0 | 0 | 293 | 293 | 0 | 0 | 0 |
| | NC7-cucurbita | 991 | 15 | 286 | 0 | 0 | 981 | 981 | 19 | 0 | 0 |
| | NC7-cucurbits.misc | 2 | 0 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | NC7-daucus | 1,058 | 0 | 134 | 0 | 0 | 1,033 | 1,033 | 16 | 0 | 0 |
| | NC7-ocimum | 96 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | NC7-parsnips | 72 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total: | 7,242 | 18 | 2,760 | 0 | 0 | 6,988 | 6,990 | 212 | 0 | 0 |
| **VanRoekel** | NC7-euphorbia | 218 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total: | 218 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Widrlechner** | NC7-mints | 123 | 1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | NC7-ornamentals | 2,123 | 0 | | 1 | 1 | 8 | 32 | 19 | 0 | 0 |
| | Total: | 2,246 | 1 | | 1 | 1 | 8 | 32 | 19 | 0 | 0 |
| **NCRPIS Total:** | | **47,515** | **3,263** | **3,038** | **32,171** | **5,086** | **12,345** | **37,962** | **2,142** | **296** | **3,117** |

## Year 2003 Table 5 Five-Year Summaries of NCRPIS Accession Orders

| CURATOR | GENUS CROP | TIME PERIOD | Number Orders | Number Recipients | Number Items Distributed | Number Accessions Distributed |
|---|---|---|---|---|---|---|
| **Brenner** | NC7-amaranth | 01/01/1999 - 12/31/1999 | 62 | 50 | 3,682 | 2,483 |
| | | 01/01/2000 - 12/31/2000 | 44 | 37 | 860 | 451 |
| | | 01/01/2001 - 12/31/2001 | 51 | 37 | 985 | 604 |
| | | 01/01/2002 - 12/31/2002 | 43 | 33 | 446 | 235 |
| | | 01/01/2003 - 12/31/2003 | 52 | 44 | 1,035 | 534 |
| | | Total: | 252 | 201 | 7,008 | 4,307 |
| | NC7-celosia | 01/01/1999 - 12/31/1999 | 3 | 3 | 24 | 17 |
| | | 01/01/2000 - 12/31/2000 | 6 | 6 | 11 | 8 |
| | | 01/01/2001 - 12/31/2001 | 2 | 2 | 12 | 11 |
| | | 01/01/2002 - 12/31/2002 | 7 | 7 | 9 | 7 |
| | | 01/01/2003 - 12/31/2003 | 3 | 3 | 17 | 14 |
| | | Total: | 21 | 21 | 73 | 57 |
| | NC7-echinochloa | 01/01/1999 - 12/31/1999 | 2 | 2 | 9 | 8 |
| | | 01/01/2000 - 12/31/2000 | 5 | 4 | 166 | 149 |
| | | 01/01/2001 - 12/31/2001 | 4 | 4 | 36 | 33 |
| | | 01/01/2002 - 12/31/2002 | 4 | 4 | 5 | 5 |
| | | 01/01/2003 - 12/31/2003 | 5 | 5 | 26 | 26 |
| | | Total: | 20 | 19 | 242 | 221 |
| | NC7-grasses | 01/01/1999 - 12/31/1999 | 1 | 1 | 1 | 1 |
| | | 01/01/2000 - 12/31/2000 | 0 | 0 | 0 | 0 |
| | | 01/01/2001 - 12/31/2001 | 3 | 3 | 7 | 6 |
| | | 01/01/2002 - 12/31/2002 | 1 | 1 | 1 | 1 |
| | | 01/01/2003 - 12/31/2003 | 1 | 1 | 1 | 1 |
| | | Total: | 6 | 6 | 10 | 9 |
| | NC7-legumes | 01/01/1999 - 12/31/1999 | 4 | 4 | 32 | 32 |
| | | 01/01/2000 - 12/31/2000 | 4 | 4 | 12 | 11 |
| | | 01/01/2001 - 12/31/2001 | 3 | 3 | 6 | 6 |
| | | 01/01/2002 - 12/31/2002 | 7 | 5 | 69 | 50 |
| | | 01/01/2003 - 12/31/2003 | 5 | 5 | 31 | 26 |
| | | Total: | 23 | 21 | 150 | 125 |
| | NC7-melilotus | 01/01/1999 - 12/31/1999 | 9 | 9 | 287 | 254 |
| | | 01/01/2000 - 12/31/2000 | 16 | 12 | 712 | 554 |
| | | 01/01/2001 - 12/31/2001 | 13 | 11 | 57 | 49 |
| | | 01/01/2002 - 12/31/2002 | 5 | 5 | 43 | 42 |
| | | 01/01/2003 - 12/31/2003 | 12 | 11 | 211 | 198 |
| | | Total: | 55 | 48 | 1,310 | 1,097 |
| | NC7-panicum | 01/01/1999 - 12/31/1999 | 2 | 2 | 7 | 7 |
| | | 01/01/2000 - 12/31/2000 | 9 | 8 | 58 | 49 |
| | | 01/01/2001 - 12/31/2001 | 8 | 8 | 662 | 650 |
| | | 01/01/2002 - 12/31/2002 | 2 | 2 | 9 | 9 |
| | | 01/01/2003 - 12/31/2003 | 7 | 6 | 719 | 661 |
| | | Total: | 28 | 26 | 1,455 | 1,376 |
| | NC7-perilla | 01/01/1999 - 12/31/1999 | 4 | 4 | 61 | 20 |
| | | 01/01/2000 - 12/31/2000 | 6 | 6 | 41 | 21 |
| | | 01/01/2001 - 12/31/2001 | 7 | 7 | 41 | 22 |
| | | 01/01/2002 - 12/31/2002 | 4 | 4 | 26 | 22 |
| | | 01/01/2003 - 12/31/2003 | 7 | 7 | 56 | 22 |
| | | Total: | 28 | 28 | 225 | 107 |
| | NC7-quinoa | 01/01/1999 - 12/31/1999 | 10 | 10 | 294 | 163 |
| | | 01/01/2000 - 12/31/2000 | 21 | 19 | 342 | 149 |
| | | 01/01/2001 - 12/31/2001 | 18 | 15 | 239 | 173 |
| | | 01/01/2002 - 12/31/2002 | 23 | 22 | 333 | 161 |
| | | 01/01/2003 - 12/31/2003 | 23 | 21 | 276 | 195 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Total: | | 95 | 87 | 1,484 | 841 |
| | NC7-setaria | 01/01/1999 - 12/31/1999 | 7 | 6 | 27 | 26 |
| | | 01/01/2000 - 12/31/2000 | 13 | 12 | 795 | 757 |
| | | 01/01/2001 - 12/31/2001 | 6 | 6 | 20 | 19 |
| | | 01/01/2002 - 12/31/2002 | 9 | 8 | 48 | 43 |
| | | 01/01/2003 - 12/31/2003 | 7 | 7 | 58 | 53 |
| | Total: | | 42 | 39 | 948 | 898 |
| | NC7-spinach | 01/01/1999 - 12/31/1999 | 11 | 10 | 1,061 | 332 |
| | | 01/01/2000 - 12/31/2000 | 7 | 7 | 670 | 348 |
| | | 01/01/2001 - 12/31/2001 | 12 | 11 | 1,736 | 354 |
| | | 01/01/2002 - 12/31/2002 | 12 | 11 | 767 | 362 |
| | | 01/01/2003 - 12/31/2003 | 14 | 12 | 321 | 260 |
| | Total: | | 56 | 51 | 4,555 | 1,656 |
| | NC7-umbels | 01/01/1999 - 12/31/1999 | 14 | 13 | 180 | 117 |
| | | 01/01/2000 - 12/31/2000 | 11 | 11 | 141 | 122 |
| | | 01/01/2001 - 12/31/2001 | 15 | 13 | 105 | 94 |
| | | 01/01/2002 - 12/31/2002 | 25 | 20 | 305 | 213 |
| | | 01/01/2003 - 12/31/2003 | 19 | 16 | 310 | 151 |
| | Total: | | 84 | 73 | 1,041 | 697 |
| | Brenner Total: | | 710 | 620 | 18,501 | 11,391 |
| **Curator** | NC7-asters | 01/01/1999 - 12/31/1999 | 8 | 8 | 15 | 14 |
| | | 01/01/2000 - 12/31/2000 | 8 | 8 | 87 | 40 |
| | | 01/01/2001 - 12/31/2001 | 6 | 5 | 10 | 7 |
| | | 01/01/2002 - 12/31/2002 | 8 | 6 | 15 | 11 |
| | | 01/01/2003 - 12/31/2003 | 7 | 7 | 25 | 21 |
| | Total: | | 37 | 34 | 152 | 93 |
| | NC7-brassica | 01/01/1999 - 12/31/1999 | 52 | 46 | 2,172 | 1,119 |
| | | 01/01/2000 - 12/31/2000 | 69 | 56 | 1,238 | 856 |
| | | 01/01/2001 - 12/31/2001 | 35 | 32 | 460 | 408 |
| | | 01/01/2002 - 12/31/2002 | 52 | 48 | 1,125 | 932 |
| | | 01/01/2003 - 12/31/2003 | 60 | 51 | 2,878 | 884 |
| | Total: | | 268 | 233 | 7,873 | 4,199 |
| | NC7-crucifers | 01/01/1999 - 12/31/1999 | 15 | 13 | 299 | 227 |
| | | 01/01/2000 - 12/31/2000 | 16 | 15 | 72 | 66 |
| | | 01/01/2001 - 12/31/2001 | 22 | 18 | 640 | 268 |
| | | 01/01/2002 - 12/31/2002 | 24 | 23 | 241 | 212 |
| | | 01/01/2003 - 12/31/2003 | 15 | 15 | 89 | 79 |
| | Total: | | 92 | 84 | 1,341 | 852 |
| | NC7-cuphea | 01/01/1999 - 12/31/1999 | 12 | 11 | 110 | 98 |
| | | 01/01/2000 - 12/31/2000 | 10 | 8 | 122 | 89 |
| | | 01/01/2001 - 12/31/2001 | 16 | 12 | 713 | 482 |
| | | 01/01/2002 - 12/31/2002 | 12 | 9 | 255 | 222 |
| | | 01/01/2003 - 12/31/2003 | 21 | 14 | 394 | 247 |
| | Total: | | 71 | 54 | 1,594 | 1,138 |
| | NC7-flax | 01/01/1999 - 12/31/1999 | 14 | 13 | 297 | 259 |
| | | 01/01/2000 - 12/31/2000 | 8 | 8 | 120 | 118 |
| | | 01/01/2001 - 12/31/2001 | 14 | 14 | 268 | 223 |
| | | 01/01/2002 - 12/31/2002 | 8 | 8 | 73 | 63 |
| | | 01/01/2003 - 12/31/2003 | 6 | 6 | 96 | 95 |
| | Total: | | 50 | 49 | 854 | 758 |
| | NC7-flax.wilds | 01/01/1999 - 12/31/1999 | 3 | 3 | 26 | 16 |
| | | 01/01/2000 - 12/31/2000 | 0 | 0 | 0 | 0 |
| | | 01/01/2001 - 12/31/2001 | 2 | 2 | 22 | 19 |
| | | 01/01/2002 - 12/31/2002 | 2 | 2 | 18 | 12 |
| | | 01/01/2003 - 12/31/2003 | 3 | 3 | 20 | 19 |
| | Total: | | 10 | 10 | 86 | 66 |
| | NC7-sun.cults | 01/01/1999 - 12/31/1999 | 55 | 39 | 2,114 | 1,095 |
| | | 01/01/2000 - 12/31/2000 | 28 | 27 | 887 | 740 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 01/01/2001 - 12/31/2001 | 46 | 33 | 1,500 | 766 |
| | | 01/01/2002 - 12/31/2002 | 47 | 39 | 628 | 458 |
| | | 01/01/2003 - 12/31/2003 | 47 | 36 | 611 | 414 |
| | Total: | | 223 | 174 | 5,740 | 3,473 |
| | NC7-sun.wilds | 01/01/1999 - 12/31/1999 | 35 | 29 | 704 | 448 |
| | | 01/01/2000 - 12/31/2000 | 21 | 15 | 820 | 588 |
| | | 01/01/2001 - 12/31/2001 | 37 | 30 | 1,323 | 880 |
| | | 01/01/2002 - 12/31/2002 | 34 | 21 | 898 | 652 |
| | | 01/01/2003 - 12/31/2003 | 43 | 25 | 874 | 593 |
| | Total: | | 170 | 120 | 4,619 | 3,161 |
| | Curator Total: | | 921 | 758 | 22,259 | 13,740 |
| **Millard** | NC7-corn.kin | 01/01/1999 - 12/31/1999 | 8 | 8 | 19 | 6 |
| | | 01/01/2000 - 12/31/2000 | 9 | 9 | 20 | 7 |
| | | 01/01/2001 - 12/31/2001 | 7 | 7 | 13 | 7 |
| | | 01/01/2002 - 12/31/2002 | 5 | 5 | 16 | 7 |
| | | 01/01/2003 - 12/31/2003 | 8 | 8 | 23 | 8 |
| | Total: | | 37 | 37 | 91 | 35 |
| | NC7-maize | 01/01/1999 - 12/31/1999 | 231 | 167 | 4,536 | 2,805 |
| | | 01/01/2000 - 12/31/2000 | 257 | 193 | 18,480 | 10,981 |
| | | 01/01/2001 - 12/31/2001 | 313 | 210 | 7,269 | 4,637 |
| | | 01/01/2002 - 12/31/2002 | 426 | 285 | 7,258 | 3,980 |
| | | 01/01/2003 - 12/31/2003 | 254 | 187 | 5,368 | 2,938 |
| | Total: | | 1,481 | 1,042 | 42,911 | 25,341 |
| | Millard Total: | | 1,518 | 1,079 | 43,002 | 25,376 |
| **Reitsma** | NC7-chicory | 01/01/1999 - 12/31/1999 | 6 | 5 | 123 | 115 |
| | | 01/01/2000 - 12/31/2000 | 5 | 5 | 52 | 52 |
| | | 01/01/2001 - 12/31/2001 | 6 | 6 | 288 | 175 |
| | | 01/01/2002 - 12/31/2002 | 8 | 8 | 261 | 134 |
| | | 01/01/2003 - 12/31/2003 | 8 | 7 | 192 | 144 |
| | Total: | | 33 | 31 | 916 | 620 |
| | NC7-cucumis | 01/01/1999 - 12/31/1999 | 54 | 46 | 3,063 | 2,083 |
| | | 01/01/2000 - 12/31/2000 | 60 | 45 | 1,555 | 1,235 |
| | | 01/01/2001 - 12/31/2001 | 59 | 49 | 1,229 | 933 |
| | | 01/01/2002 - 12/31/2002 | 59 | 47 | 2,864 | 1,787 |
| | | 01/01/2003 - 12/31/2003 | 48 | 37 | 1,905 | 1,394 |
| | Total: | | 280 | 224 | 10,616 | 7,432 |
| | NC7-cucurbita | 01/01/1999 - 12/31/1999 | 16 | 15 | 170 | 137 |
| | | 01/01/2000 - 12/31/2000 | 19 | 18 | 457 | 363 |
| | | 01/01/2001 - 12/31/2001 | 22 | 20 | 288 | 156 |
| | | 01/01/2002 - 12/31/2002 | 20 | 17 | 165 | 132 |
| | | 01/01/2003 - 12/31/2003 | 12 | 12 | 194 | 168 |
| | Total: | | 89 | 82 | 1,274 | 956 |
| | NC7-cucurbits.misc | 01/01/1999 - 12/31/1999 | 2 | 2 | 2 | 1 |
| | | 01/01/2000 - 12/31/2000 | 0 | 0 | 0 | 0 |
| | | 01/01/2001 - 12/31/2001 | 2 | 2 | 2 | 1 |
| | | 01/01/2002 - 12/31/2002 | 0 | 0 | 0 | 0 |
| | | 01/01/2003 - 12/31/2003 | 1 | 1 | 1 | 1 |
| | Total: | | 5 | 5 | 5 | 3 |
| | NC7-daucus | 01/01/1999 - 12/31/1999 | 20 | 16 | 457 | 307 |
| | | 01/01/2000 - 12/31/2000 | 11 | 11 | 171 | 169 |
| | | 01/01/2001 - 12/31/2001 | 13 | 12 | 235 | 211 |
| | | 01/01/2002 - 12/31/2002 | 11 | 11 | 75 | 67 |
| | | 01/01/2003 - 12/31/2003 | 13 | 12 | 426 | 294 |
| | Total: | | 68 | 62 | 1,364 | 1,048 |
| | NC7-ocimum | 01/01/1999 - 12/31/1999 | 7 | 7 | 206 | 88 |
| | | 01/01/2000 - 12/31/2000 | 7 | 7 | 245 | 75 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 01/01/2001 - 12/31/2001 | 5 | 5 | 97 | 79 |
| | | 01/01/2002 - 12/31/2002 | 8 | 8 | 20 | 18 |
| | | 01/01/2003 - 12/31/2003 | 8 | 8 | 52 | 42 |
| | | Total: | 35 | 35 | 620 | 302 |
| | NC7-parsnips | 01/01/1999 - 12/31/1999 | 2 | 2 | 8 | 8 |
| | | 01/01/2000 - 12/31/2000 | 0 | 0 | 0 | 0 |
| | | 01/01/2001 - 12/31/2001 | 0 | 0 | 0 | 0 |
| | | 01/01/2002 - 12/31/2002 | 2 | 2 | 9 | 8 |
| | | 01/01/2003 - 12/31/2003 | 1 | 1 | 1 | 1 |
| | | Total: | 5 | 5 | 18 | 17 |
| | | | | | | |
| | | Reitsma Total: | 515 | 444 | 14,813 | 10,378 |
| **VanRoekel** | NC7-euphorbia | 01/01/1999 - 12/31/1999 | 2 | 2 | 2 | 2 |
| | | 01/01/2000 - 12/31/2000 | 3 | 3 | 37 | 37 |
| | | 01/01/2001 - 12/31/2001 | 1 | 1 | 1 | 1 |
| | | 01/01/2002 - 12/31/2002 | 4 | 4 | 8 | 6 |
| | | 01/01/2003 - 12/31/2003 | 2 | 2 | 9 | 7 |
| | | Van Roekel Total: | 12 | 12 | 57 | 53 |
| | | | | | | |
| **Widrlechner** | NC7-mints | 01/01/1999 - 12/31/1999 | 3 | 3 | 8 | 8 |
| | | 01/01/2000 - 12/31/2000 | 3 | 3 | 37 | 35 |
| | | 01/01/2001 - 12/31/2001 | 5 | 5 | 75 | 42 |
| | | 01/01/2002 - 12/31/2002 | 4 | 4 | 22 | 19 |
| | | 01/01/2003 - 12/31/2003 | 9 | 9 | 45 | 39 |
| | | Total: | 24 | 24 | 187 | 143 |
| | NC7-ornamentals | 01/01/1999 - 12/31/1999 | 84 | 77 | 561 | 222 |
| | | 01/01/2000 - 12/31/2000 | 76 | 72 | 496 | 216 |
| | | 01/01/2001 - 12/31/2001 | 83 | 77 | 740 | 230 |
| | | 01/01/2002 - 12/31/2002 | 103 | 88 | 779 | 361 |
| | | 01/01/2003 - 12/31/2003 | 108 | 91 | 883 | 320 |
| | | Total: | 454 | 405 | 3,459 | 1,349 |
| | | | | | | |
| | | Widrlechner Total: | 478 | 429 | 3,646 | 1,492 |
| | | | | | | |
| **NCRPIS Total:** | | | **4,154** | **3,342** | **102,278** | **62,430** |