



MIDWEST APPLE IMPROVEMENT ASSOCIATION

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Purdue University ♦ 1165 Horticulture Building ♦ West Lafayette, IN 47907-1165
(765) 494-6968 ♦ FAX: (765) 494-0391 ♦ E-mail: awhipkey@purdue.edu
<http://www.hort.purdue.edu/newcrop/maia/>

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2002, Making the Best Better

David Doud

Another year and while we carry on with our business, the mission of MAIA continues in its quest for 'winners' suited to our Midwestern climate. We turn a small corner this spring with the first cross with the Kazakhstan material projected to be made. The exotic material has multiple disease resistance and a decent sized fruit that some compare to McIntosh, one of the 'elites'. Though the cross will not involve many seeds it is notable in that the material that catalyzed the organization is now being utilized.

Until now the bulk of the crosses have been with the finest of our modern varieties and while most have better than average cropping reliability, there is no reasonable hope of getting a 'winner' whose spring frost avoidance is head and shoulders above Rome. It is interesting to contemplate that with the numbers of seedlings we now have in the field, the odds are there is a winner out there. This spring, breeding will continue to focus on modern combinations with GoldRush and/or Honeycrisp to be a parent in the majority. It is worth noting that we have made significant numbers of seedlings from unusual sources, *M. brevides* (small, but with 22% soluble solids), CQR10T17 (self thinning scab resistant), and a number of crosses with red flesh. Some of these will probably be transitional accessions that will need another generation or more before any-

one will want a block of them in the orchard, but the groundwork is being laid and I hope you all are excited about it. Read about Diane Miller's work evaluating freeze tolerance in the 'Report from Dawes', and consider how important that will be in evaluating the Kazakhstan material. A year from now we should hear reports on fruit from these seedlings—fruit breeding may be slow, but time flies and in two years there should be reports on fruit from crosses we have made.

I am pleased to report that our membership is holding steady, actually gaining a few new members, and interest in new varieties is as high as it has ever been. I think we know that we are all niche marketers and what better niche to have than our own special, distinctive varieties. Last season's hail impaired crop sold strongly at retail, reinforcing faith that we can provide a product that will be demanded by consumers and that mass marketers cannot match. So, let's all pat each other on the back, step back and appreciate the beauty of this season and our business, send in your membership with the appreciation that visionaries are in short supply, and take quiet pride in what we are doing for posterity.

MAIA Annual Meeting

A beautiful November day greeted the 30 or so attendees to the annual meeting at the Dawes facility. The legacy of Beman and Bertie Dawes, founded in 1929, the arboretum is a beautiful facility nestled in the rolling terrain east of Columbus. Our meeting room had a window wall overlooking a sunken garden and long views down a hill over part of the collection and fields to distance wooded hills.

As people began to arrive, tables were arranged, projector set up, Diane Miller arrived with the lunch, Phil Forsline with apples from seedlings grown from seeds collected on his trips, and a table of modern apples was arranged for sampling. After introductions and re-acquaintanceing, the meeting commenced.

Diane Miller presented her work of the past year on flower bud hardiness and blossom frost survival. Our desire for apples that will avoid spring cold damage that devastates our crops periodically calls for research into the nature of the damage and for a regimen of replicable laboratory testing to evaluate selections. Diane has developed such a regimen and subjected blossoms of *Malus domestica*, *M. sieversii*, and *M. coronaria* to freezing treatments and evaluations. Results (very generalized here) showed the styles to be the most sensitive to damage. Cultivars vary in sensitivity to freezing temperatures. Blossom survival differences between cultivars are not explained by stage of development. The

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Apple Breeding Worldwide

(Condensed from Jim Ballard's 2002 PNWFTA report*)

Australia

Applethorpe Research Station located in Stanthorpe, Queensland began in 1964 and by 1989 had released **Earlidel** and **Summerdel**, both summer apples. In 1986 the program included disease resistance into its priorities.

Agriculture Western Australia began in 1972 and by 1985 had released **Pink Lady** and **Sundowner**, both very late maturing varieties. Primary goals are for export marketing.

Belgium

Fruittelcentrum K.U. Leuven located in Heverlee began in 1989 with disease resistance, tree growth form (architecture) and others. To date one variety has been released: **Merlijn** (Jonagold × Liberty) which matures in midseason.

Brazil

The Apple Breeding Project of Epagri located near Cacador, Santa Catarina which is a near tropical area and requires varieties with very low chill and broad spectrum disease resistance. Eleven varieties have been released to date with **Daiane** being commercially planted.

Bulgaria

Fruitgrowing Institute, Plovidiv located at Ostromila, Plovidiv, Bulgaria began in 1986 with priorities of disease resistance, early and late maturation, and growth habit.

Canada

Pacific Agri-Food Research Center located in Summerland began in 1924 and have released Spartan, Summerred, Sinta, Sunrise, Silken, Chinook, Creston, and the columnar types, Golden Sentinel and Scarlet Sentinel to date.

China

There are currently nine (9) active breeding programs located throughout China with Fuji being a primary breeding parent in many of them. A few varieties have made it to the US including **Huaguan** and **Huashuia** both of which are Fuji sibs and inferior to Fuji.

Czech Republic

Research and Breeding Institute of Pomology located near Hologousy began in 1951 and has released eleven varieties including the newer **Angold**, **Jarka**, **Julia**, **Resista** and **Selena**.

England

Horticulture Research International located at East Malling, Kent has been active for many decades. Releases include **Meridian**, and the columnar types named **Telamom**, **Trajan**, **Tuscan**, **Maypole**, **Charlotte**, **Obelisk** and **Totem**.

They also have recently released an interesting new apple rootstock, **M.116** which is similar to MM106 with resistance to crown rot and WAA.

France

Centre de Recherches INRA, Angers located in Beaucouze Cedex has long had disease resistance as a priority. More recently the priority of "one fruit per cluster" (no thinning) has been introduced in a few

scab resistant selections.

Releases so far include Florina, a late maturing super-sweet variety and Baujade, a disease resistance Granny Smith type.

Delbard Pepinieres International located near Commeny is a private breeding program and have released Delbard Jubilee, Tentation and Delbarestivale (which has excellent taste in Southern Indiana for a mid season apple).

Germany

Federal Centre of Breeding Research on Cultivated Plants is located near Dresden and began in 1928. Many varieties have been released in recent years which have resistance to disease including **Reanda**, **Rebella**, **Remo** and **Rewena**.

This station also recently released a series of dwarfing apple rootstocks referred to as the **Supporter** series.

Greece

National Agricultural Research Foundation located in Naoussa has released **Naoussa** (Golden x Granny) and **Makedonia** (Golden × Jonathan) since 1973.

Hungary

University of Horticulture and Food Industry located near Budapest began some 25 years ago and have released **Jonager**, **Nyari zamatos**, **Kovelit** and **Kovaugaszt**.

Italy

CIV Consorzio Italiano Vivaisti located near Via Romea is a private program of three Italian nurseries. Since 1988 they have released **Giotto**, an early season type, **Rubens** and will soon release a numbered selection (DA-73).

Instituio di Coltivazioni Arboree located near Bologna. So far, two varieties have been released, namely **Primiera** (from PRI) and **Gold Chief**.

Research Centre Laimburg, South Tyrol located near Pfatten is a new program beginning in 1996. Currently some 14,000 seedlings are being evaluated.

Japan

There are eight (8) government funded programs and numerous private programs active in apple breeding. Many of these have been involved in apple breeding for well over 100 years.

Some of the more prominent programs include the following:

Apple Research Center located near Morioka, Iwate began in 1939. The most notable introduction was **Fuji** in 1962. They also have released a series of rootstocks.

Aomori Apple Experiment Station located near Botandaira, Kuroi-sha, Aomori began in 1928 and have release many varieties including **Mutsu**, **Megumi** and **Hokuto** (excellent quality in southern Indiana).

The Netherlands

Centre for Plant Breeding & Reproduction Research located

near Wageningen began in 1948 and have introduced several newer varieties including **Elstar**, **Elan**, **Elise**, **Bellida**, **Ecolete** and **Santana**.

New Zealand

The Horticultural and Food Research Institute of NZ located in Hafvelock North began in 1969 and have recently introduced (to commercial production only) **Sciros**, **Pacific Rose**, **Scired**, **Pacific Queen**, **Sciearly**, **Pacific Beauty** and **Jazz**

Norway

Ullensvang Research Centre located near Leikanger is active in breeding short season varieties with disease resistance. Newer releases include **Nanna**, **Siv**, **Eir** and **Idunn**.

Poland

Research Institute of Pomology and Floriculture located near Skierniewice. They have released several varieties over the last 20 years including some which are disease resistant. This station is also active in rootstock breeding for hardiness and dwarfing.

Warsaw Agricultural University located near Warsaw began in 1975 and have released three scab resistant varieties, namely **Witos**, **Sawa** and **Alka**.

Romania

Fruit Research Institute of Pomology located near Arges began in 1948. In recent years, the main objective has been resistance to fireblight.

Republic of South Africa

ARC-Infruitec located at Stellenbosch began in 1955 and have recently release the apples, **Drakenstein** and **Golden Gift**. **Very soon a newer one will be released called African Carmain to commercial production.**

Russia

All Russian Research Institute of Horticultural Breeding located near Zhilina, Orel began in 1955 with the goal of combining winter hardiness, scab resistance, high acids, dwarf form and triploid types (by use of tetraploid parents) into one type. Currently there are around 38 selections in advanced testing.

There are six other affiliated stations located throughout Russia. One in particular, I visited in 1994 is located just outside of Krasnodar (near the same latitude as S. Indiana) which was involved in breeding many other fruits and tree nut species.

Sweden

Swedish University of Agricultural Sciences located near Kristiansstad began in the early 1940s expressly to breed short season varieties. Some of the more popular ones are **Katja (aka Katy)** and **Aroma**.

Switzerland

Federal Research Station located near Wadenswil. Varieties released from this station include **Swiss Orange**, **Maigold**, **Arlet (aka Swiss Gourmet)**, **Iduna**, **Marina** and **Ariwa**.

South Korea

National Horticultural Research Institute located in Suwon began in 1954 and have recently began to use newer varieties (like Fuji) for breeding purposes. Several newer siblings have been recently planted commercially.

United States

University of Minnesota Horticulture Research Center located near Excelsior has been active since 1878 have released a number of apples over the years including **Haralson**, **Regent**, **Sweet Sixteen**, **Honeycrisp** and **Zestar**.

WSU Apple Breeding Project located in Wenatchee is a very new program beginning in 1994 with primary objectives of superior commercial qualities (to replace Red Delicious).

Cornell University located in Geneva began 1895 and has released a whopping 65 apple varieties. The more popular ones include **Cortland**, **Macoun**, **Empire**, **Jonagold** and **Liberty**.

The collective **PRI group** which includes the following:

Purdue University located near West Lafayette, Indiana
Rutgers University (Cook College) located near New Brunswick, NJ
University of Illinois located in Urbana, IL

This project began in 1946 expressly to breed apples with scab resistance. A rather large number have been released including the more popular **Redfree**, **Jonafree**, **William's Pride**, **Enterprise**, **Gold-Rush**, **Pristine**, and more recently, **Sundance** and **Pixie Crunch**.

Of special interest to MAIA is the collaboration of Dr. Jules Janick who has assisted us in hybridizing and evaluation techniques.

Yugoslavia

Institute of Fruit Growing and Viticulture located at Trg Dositeja Obradovica began in 1985 with priorities of disease resistance, columnar growth form, and aphid resistance.

Several selections are in the late stages of evaluation.

Srbija Institute, Fruit & Grape Research Centre located near Cacak began in 1973. Several varieties have been introduced including **Cacanska pozna** and **Cadel**.

*An expanded and very comprehensive version of this report can be obtained by sending \$25.00 to Jim Ballard, 1101 West Orchard Ave., Selah, WA 98942. And I highly recommend this publication to all MAIA members.

Ed Fackler

Crosses made in 2001

GoldRush × CQR10T17	5720	seed
CQR10T17 × GoldRush	234	seed

Cross to be made at Purdue

University in 2002
GoldRush × Honeycrisp

History of the PRI Apple Breeding Program

Jules Janick

Introduction

Scab incited by the ascomycete *Venturia inaequalis* (Cke.) Winter is the single most destructive disease of the cultivated apple in all humid production areas of the world. Control requires a continuous cover of fungicides which is a significant part of the cost of production. Furthermore, many scab fungicides such as Benlate have become ineffective due to resistance of the organism. Heightened concerns over residues and environmental effects associated with pesticides have contributed to the search for alternate methods of disease control. In the United States, although difference in susceptibility were long noted in standard cultivars of apple, none could be considered resistant and popular ones such as 'Delicious' and 'McIntosh' were highly susceptible. 'Antonovka', introduced by Michurin in Russia, had become known in Europe for its high scab resistance and prior to WWII, C.F. Rudloff and M. Schmidt started using this cultivar in controlled crosses with susceptibles. However due to the quantitative nature of resistance, only a low proportion of highly resistant seedlings were obtained. Schmidt hybridized susceptible cultivars with *Malus micromalus* and while field immune segregates were obtained, the fruit size was so small and quality so low, that the breeding program was abandoned.

Origins of the PRI Program

The PRI cooperative scab-resistant apple breeding program between Purdue University, Rutgers, The State University of New Jersey, and the University of Illinois, has a long and interesting history involving many scientists and collaborators. The original program dates to a formal 1945 collaboration between J. Ralph Shay, (1918–1980) pathologist at Purdue University and L. Fredric Hough, (1915–1993) horticulturist at the University of Illinois to develop scab resistant apples. Interestingly, the program was initiated before the environmental implications of the program were realized, and the goal was simply one of serving the needs of fruit growers. In 1948, Hough moved to the Department of Horticulture and Forestry at Rutgers, The State University of New Jersey and shortly thereafter Rutgers joined Illinois and Purdue as the third partner in the collaboration and a large volume of valuable susceptible apple germplasm developed by the late Professor M.A. Blake was thereby made available to the program. In 1950, Daniel F. Dayton joined the program at Illinois while pursuing graduate studies as did Edwin B. Williams, a graduate student of Shay. Both Dayton and Williams remained with the program upon completion of their PhD degrees with Dayton continuing leadership for the Illinois team with Williams assuming leadership of the Purdue program when Shay left to join the University of Oregon in 1966. J.B. Mowry, stationed at the Illinois Horticultural Experiment Station, Carbondale, Illinois joined the collaboration in 1952 and tested material until his death in 1986. In 1955, Catherine H. Bailey, a graduate student of Hough and research associate became a participant at Rutgers. Jules Janick of the Department of Horticulture joined the Purdue program in 1954 and Frank H. Emerson was a part of the program from 1967 to 1988. Schuyler S. Korban replaced Dayton at the University of Illinois upon his retirement in 1982. Shawn A. Mehlenbacher replaced Hough after his retirement in 1981, remained with the program from 1982–1986, and was in turn replaced by Joseph Goffreda in 1989. Other participants in PRI included Jeffrey A. Crosby and Paul C. Pecknold at Purdue University, P.A. O'Connor and S.M. Ries at the University of Illinois, and A. Voordeckers at Rutgers University, H.F. Goonewardene, a

USDA employee stationed at Purdue, investigated insect resistance in PRI germplasm from 1973 to 1988.

The germplasm exploited by Shay and Hough can be traced to breeding studies of Professor C.S. Crandall (1852–1929) at the University of Illinois carried out as early as 1907. Crandall had assembled a large collection of *Malus* species and forms at the beginning of the century and initiated an intensive study of crosses between cultivated apples and crab-like forms. A summary of Crandall's work was published in Bulletin 275 of the University of Illinois (1926) that describes all the material in the program. Crandall, influenced by the rediscovery of Mendel, was attempting to determine inheritance patterns in *Malus*. Ironically, he did not work with characters that would enable him to identify single genes nor did he evaluate his material for disease resistance. The voluminous data he collected and maintained at the University of Illinois has never been completely analyzed although the designations reported in Bulletin 275 describing his species sources have become justly famous. The selection he labeled *Malus floribunda* 821 was the original source of the V_f gene. Fortunately, his breeding material was maintained following his retirement in 1927, but remained unevaluated until L.F. Hough joined the Department in 1942 as a graduate student and plant breeding assistant.

The spring of 1943 was unusually cool and wet resulting in a severe epidemic of scab which defoliated all susceptible unsprayed apple trees. Hough noted that one progeny, an F_2 of *Malus floribunda* 821 × Rome Beauty segregated a 1:1 ratio of resistant to susceptible suggesting the involvement of a single gene later termed V_f . Hough published his results in 1944 in a famous paper entitled "A survey of the scab resistance of the foliage of seedlings in selected apple progenies." The paper was brought to the attention of J.R. Shay, a young professor who joined the Purdue's Department of Botany and Plant Pathology from Arkansas and who had received his PhD from the University of Wisconsin where a program on the pathogenicity of *Venturia inaequalis* had been under investigation. (In the 1940s, considerable interest in the genetics of the ascomycetes had been engendered by the work of Beadle and Tatum in *Neurospora*.) Shay and Hough decided to collaborate on a scab resistance breeding program with the objective to advance genetic resistance identified by Hough into improved horticultural backgrounds and identification of additional resistant *Malus* germplasm through testing of material in arboreta and other collections. The first screened hybrid progenies were planted in the field in 1947 and began fruiting at Illinois in 1951. A formal cooperative program was established in 1945 between the agricultural experiment stations associated with Purdue University and the University of Illinois.

Techniques and Strategy

Techniques for controlled greenhouse screening of hybrid progenies were developed by Shay making it possible to identify resistant segregates within two months after seed germination. Resistance of apple to scab was scored according to symptoms on young leaves grown under greenhouse conditions. 0 = no macroscopic evidence of infection; 1 = pinpoint pits, no sporulation; 2 = irregular chlorotic or necrotic lesions and no sporulation; 3 = few restricted sporulating lesions; and 4 = extensive, abundantly sporulating lesions. The class M was added to indicate a mixture of necrotic, nonsporulating, and sparsely sporulating lesions (Shay and Hough 1952a). Only class 4

was considered as field susceptible; all the others classified as field resistant and did not show symptoms of infection when grown outdoors where conditions for scab are very favorable. Using a broad definition of resistance, crosses of heterozygous resistant with homozygous susceptibles segregate 1 resistant : 1 susceptible but usable resistance (completely nonsporulating i.e., class 0, 1, and 2) is lower, typically 30%. For example although V_f is traditionally considered to be a simply inherited, dominant factor conditioning qualitative resistance, it is often associated with any number of quantitative resistance factors which make it less vulnerable to attack by new races of the fungus. Progeny segregation ratios and the frequency distribution of leaf reaction classes suggest the complexity of the genetic basis of resistance derived from V_f .

The goals of the program were twofold: genetic improvement of apple and an elucidation of the genetics of resistance in apple. The breeding strategy consisted of a modified backcross program with the entire spectrum of susceptible cultivars serving as recurrent parents. Several *Malus* species were used to incorporate their resistance factors into more advanced pomological backgrounds. The extensive effort to evaluate the nature of resistance and the stability of resistance was carried out in studies parallel to the breeding program. Many *Malus* species and hybrids with genetic resistance useful in breeding were subsequently identified. Through a series of intercrosses (tests of allelism) it was established that 11 of the 25 sources were due to the same V_f gene (Williams and Kuc 1969). Six loci for qualitative resistance (defined gene pools) were identified as shown in Table 1.

Five different virulent races of *V. inaequalis* were identified and race 6 has been subsequently identified in Germany (Parisi et al. 1993) as shown in Table 2. Recently race 7 has appeared which attacks *M. floribunda* 821 and questions the durability of the V_f gene without modifiers. Fortunately race 7 does not attack 'Golden Delicious' which indicates the presence of modifiers in this cultivar (Y. Lespinasse, pers. commun.).

In addition to screening for apple scab, screening for other diseases was carried out in the field from natural infection. These included the diseases fireblight incited by *Erwinia amylovora* (Burr.A) Winslow et al.; cedar-apple rust incited by *Gymnosporangium juniperi-virginianae* Schw.; and powdery mildew incited by *Podosphaera leucotricha* (Ell. & Ev.) Salm. Some screening for mildew were carried out in England under the assistance of the late A.G. Brown of the John Innes Institute.

The original breeding program was uniquely a true cooperative effort between the three stations. While crossing was carried out at each location, the bulk of the successful hybridizations was achieved by Hough who each spring traveled with his team of pollinators from New Brunswick, New Jersey to Geneva, New York, and on to New Hampshire, following spring in its northern trek. All seeds were assembled at Purdue University and screened for scab at the Department of Botany and Plant Pathology. Resistant seedlings were either planted

Table 1. Defined gene pools for resistance to apple scab.

Symbol	Original <i>Malus</i> source
V_f	<i>M. floribunda</i>
V_m	<i>M. micromalus</i> (pit)
V_r	<i>M. pumila</i> (Russian) 12740-7A (probably <i>M. seversia</i>)
V_{bj}	<i>M. baccata jackii</i>
V_b	Hansens's <i>baccata</i> # 2
V_a	Antonovka PI 1722623 (pit)

Table 2. Races of *Venturia inaequalis* and differential hosts of apple.

Race	Source	Susceptible material
1	Worldwide	Most of the world's cultivars
2	South Dakota, US	<i>M. baccata</i> , 'Dolgo', 'Alexis', 'Bittercrab' segregates of R12740-7A, 'Geneva'
3	Nova Scotia, Canada	'Geneva'
4	Lafayette, Indiana, US	Segregates of R12740-7A
5	Norwich, England	<i>Micromalus</i> pit type resistance, <i>M. atrosanguinea</i> 804
6	Ahrensburg, Germany	'Prima' (V_f cultivars) but not 'Evereste' <i>M.</i> × "Perpetu" and <i>M. floribunda</i> 821
7	England - Europe	<i>Malus floribunda</i> 821

directly to the field or grown in a nursery and then divided between cooperators with the bulk of the progenies evaluated at Indiana and Illinois. Fruit of promising seedlings each year were compared in a joint display and used in crosses in the following years. By 1967 the most promising selections, called Co-ops to underscore the cooperative nature of the program, were released to interested testers including fruit growers and experiment stations in other states. In addition, promising selections were shared worldwide with international cooperators.

Accomplishments

Up to the present time over 1500 selections have been made of which 44 have been released for advanced testing as Co-ops, and of these 13 have been named as shown in Table 3. Joint releases from other PRI selections include; McShay (1988) released in cooperation with Oregon State University, 'Priam' (1974) and 'Juliet' (1999) released in France; 'Primiera' (1995), released in Italy; 'Primivera' (1996) released in Quebec, Canada; and Constance (1995) released in Germany by an organic grower. 'Nambu' (1994) is a PRI selection that was released without authorization in Japan. 'Viking' (1969), released in Wisconsin, is a PRI selection but proved to be scab susceptible.

An attempt was made to carry each source of resistance forward but resistance derived from *Malus floribunda* received the most attention because two F_2 selections of the original *Malus floribunda* 821 × Rome Beauty cross carrying the designation F_2 26829 and F_2 28830 were more advanced in size and quality. The selection F_2 26829 while

Table 3. PRI and joint releases of scab-resistant apples.

PRI releases	Co-op no.	Year released	Joint releases	Co-op no.	Year released
Prima	2	1970	Priam	-	1974
Priscilla	4	1972	McShay	-	1988
Sir Prize	5	1975	Primiera	42	1995
Jonafree	22	1979	Nambu	-	1994
Redfree	13	1981	Constance	-	1995
Dayton	21	1988	Primivera	-	1996
Williams' Pride	23	1988	Juliet	43	1999
Enterprise	30	1993			
GoldRush	38	1993			
Pristine TM	32	1994			
Scarlett O'Hara TM	25	2000			

only 2 generations from the original small fruited species had unusually good quality and was about 5 cm in diameter. A breakdown of the pedigrees of the 44 Co-op selections indicate that all of the 44 released date back to *M. floribunda* although Co-op 41 also has *M. atrosanguinea* 804 in its pedigree. Of the 43 floribunda selections only one Co-op derived from 26830 entirely (Co-op 11), one has both F₂ 26829 and F₂ 26830 in its pedigree, and three have F₂ 26829 on both sides. The scab resistant program at Cornell University originated from material derived from F₂ 26829 and the two releases, 'Liberty' and 'Freedom' carry the *V_f* gene.

In 1963, the three cooperating universities in conjunction with other interested American and Canadian breeders formed a loose cooperative organization known as The Apple Breeder Cooperative (ABC) and workers in several other states have participated in testing selections. Introductions of the Co-op selections and the release of scab-immune cultivars created great interest in the program throughout the world. Several countries, including Australia, Brazil, Canada, Czechoslovakia, England, France, Italy, Poland, South Africa, Romania, Sweden, and Russia have incorporated PRI germplasm in their apple breeding programs. By 2000 over 50 scab resistant sections have been released.

Future Prospects

The excellent progress in developing new apple scab immune cultivars was due to administrative support at the three institutions, the ability and willingness of the cooperating workers to pool their efforts and facilities, and the tremendous effort carried out in the Department of Botany and Plant Pathology at Purdue University under the guidance first of J.R. Shay and later of E.B. Williams to carry out an efficient greenhouse screening procedure. About 380,000 seedlings were screened. Although the scab resistant program still exists between the three institutions, activity has declined as the universities at each location reduced support. By 1993 the Department of Botany and Plant Pathology discontinued their input and the Purdue program was carried on by Jules Janick who was directed to be concerned only with evaluating the remaining selections, although crossing was continued. At the University of Illinois Dr. Korban's program became oriented to the molecular biology of scab resistance. Screening has continued at Rutgers but the apple breeding program is just one small part of a general fruit breeding program. However, just as the Universities were fatigued with funding, a number of fruit growers have become believers in the program and have formed an organization called the Midwest Apple Improvement Association to continue the breeding efforts. Crosses have been made at Purdue and are supplied to the organization. Screening in 1998, 1999, and 2000 were carried out by Diane Doud Miller at Ohio State University. At the same time international interest in scab resistant breeding has continued in Europe.

Conclusion

The PRI program remains as an example of what can be accomplished in tree fruit breeding programs, long discounted for their slow progress, by a concerted attempt at transferring desirable genes from interspecific hybridization. Several serendipitous discoveries were made. By impatiently using the first fruiting selections from crosses as parents, reduced juvenility and increased precocity were selected. The advantages of diversity were demonstrated by the incorporation of a tolerance to a number of insects and diseases and long storage ability. The impact of the program is expected to be fully realized in the 21st century as more breeding programs worldwide incorporate this disease resistant material developed by the PRI program.

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2002 MAIA Meeting

This year's meeting will be held at Purdue University this November.

Make sure we have your email address if you would like to be notified by email.

Details will also be posted on the MAIA website www.hort.purdue.edu/newcrop/maia

Midwest Apple Improvement Association

Operating Statement

January 1, 2001 thru December 31, 2001

Total income	\$5833.23
Total expenses	\$6477.99
Total assets	\$10221.36

Evaluation of Apple (*Malus sieversii*) germplasm from Kazakstan

Dr. Diane Doud Miller

In Ohio, we have under evaluation approximately 900 seedling trees of the wild apple species *Malus sieversii*. The seeds were collected by USDA plant explorers during three collection trips (1993, 1995, 1996) to central Asia, specifically Kazakstan, Kyrgyzstan, Uzbekistan, and Tajikistan (Hokansen et al. 1997). This central Asia area is believed to be the “center of origin” of apple so scientists expect great diversity of traits of *Malus* to be present in this material. The area became open to western explorers only after the break-up of the Soviet Union.

There is interest among apple breeding programs around the world in incorporating interesting traits from the *M. sieversii* material into new apple cultivars but first these interesting traits must be identified! There is a world-wide effort underway to evaluate the material. The Plant Genetics Resources Unit (PGRU) in Geneva, New York has distributed over 1300 seed populations (28,300 seeds) of *M. sieversii* to 24 cooperators worldwide for evaluation (Luby et al. 2000). Among the interesting traits already discovered in this material are new genetic sources of scab resistance, including multiple gene resistance. Many seedlings have also been screened for fireblight resistance and cedar apple rust resistance. Over time, there will be selection made horticultural traits of fruit and tree quality.

In Ohio, we are currently evaluating this material for time of leafing (known to be related to time of flowering) with the goal of finding late-leafing (i.e. late-spring-blooming) seedlings. The seedlings Ohio acquired are hoped to have special potential for late-leafing (or frost tolerance of blossoms) because: the 1993 collection was made after a frost at bloom, so the apples collected were either from late bloom or frost-escape flowers; the 1995 collection took more than 120 days to break seed dormancy (thought to be related to late bloom) and were collected from the “big apple” area of Kazakstan; the 1996 collection took 120 or more days to break seed dormancy. The best of these seedlings will be used as parents to move back the bloom date in breeding apple cultivars better adapted to our Midwest environmental conditions. The research we have in progress is to determine “the best” of these seedlings.

The Ohio *M. sieversii* seedlings were planted at Dawes Arboretum, Newark, OH in spring 1999. Prior to this the 1993 and 1995 seedlings had been acquired by Mitch Lynd in 1997 in a circuitous route from PGRU, Geneva, NY through Dr. Curt Rom, University of Arkansas. When the material was acquired plans were not in place to field plant it, so the seedlings were grown in containers at OSU, Columbus during 1998 to increase both health and size. The 1996 seedlings were sent directly from PGRU to Mitch Lynd and were field planted at Dawes as small seedlings, also in spring 1999. There are approximately 250 seedlings in the 1993 group (progeny from 28 mother trees), 250 seedlings in the 1995 group (progeny from 28 mother trees) and 400 seedlings in the 1996 group (number of mother trees not yet known by us).

The Ohio 1993 and 1995 seedlings were screened but not rouged by PGRU personnel for resistances to apple scab, fireblight and cedar apple rust and this information recorded on the USDA Germplasm Resources Information Network (GRIN) system. The 1996 seedlings have not been screened. There are at least three resistance genes present in the material for apple scab the *f* gene already in use in

breeding (*Vf*, A type; and to which scab resistance has been noted), the *r* gene (Russian resistance; B type) and *n* gene (necrotic type) and an additional currently uncharacterized resistance. There are some seedlings which contain multiple genes for scab resistance, e.g. *f* + *r*.

To begin the process of selecting potentially outstanding breeding parents from this Kazak material, we have obtained and collated the information on each 1993 and 1995 seedling from the GRIN system. Of the 500 1993 + 1995 seedlings there are 7 which are potential “elites” based on multiple resistances. These seven contain the Russian-type scab resistance (of value for creating multiple gene scab resistance in combination with *Vf* for incorporating a new scab resistance gene) plus resistance to cedar-apple rust plus resistance to fireblight (< 10% infection after 2 seasons inoculations). (There are many seedlings which offer 1 or 2 characteristics.) Four of these seven elites are present in the Dawes collection. All are present in a back-up set of the 1993 and 1995 collection propagated on M111 rootstock and planted at a Midwest Apple Improvement Association (MAIA) cooperator’s orchard in Ohio. In addition, 5 copies of these seven have been grafted onto M9 rootstock growing in containers for potential use in MAIA breeding efforts. We do not know the fruit characteristics of these seven selections but first fruiting of some of the 1993 collection shows small crab-apple type fruit with early August ripening. It’s anticipated that the 1995 and 1996 seedlings will have higher fruit quality.

In spring 2000, the 1993 and 1995 seedlings at Dawes Arboretum were rated for time of budbreak (leafing) in comparison with branches of ‘Delicious’ and ‘Rome Beauty’ cut from a commercial orchard in close proximity. There were 4 seedlings from the 1993 collection and 9 seedlings from the 1995 collection which leafed out as late or later than ‘Rome Beauty’. One of the late leafers also has *r* gene for scab resistance and cedar apple rust resistance! This is an example of the kinds of combinations we hope to find. The 1996 collection seedlings are still quite small (1–2 ft) and were quickly evaluated and 11 flagged for lateness of leafing but these will need more careful evaluation before conclusions can be drawn.

There were 30 seedlings from the 1993 collection and 71 seedlings from the 1995 collection that leafed-out in the time period between ‘Delicious’ and ‘Rome Beauty’. While it would be greatly desirable to have later leafing, if the disease and horticultural traits of these seedlings are excellent, they may have value as parents. All of the trees of each collection will be evaluated for time of budbreak for two additional years.

Hokanson, S.C., J.R. McFerson, P.L. Forsline, W.F. Lamboy, J.J. Luby, A.D. Djangaliev, and H.S. Aldwinckle. 1997. Collecting and managing wild *Malus* germplasm in its center of diversity. *HortScience* 32(2):173–176.

Luby, J., P. Forsline, H. Aldwinckle, V. Bus, and M. Geibel. 2001. Silk road apples—collection, evaluation, and utilization of *Malus sieversii* from central Asia. *Amer. Soc. Hort. Sci.* (in review/press).

Observations and Comments

Chris Doll

Members of MAIA seem to have a dream somewhat like I had 20–50 years ago when I dreamed about finding a surefire cure for fire blight and may fame and fortune would be made. Time has proven otherwise, and now I'm slightly involved in developing the "perfect apple" so that all members can enjoy their endeavors more.

Mitch and David asked for a few observations and comments from this old apple knocker. I grew up in southern Illinois picking the Big 3 plus a few like Fameuse, Black Twig, and Grimes Golden. Then I ran an experimental farm for Iowa State University that had 100 plus varieties on trial, including the last of the Iowa State breeding program which was aimed at developing varieties for the upper Midwest. Some varieties like Joan, Secor, and Sharon didn't go far, and neither did the Jonadel and Chieftain which I selected.

My Extension career in Illinois limited access to variety studies to grower orchards. But in retirement, Stark Brothers Nurseries have given me to opportunity to help evaluate their test orchard and life was worth living again. However, it is a challenge to select a variety that might make it in the market place (either commercial or home) for future growers. And while evaluating the 100 plus varieties there, the mental concern remains that whether I would have selected Jonathan, Red Delicious, McIntosh, or Golden Delicious for today's marketplace.

Forty years ago, my department head at ISU put down apple breeders (he was a sweet corn breeder) by saying that no breeding program had come up with a commercial apple better than the chance seedling selection over time. Of course, Cortland was on the market, but my college professor at Illinois said that Cortland was sired by McIntosh and dammed by Ben Davis. But now the breeders are making advances and the future is bright.

I also had some familiarity with the apple scab program. Dr. Fred

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pattern of freezing was the same across varieties, with first damage exhibited at the base of the style.

Diane examined *M. severisii*: blossoms of 12 accessions from Geneva NY. Interestingly, *M. severisii* generally (but not in all cases) tends to bloom early compared to *M. domestica*, but *M. severisii* survived as well as controls that were at a lesser stage of development.

Also evaluated was *M. coronaria*, our native apple. Results indicated *M. coronaria* survived freezing better than Rome.

With a laboratory regimen such as Diane has developed, evaluating selections for freeze hardiness will not have to wait for a test spring and the Kazakhstan material can be evaluated as possible breeding parents.

Phil Forsline then took the stage with two presentations: *Apple Collecting Adventures in Kazakhstan, Russia, China, and Turkey*, where he presented a fascinating overview of his several expeditions, detailing locations and conditions encountered. In *Worldwide Evaluation and Utilization of Wild Apple from Kazakhstan with joint breeding efforts in Geneva, NY and Newark, OH (MAIA)*, Phil discussed how these new to us genetics are being integrated into breeding programs. Of note is the cryogenically (liquid nitrogen) preserved germplasm, which is actually the bulk of the collected material.

Hough was my advisor in college; Dr. Dayton was a coworker at Illinois when I came back; Dr. Shay came to the farm in Iowa while I was there; and I guess I have met most of the leaders since their time. My hope and prayer is that greater results happen more quickly from this group.

My experience with breeding apples is nonexistent, and I haven't found many bud sports. I did try crossing horseradish and from about 10,000 seedlings was able to select 8 that have now been reduced to 3 potential clones for the industry. May this program improve on this.

The evaluation process will be long and difficult as you (we) strive to find "Utopia" with the size, texture, flavor, skin quality, and color, disease and insect resistance, late blooming, self-fertility, precociousness, compatible, non-dropping, heat resistant, etc., variety. Some personal preferences will show, especially in the fruit quality and flavor components, but diversity will be needed anyway for the seasonal harvest and market concerns.

And so in conclusion, I have tasted many apple varieties and consumed my fair share of the crop. My current preferences makes a longer list that MAIA may want to release, as I like Golden Delicious, Honeycrisp, Fuji, Cameo, Senshu, Gala, and Splendor. But in their prime, Jonathan, Delicious, Mutsu, Jonagold, ad infinitum, are also very good.

P.S. GoldRush is a unique apple and I have been suggesting its use in late season ciders. And for the record, the 2001 cider contest winners in Illinois and Indiana contained Goldrush (15% and 25% respectively).

After a break for lunch and apple tasting, the group heard updates from Jules Janick of Purdue University on the PRI apple breeding program and also from Peter Hirst on the New Zealand apple breeding efforts.

A short business meeting was held where it was agreed to move the office and contact for MAIA to Anna Whipkey
Purdue University
1165 Horticulture Building
West Lafayette, IN 47907-1165
(765) 494-6968, FAX: (765) 494-0391, E-mail: awhipkey@purdue.edu
www.hort.purdue.edu/newcrop/maia/

Future crosses were discussed and a meeting at Purdue in Nov 2002 was suggested.

A tour of the arboretum finished the day. Comfortable coaches pulled by tractor carried participants through a portion of the grounds, including a stop at the Kazakhstan planting. As we rolled through a wooded area I couldn't help noticing, the name 'Mitch' carved in a beech tree, and couldn't help speculating on how it got there. It was a great time, hope to see everyone this November in West Lafayette—details to be announced.

Respectfully submitted (except the part about Mitch), David Doud