The Small Fruit Breeding Program in New York State[1]

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The small fruit breeding programs scattered throughout the United States reflect the needs of the industry. Some of the major breeding objectives include: regional adaptation as related to high and low temperature stress, special moisture requirements, length of growing season, specific resistance to indigenous insects and diseases and breeding for such fruit characteristics as size, firmness, color and processing ability.

The small fruit breeding program at the New York State Agricultural Experiment Station began in the early 1900's. To date, 33 raspberry, 34 strawberry, 1 gooseberry and 3 blackberry varieties have been named and released. Some of the well known varieties released before 1940 include: Bristol and Dundee black raspberries; Marcy, Newburgh, Indian Summer and Taylor red raspberries and the Catskill strawberry. Between 1940 and 1965, 17 varieties were named; 13 of these are still found in nursery catalog listings. Since 1965, the following varieties have been named: Hilton red raspberry; Heritage fall bearing red raspberry; Brandywine purple raspberry; Huron and Jewel black raspberries; and Gala, Garnet and Holiday strawberries.

The major research effort in the breeding program has been toward the development of superior varieties of strawberries, raspberries (red, black and purple) and blackberries. Only a small portion of time has been spent on the evaluation of blueberries, gooseberries, currants, minor fruit plants and nut crops. The "back-to-nature" trend, green revolution, high cost of fruit and lack of availability on the fresh market have interested many gardeners and growers in small fruit crops. These crops offer the highest potential income per acre of any of our fruit crops.

One of the major components of a small fruit program which is frequently lacking is support for cultural and innovative studies on new varieties. For example, Heritage, because of its unique bearing habit, has not been subjected to extensive cultural trials. Questions regarding cane density, optimum fertilizer requirements, row width, water requirement and photoperiod response have not been solved.

Strawberry Breeding

Most of the germ plasm used in the strawberry breeding program has involved octoploid lines. No time has been devoted to synthesizing new octoploid lines or levels of ploidy. Crosses to various species such as *Fragaria virginiana, F. glauca* and *F. ovalis* were made in order to incorporate certain characteristics. Varieties have been secured from around the world and evaluated for their breeding potential. For example, Red Gauntlet from England, some of the Sengana varieties from Germany and such Dutch varieties as Gorella, Ostara, Rabunda and Revada have been used. From the U.S. programs, many of the USDA varieties and selections have been used because they not only possess such characteristics as root disease resistance, good fruit characteristics but are more adapted than varieties from other regions. A few California and New Jersey varieties and selections have been used with specific characteristics. For example Shasta, Lassen and Torrey from California

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and Raritan and Sparkle from New Jersey.

Breeding systems for the most part involve pedigree or modified pedigree systems. Limited use has been made of inbreeding because of the great reduction in plant vigor and performance. Backcrossing, recurrent backcross and testcross systems have been used for specific reasons. Since strawberries are quite compatible, there are no major barriers in crossing.

The major basic breeding objectives for New York are *productivity vigor, large fruit size, attractiveness* and *good quality.* There are many components of productivity, e.g., a good plant stand, a number of trusses per crown or number and size of berries per truss. Productivity is one of the most important characteristics a variety can exhibit. A plant which produces only a few fruits which are large, attractive, firm and of good quality has little commercial value and likewise a plant which is extremely productive with small, soft, poor quality fruit has no value. Catskill has remained in the variety picture since 1934 because of its productivity. The fruit characteristics are poor based on today's standards. Sunrise on the other hand has many good fruit characteristics but, in northern regions, it has not been as productive as further south.

Earlidawn is still a leading variety in the Northeast. Productivity in this variety can only be achieved by early planting and cultural practices aimed at establishing a good matted row. If planted late, the final row will be sparce and productivity greatly reduced. Vigor can be expressed in two ways: (1) number of runners produced or (2) size and branching of the crown.

Large fruit size has been an American fantasy. For the fresh fruit market or U-pick operation, large fruit size is a definite advantage. For mechanical harvesting large numbers of uniform size fruits are desirable. There are many sources for large fruit size, namely, Jerseybelle, Vesper, Guardian and Holiday. Fruit shape may make certain fruits appear larger than others of the same weight. Guardian, for example, is a long wedge-shaped fruit compared to Holiday which is oblate.

A glossy attractive fruit has great eye appeal on the retail market. A processing or freezing variety needs good internal color. In the New York program, Raritan has been one major source for attractive fruit color. Raritan is one of the parents of Holiday. Holiday in turn has been used extensively because of its attractiveness and extreme firmness. Garnet and Gala released in 1966 and 1965 respectively have a slightly pubescent epidermis inparting a slightly dull appearance. The amount of pubescence may vary somewhat from season to season.

Quality is a very subjective factor. Suwannee, Fletcher and Fairfax have long been recognized as varieties with exceptional quality. The strawberry market has not demonstrated that a premium price can be obtained for exceptional quality. Varieties which are tart when eaten in the field are much more acceptable when sugar is added at the table. An aromatic characteristic can provide a component of flavor. Holiday can be identified by its fruity aroma. Under high temperatures, some growers define the aroma as an "off-flavor."

Specific breeding objectives or characteristics include: *fruit firmness, season of ripening, concentrated ripening, ease of picking, fruit placement, processing ability, disease and insect resistance.*

During the past 10 years, fruit firmness has been an important objective in New York's program as well as other programs in the U.S. As a result, many of the new varieties are far superior to old varieties in firmness. In New York, during strawberry sea-

son, a week of high temperatures may be experienced. Many of the old varieties are extremely susceptible to injury during picking. Bruised or damaged fruit has a very short shelf-life and is unattractive. In conjunction with firm flesh, a "tough skin" has been sought. From the breeding work, it was determined that these two characteristics are not correlated. It is difficult to assess the true resistance of the epidermis to abrasion as the seeds can offer protection. Fruit with sunken seeds are very susceptible to abrasion while those with large, raised, numerous seeds have a built-in protection. Holiday has a good "tough" skin despite its lack of seed protection possessed by such varieties as Guardian. Guardian frequently exhibits an extremely seedy appearance which can be objectionable. In some varieties the seeds are very close together while in others they are more widely spaced.

The season of ripening has always been of interest to the grower. More emphasis has been placed on early ripening varieties than late ripening. The major reason for growing early varieties is to capitalize on the higher price for the first fruit of the season. Since early varieties are subject to frost injury in northern areas, the cost of frequent irrigation may not off-set the early price difference. Varieties vary greatly in fruit development in response to cool temperatures. Pollination may also be affected under cool conditions. Early and late ripening characteristics are available for breeding. The major task of the plant breeder is to incorporate the season of ripening into superior genotypes.

Concentrated ripening has been of interest to the New York program even though no active mechanical harvesting project is being carried out. Large-fruited, erect truss types, concentration of ripening within the truss as well as trusses with reduced number of berries which ripen at one time has been studied. Holiday has exhibited good concentrated ripening in most seasons with over 85% of the total potential crop ripe at one time. In seasons with higher temperatures, the large primaries ripen in advance of the secondaries. Other clones have exhibited good production requiring three pickings at the most. From a U-pick standpoint, concentrated ripening is not desirable. Maintenance of size and a long season of ripening is important. If inclement weather occurs during harvest, a smaller percentage of the total crop may be lost.

Ease of picking and *fruit placement* are important for both mechanical harvesting and hand picking. Ease of picking from a processing standpoint may involve the removal of the calyx or commonly referred to as capping. Clones which cap easily generally have a slight neck or raised calyx and reduced attachment. Clones have been selected with nearly 100% capping ability. The type of scar formed is very susceptible to fungal infections and deteriorates rapidly. A raised calyx which can be easily removed by a machine at the processing plant is more practical. For Upick or fresh market, a brittle pedicel is desirable. This makes hand picking very easy and reduces the chance of the entire truss being removed by pulling on a single berry. A shorter portion of pedicel remaining attached to the fruit is sought. To date, none of the New York clones have exhibited a high percentage of pedicel breakage at the calyx junction. Most pedicels break leaving 20-50 percent of the pedicel attached to the fruit. Without some care being exercised, these pedicels can puncture adjacent fruit when placed in a container. Other types of fruit attachment are being investigated. A number of new varieties including Holiday exhibit very brittle pedicels. Fruit placement has many

advantages. Clones with short trusses are difficult to harvest mechanically or by hand as many of the fruits are left behind. Long trusses offer better fruit exposure and access. Exposed fruit also dries off more quickly and is less prone to rot. Exposed fruits have a disadvantage when there is a pounding rain or sleet storm. Some clones, with long trusses, can exhibit a tangled effect which is obviously undesirable, while others are well placed.

Processing ability is extremely important in the Northwest. Most of the eastern production is based on consumer processing into a small frozen pack, freezer jam, or preserves. Such varieties should have good color, texture and flavor. A frozen pack, upon thawing, should retain some of the original berry shape without becoming rubbery or flattening out. Frozen samples are made each year from promising selections at the New York State Agricultural Experiment Station.

More emphasis has been placed on breeding for disease rather than insect resistance. This is due in part to the fact that more is known about diseases and sources of resistance while resistance to many major insect pests is not fully understood nor have resistances been identified. Verticillium wilt and red stele are important root diseases in New York. With more use being made of fumigation, such resistance may not be as important as in the past. However, many growers are fumigating with Vorlex, which does not give the control that tarp fumigtion does.

The USDA has released many varieties which have good field resistance to rot diseases. These have been used extensively in the New York program as the major sources of resistance. Fruit rot problems are receiving considerable attention. Clones are continually being screened for degrees of susceptibility to various rot organisms. Differences are being observed but no good source of resistance has been identified. Many environmental factors influence the type and amount of fruit rot in any given year. In the Northeastern area, leaf diseases are not a serious problem. Some leaf-scorch and leafspot occurs but to date have not proved to be of economic importance. Mildew is a common pathogen; however, during selection and evaluation clones susceptible to leaf diseases are discarded.

Insect problems have been with the industry for many years. The most serious insects pests in New York are the tarnished plant bug, clipper and weevil. To date, no sources of resistance have been identified. An effort to screen varieties and selections has been complicated by time of flowering and insect populations. Only slight differences in genotypes have been observed in the field.

Rubus Breeding

The total raspberry and blackberry acres in the U.S. has decreased markedly over the past seventy years. In New York, the acreage has decreased from over 12,000 acres in 1900, to less than 2000 in 1970. There are four major reasons for this decline: (1) the poor quality of nursery stock, which today has drastically changed as a result of the virus-indexing program, (2) the effect of the child labor laws which restrict the age of youths working in the field, (3) the lack of good varieties, and (4) the movement away from crops requiring extensive hand labor to fully mechanized production. Raspberries have been grown in New York; therefore, with the development of superior varieties and movement toward mechanized cultural and harvesting practices, it may be possible to revive an industry in New York.

There are many Rubus species forming a vast pool of germplasm. Not all desirable characteristics have been identified or observed, e.g., extreme

winter hardiness and good fruit rot resistance. It may be possible to circumvent winter hardiness problems by exploiting the fall-bearing characteristic.

Many of the basic breeding objectives are similar to those of the strawberry such as *good plant vigor, productivity, large fruit size, good fruit color* and *quality*. Good plant vigor is important because most of our eastern plantings are grown without trellis (free standing). In many cases, total cane growth is not excessive requiring elaborate trellising.

Productivity is a function of fruit size and number of fruits produced per lateral. Large fruit size is important because the majority of the fruit production is sold on a U-pick basis or at the roadside market. Good fruit color and quality are important from a freezing and processing standpoint.

Some of the specific characteristics or objectives in the New York breeding program include: breeding for *small seed size*. Heritage, for example, has small easily masticated seeds while many of the thornless blackberries have very large stoney seeds, which are very objectionable to many people. In making preserves, *Rubus* seeds can easily be removed. Others prefer bright colored seeds in the jam.

There are many reasons why thornlessness has been of interest. To date no good source of thornlessness has been found which is winter hardy in blackberries. The varieties developed by the United States Department of Agriculture are not hardy for most parts of New York, therefore the erect thorny types such as Darrow are the only varieties recommended. An effort in the breeding program is being made to breed for reduced thorniness. Several sources of thornlessness exist in raspberries and are being utilized. However, since there are many more desirable horticultural characteristics needed than thornlessness, this is a minor objective.

Season of ripening, as in many other fruits, is highly desirable. Red raspberry varieties exhibit a wider range in ripening than other *Rubus* fruits. Black raspberry varieties do not exhibit a wide range in season of ripening, therefore the introduction of the characteristics from red raspberry are being used to spread the season. Black raspberries exhibit concentrated ripening, allowing only a short period of time for marketing and U-pick operations. In many regions, black raspberries are harvested by machine, therefore, concentrated ripening is advantageous.

Increased *fruit firmness* is extremely important with a fruit as perishable as raspberries and blackberries. Use has been made of the fruit firmness exhibited by Newburgh and Heritage. Factors which contribute to firmness are small compact druplets, druplet pubescence and fruit shape. Breeding at East Malling has utilized the black raspberry as a source of firmness.

Another minor objective has been adaptation to *mechanical harvesting*. No machines have been developed or used in New York, however, notes and crosses have been made with this in mind. Easy fruit separation from the torus, good fruit position and increased lateral strength are valuable characteristics for mechanical harvesting.

Three major *Rubus* diseases are of concern to the grower: Verticillium wilt (primarily in black raspberries), spur blight in red raspberries and fruit rots. The variety Scepter has exhibited the best field tolerance to root diseases in New York and is therefore being used in breeding. Heritage cannot tolerate high soil moisture levels. Scepter (a late fruiting fall bearer) has been used as a source of tolerance for the fall bearing program. No program has been established to date to screen material for resistance. Spur blight is one of the most serious cane

diseases in eastern Europe. New York plantings are frequently heavily infected but no data have been accumulated showing the effect on cropping. Fruit rots are of concern to any small fruit grower. The perishability of raspberries is due extensively to the susceptibility of the fruit to various rot organisms. Varieties and selections in the breeding program are being screened for rot incidence.

Three major insect problems in New York are crown borers, tarnished plant bug, and the raspberry aphid. The tarnished plant bug is extremely serious on late summer fruiting varieties as well as fall bearers. No sources of resistance have been identified. The raspberry aphid is the major mosaic virus vector. Sorces of immunity to this insect have been identified and are being used in the breeding program. Two parents used extensively are Canby and New York 632. Both have derived their immunity from Lloyd George. These genotypes make it possible to continue the breeding program without going back into species material to recover immunity. A study is underway to see if greenhouse screening for aphid immunity can be correlated with field results.

Field evaluations have been made on 36 varieties of red raspberries as to susceptibility to attack by adult and larval forms of the eastern raspberry fruitworm, *Byturus rubi* Barber. Canby, Pynes Royal, Viking and New York 632 appear to be nearly resistant to this pest, while Latham, Fallred, Scepter, September and Durham were the most susceptible. The use of Canby and New York 632 in the breeding program offer an additional advantage.

Fallbearing raspberries offer an alternative system of fruiting which could potentially eliminate all of the hand labor cultural requirements. Breeding for fall bearing raspberries was initiated in New York in 1934. From this program, Indian Summer, September and Heritage were released. Heritage has become the most popular fall bearing red raspberry. Its original release was for the home gardener however, many commercial plantings of this variety have been made throughout the U.S.

The major objectives of the fall bearing program involve (1) *selection and breeding for early ripening types,* (2) *increased branching,* (3) *increased fruit size,* (4) *erect cane habit,* and (5) *ease of harvest.* Early ripening is important because of inclement weather possible in the fall and early frosts. Genes for earliness are available as seedlings have been observed to ripen fruit in early July. Early ripening genotypes are generally short and thin-caned as only a limited amount of time has been devoted to cane growth before flowering and fruiting was initiated. Most of the early fruiting types produce small fruit which is soft and coarse. Fruit or production potential is a function of the degree or amount of branching and number of fruits per lateral. Some clones produce far more flowers than they can support or develop. Branching has been increased from a limited fruiting surface at the tip of the primocane to a full complement of laterals extending two-thirds the length of the cane. It has been difficult to increase the fruit size in fall bearers because of the larger number of potential fruits produced. Transfer of large fruit size in summer fruiting clones has not been achieved as successive backcrossing to recover productivity results in loss of fruit size. It is suggested that small fruit size is linked to one of the aspects of the fall bearing habit.

Easy fruit separation is found in many *Rubus strigosus* clones. The small round fruits have less attachment than the long conic fruits with many druplets. A hand vibrator has

been used to evaluate potential mechanical harvesting.

Erect cane habit is another objective. Fruit borne on erect canes is in a good position for mechanical harvesting and flexible enough for multiple harvest. Nearly all of the *R. strigosus* clones are extremely thin caned which arch as the fruit ripens and matures. The more sturdy erect cane habit was obtained from *Rubus ideaus*. To date, Heritage has exhibited the most erect cane habit. In areas where growth is over five feet or growth is more rapid, Heritage canes are not as sturdy and arch under cropping. In Michigan, New York, New England and parts of Ohio and Pennsylvania, growth generally averages 4-5 feet with little arching under heavy cropping.

There are additional basic and specific characteristics which have not received attention. The breeding program has tried to emphasize those of importance which will greatly improve present cultivars.

Blackberry breeding has continued with emphasis on four major objectives: (1) *consistent production and vigor,* (2) *increased winter hardiness,* (3) *thornlessness* and (4) *increased fruit size* and *fruit number per lateral.*

Most of the New York breeding program has been carried out within the species *R. allegheniensis.* The erect cane habit found in *R. allegheniensis* along with a number of acceptable horticultural characteristics made it the logical species to exploit. However, the narrow gene base has not enabled rapid advances to be made. Consistent productivity and vigor are dependent on cane hardiness. Clones have been screened over the years for winter hardiness with few exhibiting more hardiness than Darrow, Bailey and Hedrick. Accessions from northern regions have not proved to be sources for increased hardiness as most of them have a complete snow cover during the winter. Future plans are to screen as many sources of blackberries as possible in order to find material with increased hardiness.

The thornless characteristic would be a valuable improvement in the erect thorny varieties. None of the sources screened which have the Merton thornless characteristic found in such varieties as Smoothstem, Thornfree, Black Satin and Dirksen, have been winter hardy in New York. A collection of *Rubus canadensis* clones was made as a possible source of thornlessness. All of the clones screened are triploids and exhibit various degrees of near-thornlessness. Many of the clones do not have thorns directly on the canes but exhibit varying degrees of thorns on the back of the leaf midrib. These clones exhibit hardiness similar to Darrow.

Little advance has been made within the species *R. allegheniensis* on fruit size. The Arkansas program has made good progress in this direction by utilizing other southern adapted species which are large fruited. Because of the hardiness problem it has not been possible, to date, to transfer the larger fruit size of the thornless blackberries into the erect types. More attention has been paid to increasing the number of fruits per lateral. Many of the trailing or semi-erect blackberries are extremely productive. All of these types require extensive hand labor in training and pruning. A self-supporting erect cane habit offers a reduced cost input and ease of mechanical harvesting.

A minor fruit and nut project has been maintained because of the public interest in these fruit plants. Superior varieties and clones have been added to a test planting for evaluation. Of the nut crops, filbert breeding has continued with a small number of crosses and seedlings. Some 47 selections have been made for future evaluation. The interest of Cornell re-

searchers has contributed greatly to the Northern Nut Growers Association. Several of the minor fruit crops offer great potential as new food crops, which if fully exploited, would contribute to the agricultural economy.

The small fruit breeding program in New York is the only remaining program of Northeastern U.S. With continued support, and cooperation with entomologists and pathologists, new superior varieties will be developed and released for commercial production.

'Stark Early Loring' — A Mid-Season Freestone Peach

JERRY FRECON[1]

'Stark Early Loring' is a very good quality, large, firm-fleshed yellow freestone ripening 10 to 14 days before 'Loring.' In several test winters, during varying cold periods, 'Early Loring' has cropped more consistently than its parent, 'Loring.'

Origin

'Stark Early Loring' is a limb mutation of 'Loring' discovered by Mr. Frederick Beyer of McCracken County, Kentucky, in 1965. The variety was first propagated by Mr. W. D. Armstrong of the University of Kentucky in 1966, and tested by Charles Beyer of McCracken County in their fruit growing operations. Patent No. 4170 was granted to Frederick Beyer in 1977 and has been assigned as a variety for exclusive sales and distribution to Stark Bro's Nurseries & Orchards Company, Louisiana, Missouri.

Fruit Characteristics

'Stark Early Loring' is a medium-to large round, yellow-fleshed freestone peach with a slight amount of red in the flesh around the pit. It is very firm, similar to 'Loring' in both texture and quality. The overall appearance is identical to its parent, 'Loring,' with the exception of being slightly smaller in size on a consistent basis and having more red color in the skin. The fruit ripens 10-14 days on the average, ahead of 'Loring.' It achieves an 80% over-all red color well in advance of the date at which it would soften.

Tree Characteristics

'Stark Early Loring' is healthy, vigorous, highly productive. The variety has been evaluated in Stark Bro's, Louisiana, Missouri, test orchard for seven years. It is somewhat more vigorous than 'Loring' and has been on the average, more productive and consistent cropping on test sites and at the point of origin. Flowers are large and showy.

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