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White-Fleshed Peach and Apricot Breeding

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ORIGIN OF PEACH CULTURE IN THE US

Peaches are not native to the western hemisphere. They are believed to have originated in China where they were cultivated for at least 4,000 years. It is in this region where the greatest genetic diversity still exists. The spread of peaches to the west followed along ancient trade routes from China to Persia (hence the name for peach, *Prunus persica*) and from Persia into the Mediterranean region including Greece, Italy and Spain. Peaches were not introduced into North America until the late 1500s by Spanish explorers but they spread rapidly along the eastern region. By the late 1600s, both white- and yellow-fleshed peach cultivars were being produced commercially in the mid-Atlantic.

Since peach cultivars were derived from a relatively small subsample of the genetic diversity available in China, the genetic base of cultivars in the United States (US) was limited. This situation was greatly exacerbated by the introduction of Elberta in 1889, a chance open pollinated seedling from Chinese Cling. When Elberta was introduced, it was an extraordinary cultivar for the commercial shipping market because of its large fruit size and superior firmness. Elberta rapidly became the most popular variety in the US, and varieties derived from Elberta proved to be even better, further shifting the marketplace toward yellow-fleshed types. Consequently, breeding programs in the eastern US have focused primarily on developing commercial yellow-fleshed cultivars which are largely descendents of Chinese Cling (Scorza et al., 1985). The lack of breeding effort with white-fleshed varieties resulted in cultivars which lacked the size, color, and firmness of their yellow-fleshed counterparts.

Due to recent breeding efforts to develop white peaches for the commercial market, there is renewed grower interest in planting white peaches in the US. The large number of attractive white-fleshed varieties developed by Zeiger Genetics, CA, is particularly noteworthy. Today there are many white peach varieties which are highly colored and sufficiently firm for shipping. It has been my experience that the majority of white peaches being released today are of a sub-acid type, possessing a dominant allele that reduces the malic acid content of the mature fruit. In general, these varieties are especially well suited to regions with mild winters and limited bacterial spot but have not been widely adapted to eastern growing conditions. However, there are exceptions such as White Lady, which is being successfully grown commercially in New Jersey (NJ).

NJAES TREE FRUIT BREEDING PROGRAM

The state of New Jersey is the most densely populated state in the US. Consequently, peach production in NJ faces numerous challenges including high land costs, suburban sprawl, limited seasonal labor, and various environmental issues such as ground water contamination. The climate of the northeast also poses other risks. The moderating effects of the Atlantic Ocean often result in chilling requirements being satisfied by the end of December. In January and February, temperatures can rise as high as +20°C (68˚F), causing the fruit trees to lose their hardiness. Then, with the passage of an arctic cold front, the temperatures may drop to -20°C (-4˚F) in just a couple of days. Our summers are often quite humid and rainy, increasing disease pressure. Nevertheless, NJ is a major peach producing state, ranked 4th or 5th in the US. New Jersey peach growers are typically paid 2-3 times as much for their peaches as are peach growers in California because NJ is centrally located near several large metropolitan areas including Washington, DC, Philadelphia, New York and Boston.

The New Jersey Agricultural Experiment Station (NJAES) established a tree fruit program in the early 1900s to help satisfy the specialized needs of growers in this region. Today we have an active breeding program to develop new cultivars of peaches, nectarines, apricots, and apples. The main objective of the peach breeding program is to develop varieties of peaches and nectarines that are highly productive in our environment and tolerant of diseases such as cytospora canker, fusicoccum canker, and bacterial leaf spot. The fruit should be highly colored with an attractive ground color, large (preferably 6.3 cm [2 1/2 inches] or greater in diameter), and suitable for shipping. Since NJ is becoming increasingly suburbanized, there is interest in growing unique, high quality stone fruit for the roadside and local markets. Another objective of the NJAES breeding program is the incorporation of novel characters into peach that may be useful in expanding the market for peaches, especially for the roadside markets. Such characters include white-fleshed types (Goffreda, 1998), exceptional quality peen tao (flat or doughnut) peaches, and fruit with the nonmelting or stony hard fruit texture.

Listed below are a few of the most promising white peach and nectarine varieties and selections that exemplify the diversity of types being developed by the NJAES breeding program.

COMMERCIALLY AVAILABLE NJAES WHITE PEACH VARIETIES

Raritan Rose (JH Hale x Cumberland)

A white peach variety released by the NJAES in 1936. It is a fairly attractive peach ripening in Redhaven season. The fruit are 5.7 to 7 cm (2 1/4 to 2 3/4 inches) with 50% mottled red over a green-cream ground color. The tree and fruit have moderate bacterial spot resistance and the fruit have average quality. Raritan Rose is still offered in the nursery catalogs and is being grown for roadside market.

Summer Pearl® (NJ252)

Peach released by the NJAES which ripens about 3 weeks after Redhaven. Fruit have 60% red over color on a cream-green ground color. Its pubescence is quite short and the variety can be attractive in some years. The fruit are approximately 6.3 cm (2 1/2 inches) and usually firm enough for shipping short distances. Fruit quality is usually very good. However, Summer Pearl has not been very productive and is susceptible to bacterial spot.

Lady Nancy®

A white limb mutation of Jerseyqueen that was selected by Medio DeMarco, a New Jersey peach grower. It was introduced in 1989. Lady Nancy ripens with Jerseyqueen, about 4 weeks after Redhaven. Fruit are very large with about 60% pink-red over color on a cream-green ground color. Flesh color is white except at the suture which is yellow. This indicates that the mutation is not present at all cell layers and can make the flesh color of the variety somewhat less stable. Resistance to bacterial leaf spot and winter injury is similar to that of Jerseyqueen.

PROMISING NJAES WHITE PEACH SELECTIONS

K39-1 (D87-88 x J19-19)

An attractive semi-freestone peach which ripens about 2 to 3 weeks before Redhaven. Fruit are 90%+ red over cream ground with short pubescence. The fruit are 5.7 to 6.3 cm (2 1/4 to 2 1/2 inches) and have good firmness and eating quality. Trees are productive and have moderate resistance to bacterial spot.

D80-8 (NJ318 x H3-76)

A firm, nonmelting, clingstone peach ripening about 1 to 2 weeks before Redhaven. Fruit are very attractive with 75-90% red over color on a cream ground color. The fruit are 6.3 cm (2 1/2 inches) and have short pubescence. The flesh has a nonmelting texture and it has a very good sweet, sub-acid flavor. This variety is very firm and suitable for shipping. This is a recent selection which has exhibited moderate bacterial spot resistance. It is too early to assess productivity.

NJ312 (NJ293 x Jing Yu)

A semi-freestone peach ripening with Redhaven. Fruit can be attractive with 50-80% red over cream green. Fruit are 6.3 to 7.0 cm (2 1/2 to 2 3/4 inches). This peach also has a mild, sub-acid flavor. The fruit may soften rapidly limiting this selection to the roadside market. However, it has some resistance to bacterial spot and has been fairly productive.

D89-9 (NJ318 x Flavorcrest)

A freestone peach ripening just after Redhaven. Fruit color very early attaining 90% pink red blush on a cream ground color. Fruit are 5.7 to 6.3 cm (2 1/4 to 2 1/2 inches) and are bright and very attractive. The fruit are also very firm and retain their firmness on the tree for over 1 week. This peach has a mild, sub-acid flavor. This is one of several exciting selections recently made from this progeny. At this time we do not have an accurate assessment of their level of disease resistance and hardiness.

NJ318 (NJ256 x Biscoe)

A freestone peach ripening about 3 weeks after Redhaven. Fruit are attractive with 60% red over a cream-green ground color. Fruit are 6.3 to 7.0 cm (2 1/2 to 2 3/4 inches) and size well even when over-cropped. Fruit have a mild, sub-acid flavor. Trees have good bacterial spot resistance, but the fruit may soften fast. Trees have also exhibited above average susceptibility to fusicoccum canker.

DOUGHNUT-SHAPED (PEEN TAO) PEACHES

Saturn® (NJF2=NJ602903 x Pallas)

A white-fleshed, semi-freestone, peen-tao type or doughnut-shaped peach which was released by the NJAES. Fruit ripen a few days after Redhaven and are attractive with 70% red over a cream-green ground color. Fruit are 5.7 to 6.3 cm (2 1/4 to 2 1/2 inches) and have a sweet, low acid, mild flavor and sometimes develop rose-like aromatics. The fruit soften fast necessitating picking it early. Flower buds are very hardy and the tree tends to crop heavily. The fruit hang tenaciously to the tree making it a difficult variety to thin and pick. The leaves of Saturn have high bacterial spot resistance. Fruit of Saturn® can sometimes be found in major grocery stores in NJ and I suspect these were produced on the west coast.

D33-1 (NJ291 x NJF8)

A white-fleshed, clingstone, doughnut-shaped peach. Fruit ripen about 1 week after Redhaven and are 40-50% light pink-red over a cream-green ground color. Fruit are large, often 7.0 cm (2 3/4 inches) or more, but are irregular in shape and not as attractive as Saturn®. The flesh texture is firm nonmelting. Fruit are sub-acid and very sweet with a hint of floral aromatics when fully ripe. D33-1 is moderately susceptible to bacterial leaf spot and not as productive as Saturn®.

PROMISING NJAES WHITE NECTARINE SELECTIONS

K56-4 (B8-9-46 x Eastern Glo)

A semi-freestone, nectarine selection ripening 1 1/2 weeks before Redhaven. Fruit are round, very attractive, 80-95% red over cream ground, with a bright glossy finish. Fruit size is 5.7 to 6.3 cm (2 1/4 to 2 1/2 inches). Firmness is very good, suitable for shipping. We judge the flavor to be excellent with a well-balanced sugar:acid ratio. Trees are moderately resistant to bacterial spot. This is a recent selection which needs more testing.

K54-25 (B8-9-46 x Eastern Glo)

A semi-freestone nectarine selection ripening 5 to 7 days before Redhaven. Fruit are round, attractive, 90-100% red over cream ground. Fruit are 5.7 cm (2 1/4 inches). Fruit firmness and flavor are both rated as very good. Trees are productive but are moderately susceptible to bacterial spot.

THE STONY HARD GENE

The stony hard gene dramatically alters the way in which a peach ripens (Goffreda, 1992; Maness et al., 1993; Mignani and Goffreda, 1998). Fruit are much firmer than normal peaches when they are fully ripe and they maintain their firmness even at room temperature for 3 or more days. Stony hard fruit do not show the normal climacteric rise in ethylene production when ripe. However, they rapidly soften after continuous treatment with ethylene. The level of soluble solids in stony hard fruit does not appear to be adversely affected by this gene, but it may affect other flavor components. We are continuing to conduct postharvest tests on stony hard selections to determine if there is any market potential for stony hard varieties. Listed below are a few of the most promising stony hard selections from the NJAES breeding program.

L5-112 (Jefferson x 7-28) OP

A stony hard, clingstone peach ripening 1 week before Redhaven. Fruit are attractive with 70-90% red over color on a cream ground color. The combination of the stony hard and clingstone genes results in a flesh texture that is very firm, almost crunchy, when fully ripe. The fruit size

is 6.3 to 7.0 cm (2 1/2 to 2 3/4 inches). Fruit soften slowly, making this selection excellent for shipping. Trees have only slight bacterial spot resistance and are not consistently productive.

L2-42 (NJ293 x Jing Yu) OP

A stony hard, freestone nectarine ripening a few days before Redhaven. Fruit are 80% red over a cream ground color. They can be very attractive although there were finish problems in 1997. Fruit are 5.7 to 6.3 cm (2 1/4 to 2 1/2 inches) and very firm. The flavor is mild sub-acid, but can it can be bland in some years. Trees have slight bacterial spot resistance.

J19-19 (RR53-272 x 7-28) OP

An older stony hard peach selection ripening about 1 to 2 weeks after Redhaven. Fruit can be attractive with 30-90% red on a cream-green ground color. Fruit are generally 6.3 cm (2 1/ 2 inches) and have a mild, sub-acid flavor. Firmness is very good. Trees have only slight bacterial spot resistance. In recent years, this selection has been used extensively as a parent for the stony hard texture.

APRICOT BREEDING AT NJAES

The principal objective of the NJAES apricot program is to develop high quality cultivars that will be consistently productive in our region. Reducing the fluctuations in the yield of apricots will require increasing the chilling and heat requirements to induce bloom, improving the tolerance of flowers and flower buds to spring frosts, and enhancing the level of disease resistance. The ability of any breeding program to achieve its objectives is limited by the genetic variation available to it. Unfortunately, the apricot cultivars of Europe, North America, South Africa and Australia belong to the European group which is believed to be the group with the least genetic variability (Mehlenbacher et al., 1990). In contrast to the European group, the apricots of the central Asian group are rich in morphological and genetic variability, resist fluctuating mid-winter temperatures, and can be very high in soluble solids (occasionally 30% or more). The former Soviet Republic of Uzbekistan is a major apricot producing country in central Asia and at approximately the same latitude as New Jersey. Near Tashkent, the capital of Uzbekistan, is a tree fruit repository called the Central Asian Experiment Station of the Institute of Plant Industry (VIR) and a plant science research center called the Shreder Institute. Dr. David Zaurov, a postdoctoral associate at Rutgers, and I are working in collaboration with scientists from these institutes to develop cultivars adapted to a broader range of climates in the US and Europe.

The central Asian cultivar called Zard is the latest blooming apricot currently in our collection (Figure 1). It typically blooms about 7 to 10 days later than our latest European-type apricots, which is as late as our earliest peaches. Zard is reported to be more tolerant of frost and have a higher heat requirement than other apricots. Zard ripens about 2 weeks after Harcot. The fruit are small, 3.5 to 4.0 cm (1.4 to 1.6 inches), and green-yellow when soft ripe. The flesh is soft, juicy and very sweet with soluble solids between 22-24%. In recent years we have used this selection extensively in our breeding program and in the future we will be using more central Asian varieties to develop late blooming, frost-tolerant apricots. Listed below are a few of the most promising apricot varieties and selections from the NJAES breeding program.

PROMISING NJAES APRICOT VARIETIES AND SELECTIONS

Early Blush® NJA53 (RR17-62 x NJA13)

An attractive, good quality apricot ripening about 2 1/2 weeks before Harcot. The fruit are round, medium-sized, about 4.5 to 5.0 cm (1.8 to 2.0 inches). The fruit of Early Blush® have a 30-50% red blush over an orange ground color. The fruit may soften rapidly, especially at the pistil end. We generally rate the fruit quality of Early Blush® as high with soluble solids of about 17%. Hardiness and bloom date are comparable to those of Harcot in New Jersey. US Plant Patent No. 9,255 (Goffreda, 1995; Goffreda et al., 1995a).

SunGem® NJA54 (NJA2 x RR17-62)

An attractive, good quality apricot ripening about 1 1/2 to 2 weeks before Harcot. The fruit are round, small to medium, generally 4.0 to 4.5 cm (1.6 to 1.8 inches). The fruit of SunGem® have 15-40% bright red blush on an orange ground color. Flesh is dark orange and juicy. The firmness of the fruit is above average. It is full flavored and usually has a high eating quality rating. Soluble solids are in the range of 15-17% when ripe. It has not cropped well in New Jersey. US Plant Patent No. 8,674 (Goffreda, 1994; Goffreda et al., 1995b).

NJA97 (RR17-62 x NJA13)

An attractive, good quality apricot ripening about 1 1/2 to 2 weeks before Harcot. The fruit are round, medium-sized, about 4.5 to 5.0 cm (1.8 to 2.0 inches). The fruit have 30-40% red blush on an orange ground color. The flesh color is orange to dark orange. Fruit quality is consistently rated as very good, with soluble solid of 16-17%. Fruit firmness is average. Cropping of NJA97 is comparable to Harcot in New Jersey, although NJA97 tends to bloom slightly later.

Orangered® NJA32 (Lasgerdi Mashhad x NJA2)

A medium-large and attractive apricot ripening about 1 week before Harcot. Fruit are round, slightly compressed, and approximately 5.0 to 5.5 cm (2.0 to 2.2 inches). The fruit of Orangered® have a 10-50% red blush over a bright orange ground color. The flesh is dark orange, firm, and fine textured. Fruit quality is consistently rated as very good. Fruit firmness is above average, making this selection suitable for commercial production.

Jerseycot (RR18-64 x CR3-135)

Jerseycot was released by our program because it was the most consistently productive apricot selection in our collection. In the past 22 years, Jerseycot has produced at least a partial crop in all but 2 years. The fruit of Jerseycot ripens about 5 days before Harcot and is round to round-oblong, light orange with a slight green suture in some years. There is generally no blush. The fruit size is medium, approximately 3.8 to 4.8 cm (1.5 to 1.9 inches). The flesh color of Jerseycot is orange. The flavor is usually mild but can develop a melon-like quality in some years. Fruit soften quickly and drop fast, making this cultivar not suitable for commercial production (Mehlenbacher et al., 1987).

NJA113 (Jerseycot x NJA93)

A fairly large apricot ripening about 5 days before Harcot. Although earlier blooming than many of our apricots, this selection has had light to moderate crops the past couple years when we experienced several freezing events just prior to or during bloom. Fruit are round, slightly compressed, 4.5 to 5.5 cm (1.8 to 2.2 inches). The fruit are orange with 0-10% orange-red

blush. The flavor is slightly tart when firm ripe, becoming mild when soft ripe. Fruit hang well and the firmness is good, making this selection suitable for commercial production.

NJA114 (Jerseycot x NJA93)

A large apricot ripening with Harcot. This selection tends to bloom later than most of our other apricot selections, including Jerseycot. Fruit are round-oblong, slightly compressed, 5.5 to 6.0 cm (2.2 to 2.4 inches). The fruit are orange with no blush. The flavor is generally mild but it has been tart in a couple of years. Fruit have good firmness, making this selection suitable for commercial production.

NJA82 (I13-36 x NJA11)

A large apricot ripening with Harcot. This selection is one of the earliest blooming apricots in our collection, yet it often sets at least a light crop, suggesting that it may possess some tolerance to spring frosts. Fruit are oblong, slightly compressed, 4.5 to 5.5 cm (1.8 to 2.2 inches). The fruit have a 5-40% red blush over an orange ground color with a slightly green suture in some years. The fruit are tart when firm ripe, but the flesh becomes very sweet when the fruit are soft ripe with soluble solids in the range of 16-21%.

A86-83, A86-86, and A86-105 (Glabrous apricots)

Tom Foley of North American Fruit Explorers (NAFEX) provided us with open pollinated (OP) seed of an apricot cultivar called John Bonn Small from Door County, WI. He reported that this strain is cold hardy, self-fertile, and quite inbred. From this OP seed we obtained three glabrous apricots that completely lacked pubescence. We have been using these selections in our breeding program but at this time we do not know the mode of inheritance of the glabrous character.

SUMMARY

The focus of the NJAES tree fruit breeding program has been the development of productive commercial tree fruit cultivars with superior fruit quality and improved disease resistance. Because of the renewed interest in growing white-fleshed peaches and other novel stone fruit, our program has intensified its efforts to develop white peaches and nectarines for shipping, peen tao or doughnut peaches, and apricots. Several new cultivars are now available and in the next few years the number will be increasing. Tree fruit breeding is a long-term endeavor usually requiring at least 15 years between the time when the cross is first made and when the new variety can be recommended for release. Our program has been aggressively producing the next generation of seedlings which will provide improved varieties into the coming century. The objectives of the breeding program continue to evolve to better satisfy the future needs of the fruit industry and society.

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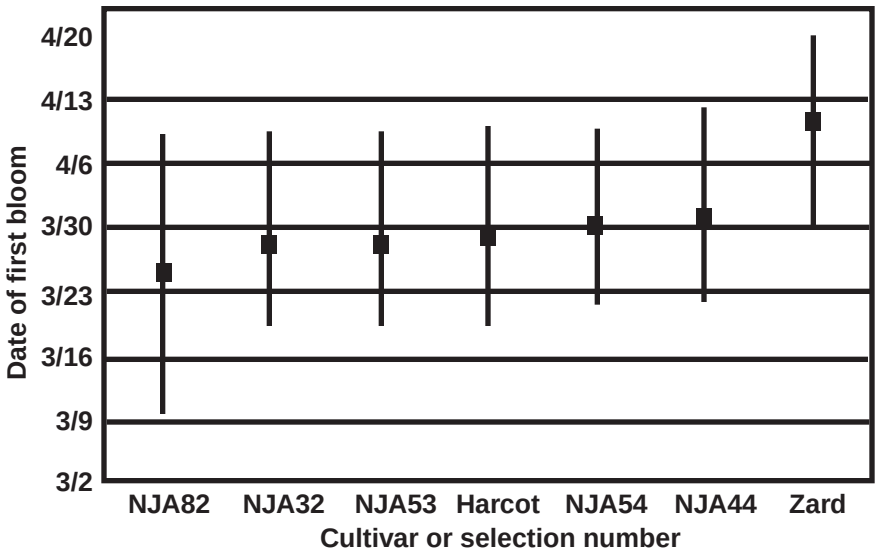

Figure 1. Range in date of first bloom over 5 years for apricots.