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Maurice Adin Blake: Father of the Modern New Jersey Peach Industry

Richard P. Marini[1]

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Abstract

Professor M.A. Blake spent his 40-year career with the New Jersey Agricultural Experiment Station studying many aspects of peaches. His early efforts centered on pruning, disease control, and general orchard management practices. Later he studied peach tree physiology, fruit tree nutrition, fruit development and ripening, and postharvest storage. He inherited a young peach breeding program from Professor Charles Henry Connors and ultimately introduced 48 peach and nectarine cultivars. To better describe and identify peach cultivars, he published methods to classify peaches based on the characteristics of the trees, leaves, flowers, fruits, and pits, and these characteristics are used today in plant patent applications. He was the first plant breeder to evaluate cold hardiness and study the inheritance of cold hardiness with controlled laboratory freezing methods. Blake published extensively on a wide range of peach topics in scientific journals, experiment station bulletins and industry newsletters. When Blake joined the Experiment Station, the New Jersey Peach industry was struggling, but largely due to Blake's efforts New Jersey became one of the top five peach-producing states.

Brief history of New Jersey peach industry. Early European settlers of the mid-Atlantic area found that peaches grew better than in their home countries and peaches were widely grown from seed. Daniel Smith probably had the first fruit tree nursery in New Jersey and offered 67 cultivars in 1806 (Blake, 1912). In the mid-1800s, despite few inputs of fertilizers, cultivation, and pest control, peaches were profitable in New Jersey due to good soils, weather conditions, and proximity to large markets. In 1890 there were 53.9 million peach trees in the United States (U.S.), with 4.4 million in New Jersey. Following the introduction of San Jose scale in the 1890s, the number of trees in New Jersey decreased 38% to 2.7 million from 1890 to 1900. The only other states in the country experiencing a decline in trees were Delaware and Maryland, whereas the number of peach trees in the U.S. increased 85% to 99.9 million. In the early 1900s, as growers learned to control San Jose scale, peach acreage began to increase. Administrators at the New Jersey Agricultural Experiment Station felt that peaches had great potential and peach research became a priority. The Experiment Station was in New Brunswick near the center of the state, and its mission was to perform peach research that would be relevant for growing conditions throughout the state. Research farms were also established in High Bridge, Hunterdon County in the northwestern part of the state, and in the southern part of the state in Vineland, Cumberland County. Before 1905 most fruit tree research publications from New Jersey delt with cultivar trials and insect and disease problems. Based on experiments performed in orchards around the state a bulletin was published in 1906 with grower recommendations on many subjects related to commercial peach production (Warren, 1906).

Blake's early career. There is little infor-

[1] Department of Plant Science, The Pennsylvania State University, University Park, PA 16802. Email: rpm12@psu.edu. This work was supported by the USDA National Institute of Food and Agriculture Federal Appropriations under project PEN04625 and accession number 1013400.

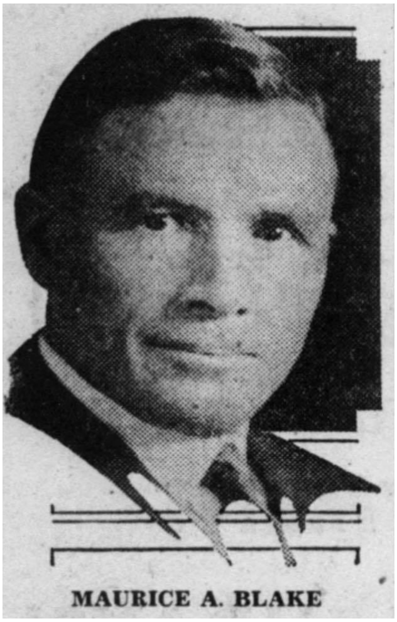

Fig. 1. Professor Maurice Aden Blake. Published in: New Jersey Agricultural Experiment Station. 1930. Fifty years of service to agriculture: being a brief history of the New Jersey State Agricultural Experiment Station, 1880-1930; on the occasion of the semi-centennial commemoration exercises, Oct. 8 and 9, 1930. New Brunswick, N.J.

mation on Maurice Adin Blake (December 1882 - 1947) before he was hired by the New Jersey Agricultural Experiment Station (Fig.1). According to Professor Ernest Christ (former fruit extension specialist and student of Blake's, personal communication) Blake grew up in Massachusetts and authored the Massachusetts Department of Agriculture circular, No. 22 "Modern Development in Peach Growing". In the fall of 1906 M.A. Blake was hired by the New Jersey Agricultural Experiment Station, bringing the number of horticulturists on staff to four. In 1909, based on his experiences establishing orchards on research farms, Professor Blake published his first Experiment Station bulletin "The First Season with the Peach Tree" (Blake, 1909). This was an extension of the information published by Warren (1906). Blake emphasized the importance of site selection, soils, good nursery stock, fall versus spring planting, soil preparation, setting the orchard, orchard design, fertilization, cover crops, intercropping peaches with vegetables, and the costs associated with orchard establishment. He estimated that with some income from intercropping with dent corn, the net expense for orchard establishment was 16 cents per tree. He recommended 11 cultivars, including 'Elberta', 'Mountain Rose', 'Early Crawford', and 'Belle of Georgia'.

The following year Blake discussed the management of peach orchards for the second season, beginning in late winter (Blake, 1910b). He discussed pruning trees during the first winter to obtain the open center form with 2 to 4 scaffold branches. He estimated the cost of pruning one-year-old trees at about 0.45 cents per tree. Instructions were provided for controlling San Jose scale and peach leaf curl, along with details for making lime sulfur for controlling both pests. He made recommendations for orchard fertilization, cultivation, and described "worming" to control peach tree borer by cutting into the burrow and killing the borer with a wire or knife. Blake estimated the cost of controlling borers based on experience with Italian laborers in his Vineland research orchard. He also explained proper summer pruning of young peach trees, including sucker removal to improve tree form and encourage fruitfulness.

In the early 1900s, many fruit experts recommended cutting budded trees back to 46 to 61 cm above the soil at planting regardless of grade, whereas others recommended cutting back to 46 or 76 cm above the soil. In 1913 Blake performed a factorial experiment, where five grades of trees with trunk diameters ranging from 9.5 to 22 mm were pruned at 7 heights 15 to 91 cm or not pruned (Blake, 1916). The first year in the orchard he measured all twig growth. The heading height resulting in the best growth depended on the tree grade and the condition of the trees at planting. For freshly dug trees, small trees headed at 15 cm grew best and large trees headed at 30 cm grew best. For stored trees that were not dried out, small trees responded well to lower heading heights and large trees grew best when headed at 91 cm. Fall-dug trees that dried out in storage grew poorly, but larger trees grew better than small trees and trees headed at 61 cm grew best. Trees that were headed low tended to produce fewer but longer branches. Blake also wrote a circular on commercial peach production (Blake 1912), where he described most of the factors involved in peach production, including site selection, cultivars, purchasing trees, planting trees, fertilization, pruning, and descriptions of pathogens and their control.

The severe winters of 1933-1934 and 1934-1935 injured many peach trees in the northeastern U.S., especially on their lower trunk. Blake observed that some genotypes had more injury than others and recommended that hardy stocks should be budded 46 cm above the soil line to minimized winter injury (Blake 1938).

Blake worked primarily with peaches, but he was interested in return apple bloom. He thinned a large 19-year-old 'Wealthy' apple tree by removing 4,575 fruits (160 kg). Since hand thinning large trees was not economical, he experimented with blossom thinning which resulted in larger fruit and better return bloom. He observed that the degree of thinning that was needed depended on the growth status of the tree (Bobb and Blake, 1938).

Classifying tree vigor and growth status. During the first year in the orchard, peach trees in New Jersey often had inadequate or excessive vigor (Blake, 1910b). Blake felt that it was important to quantify the optimum vigor level so growers could take corrective action. Based on detailed measurements of many trees, he determined that when used individually, trunk diameter, total length of shoots, total number of shoots and number of shoots longer than 60 cm did not adequately reflect tree vigor. Based on the inter-relationship of these variables he developed "The New Jersey Estimating Standard" for 1-year-old peach trees. To classify tree vigor, he suggested counting the total number of branches 7 cm or more in length and the number longer than 61 cm on each of five trees and using a chart that he developed, one could estimate the total length of shoots on a tree. The values for total shoot length per tree using this method of estimation were within 2% of the actual values (Blake and Hervey, 1928). A similar standard was developed to assess the potential capacity of bearing 'Delicious' apple trees to produce fruit of commercial quality based on the number, size, and shape of fruit spur leaves (Blake, 1929a; Blake and Davidson, 1934). Later he modified the standard to include characteristics of dormant spur buds and the length of 1- and 2-year-old shoots (Blake et al., 1945).

Peach pruning. Although there was much information available on pruning there were few data to support pruning practices. In 1910 Blake and Connors started to study pruning peach trees to evaluate different forms and timing of pruning on growth, cold hardiness, yield, and fruit quality, as well as pest control. They compared three peach cultivars with different growth habits (some cultivars had spreading branches, whereas others were more upright) and reported on the results of several experiments established in 1910 and 1912 at Vineland and New Brunswick (Blake and Connors, 1917). They compared different types of pruning performed during dormancy or mid-June plus early October. Trees grew larger at Vineland than at New Brunswick. In 1918, Blake said "The practice of pruning in America has too often been based upon theory or has developed into a fad along certain lines" (Blake, 1918). He summarized the summer pruning research that was performed before 1918. Most of the research had been performed with apple, but Blake had several years of data from peach pruning experiments. He found that summer pruning trees the season of planting tended to suppress total shoot growth but rubbing off undesirable buds low on the trunks had little effect on shoot growth and reduced the amount of dormant pruning that was needed.

Based on a detailed discussion of summer pruning research conducted during the first two decades of the twentieth century, he was probably the first to conclude that summer pruning does not check vegetative growth or induce flowering in apple more than dormant pruning.

In 1926 Blake published a 36-page Extension bulletin with 25 photos describing training and pruning peach trees to the open center form from the time of planting until tree maturity (Blake, 1926). Many peach trees were injured by the unusually cold winter of 1935, and Blake suggested that growers determine the extent of cold injury and then recommended how to prune trees depending on tree age and severity of injury (Blake, 1935). Most of the information in these bulletins is still valid today.

Disease control. Early in his career Blake worked on many aspects of tree fruit production including pest control. In 1910 Blake (1910) described the occurrence and symptoms of peach yellows and little peach, which first appeared in New Jersey in 1908. Peach yellows was introduced to the Philadelphia area by the late 1700s and the cause was unknown. We now know that yellows is likely caused by a phytoplasma (Lee et al., 1998) a group of organisms similar to viruses, but with some characteristics of bacteria, vectored by leafhoppers and can be transmitted by grafting and by seed. Little peach was discovered in Michigan in 1893 and in the Vineland orchards in 1905. The cause of little peach is still unknown. Blake stressed the importance of purchasing healthy trees from reputable nurseries, good orchard management and identifying and rouging infected trees as soon as symptoms appeared. About a decade later, Blake coauthored a bulletin describing the distribution, with detailed descriptions of symptoms for the two diseases, and summarized research conducted in other states (Blake et al. 1921). Through experimentation and good record keeping they verified that nurseries were an important source of infected trees, and they stressed the importance of propagators to be able to identify symptoms so they could avoid collecting bud wood from infected trees.

Lime sulfur is probably the oldest synthetic pesticide and was first used in the 1840s. Many growers made their own lime sulfur, but there were many questions related to its use to avoid phytotoxicity while controlling disease. Blake and Farley (1911) published a bulletin summarizing results of tests and observations made during the 1910 growing season. They described preparation of self-boiled lime and sulfur mixtures and the efficacy of their preparation for controlling peach scab while minimizing phytotoxicity. They stressed the importance of using an agitator in the spray tank and appropriate nozzles for application. They estimated the costs of materials and labor for one application of lime sulfur at 1.2 cents per tree. Data were presented for various concentrations of lime sulfur for controlling peach scab and brown rot as well as phytotoxicity symptoms. They also discussed control of plum curculio with arsenate of lead plus lime sulfur.

Peach tree response to environment. Based on his large *Prunus* germplasm collection, Blake summarized 20 years of field observations related to low temperature injury (Blake, 1930). Early-season growth in cool seasons was better for *P. davidiana* than for *P. persica,* and peach cultivars such as 'Alton' and 'Carman' grew better at 4 to 10 °C than most cultivars. Open blossoms of 'Chili', 'Greensboro' and 'Triumph' survived spring frost better than most cultivars. Weather variations influenced days from bloom to harvest for some cultivars more than others. Cultivars also varied in their ability to resist drought, diseases, arsenical injury, minimum winter temperatures, and variable winter temperatures.

To better study the effect of temperature on peach tree growth, young trees were grown in containers in the temperature-humidity controlled facilities in the Department of Botany at the University of Chicago and they found that most responses supported observations for field-grown trees (Nightingale and Blake, 1934). The accumulation of carbohydrates and nitrogen in roots and leaves depended on the combination of temperature and the amount of nitrogen applied to the trees.

Peach fruit development and quality. Predicting harvest dates for peaches was important to obtain adequate harvest labor, especially when 'Elberta' was the primary cultivar grown in the mid-Atlantic region. Blake reported dates of bloom and harvest from 1907 to 1919 for 'Elberta' trees at Vineland that he used for fertilizer experiments (Blake, 1930). Bloom varied from 29 March to 28 April, whereas harvest varied from 20 Aug. to 6 Sept. and days from bloom to harvest varied from 123 to 144. In general, the fruit development period was longer in years with early bloom. Trees fertilized with low rates of nitrogen ripened an average of five days earlier than trees receiving high rates.

Since peach maturity characteristics may not always be correlated with ground color, Blake (1929b) explained the advantages of using the plunger firmness tester to assess fruit maturity. He also provided guidelines for growers to determine how to market fruit based on flesh firmness. He compared plungers with different diameters and recommended the 4.8 mm diameter tip for peach (Blake, 1928a). To better understand peach ripening, Blake collaborated with a histologist and a biochemist to study in detail the changes within 'Elberta' fruits grown and ripened on trees that varied in vigor due to applying various rates of nitrogen (Addoms et al., 1930; Blake et al., 1930; Nightingale et al., 1930). Supplemental studies evaluated in detail the effects of tree nitrogen status and fruit maturity on flesh firmness, shipping, storability, and edible qualities of peaches as well as the chemical and physical properties of peaches stored at room temperature (Blake and Davidson, 1936). Fruit from high-nitrogen trees were softer and less red, and had lower concentrations of acid, sucrose and reducing sugars than fruits from trees receiving low rates of nitrogen. 'Elberta' fruit with acid concentrations greater than 15 (10 ml of juice required more than 15 ml of 0.1 N sodium hydroxide for neutralization) and total sugar concentration less than 7% were sour. Standards were suggested and defined as guides for the commercial harvest and sale of peaches.

In 1940, the pH, catechol tannin and titratable acidity for near soft-ripe fruits of 1899 peach genotypes were measured (Blake and Davidson, 1941). They proposed a cultivar classification system using three and four categories based on pH and titratable acidity, respectively. They also described how characteristics such as acidity and tannin concentration were inherited when parents varying in these traits were crossed. In 1941 the study was repeated. The climatic conditions for the two years were very different, and the pH, titratable acidity and tannins varied little for some cultivars, whereas other cultivars were very different. Trees with high carbohydrate status caused by winter injury or trunk girdling had high fruit tannin levels (Blake, 1942).

Low temperature injury. In the 1930s fruit trees were injured by low winter temperatures. Since it is difficult to study cold hardiness in the field, several research groups designed and built artificial freezing chambers to simulate freezing conditions. Meader constructed a circulating ethanol bath to study seasonal trends of peach fruit bud hardiness (Meader and Blake, 1943; 1945). Based on data with six cultivars they concluded that bud hardiness tended to be inversely related to previous maximum and minimum temperatures. In spring of 1942 buds, at various stages of development for 16 cultivars were frozen and some cultivars at the advanced pink stage were more cold tolerant than other cultivars at the pre-pink stage (Blake and Steeleman, 1944).

Fruit tree nutrition. Blake (1928b) described some of the problems associated with peach research in the field, especially for fertilizer experiments. First, he presented yield data from individual trees over six years that showed considerable tree-to-tree variation for yield and growth within and between years. He suggested that researchers should use at least 25 trees per treatment due to high variation. Some experiments were compromised by winter injury that greatly reduced yield some years. Since field-grown trees were so variable, and it was difficult to control the factors causing the variation, Blake (1928b) suggested that peach tree nutrition experiments should be performed in sand culture. To support his point of view, he described a commercial peach orchard displaying calcium deficiency symptoms, but soil calcium levels appeared adequate whereas as potassium levels were very high. To study the problem, peach trees were grown in sand culture with varying levels of calcium and potassium and the two elements had an interactive effect on tree growth (Davidson and Blake, 1937). Based on these results, Blake recommended complete fertilizers on sandy soils in South Jersey with attention to balancing different elements.

New Jersey Peach Council. By 1928, about two-thirds of the peach trees in New Jersey orchards were developed by the New Jersey Agricultural Experiment Station. In 1928, the New Jersey State Horticultural Society realized that some cooperative organization was needed to ensure that the peach growers of the state benefited from the peach breeding program. The New Jersey Peach Council was incorporated and consisted of 10 commercial growers appointed by the president of the New Jersey State Horticultural Society to encourage and support the scientific breeding of better peach cultivars and provide a dependable and satisfactory means of propagating and distributing trees of new cultivars and promising selections (Anonymous, 1938; Ernie Christ, personal communication). All trees offered by the Council were propagated by Princeton Nurseries and a brochure was published each year with a list of new cultivars, and a description of the cultivar and prices. At least once a season, the Council met with the Chief in Horticulture to select the seedlings to be propagated for further evaluation, arrange for a nursery to propagate the trees, decide how the trees would be distributed, the price, and the number to be sold to any one grower (Fig. 2). It is uncertain when the practice of commercial evaluation began, but during the 1960s through the 1980s, 10 commercial growers representing different New Jersey regions with varying soils and climatic conditions,


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The Peach Council Examining Trees and Fruit of the Garden State Nectarine

Seven New Commercial Peach Varieties
and One New Nectarine

TRIOGEM NEWDAY GOLDEN GLOBE
SUNHIGH GOLDENEAST
SUMMERCREST AFTERGLOW GARDEN STATE (NECTARINE)

Fig. 2. Cover photograph from the 1927 brochure of the New Jersey Peach Council

were given 10 trees per selection to evaluate before it was decided to name a new cultivar. By the 1970s trees were propagated by Adams County Nursery in Aspers, PA.

At the request of U.P. Hedrick, Blake (1937) chaired a committee of horticulturists in the Northeast in 1936 and 1937 to rate commercial peach cultivars being grown in the region. Results of the survey were presented at fruit grower meetings in the Northeast. Of the 51 cultivars considered, 'Elberta' was the outstanding commercial cultivar, followed by 'Golden Jubilee' and 'J.H. Hale'. None of the 35 cultivars considered "new" were rated as having commercial value.

Peach breeding. Blake is probably best remembered for the many peach cultivars he released from his breeding program (Table 1). At the beginning of the 20th century New Jersey growers complained that the leading cultivars, 'Early Crawford', 'Late Crawford', and 'Mountain Rose', lacked cold hardiness and fruit firmness for shipping. Therefore, growers started planting the new Shanghai or Chinese cling type cultivars, such as 'Greensboro', 'Carman', 'Waddell', 'Connetts', 'Belle' and 'Elberta'. Members of the Horticulture Division of the New Jersey Agricultural Experiment Station realized that improved peach cultivars were needed for a prosperous industry (Connors, 1928). Therefore, a peach breeding program was established in 1907 and the program was greatly expanded at Vineland in 1914. In 1907 there were eight cultivars on the approved commercial list of peach cultivars for New Jersey, but by 1944 only 'Elberta' and 'J.H. Hale' were still being planted because the others were nonprofitable. The same year the first peach cultivar from the program was named 'Liberty'. The primary objective of the breeding program was to obtain cultivars that were superior to those in existence. There was a need for high quality cold hardy yellow and white-fleshed cultivars ripening throughout the season from mid-July to late-September, as well as improved processing cultivars. In 1914 the white-fleshed 'Carman' was the leading cultivar in New Jersey because it was hardy and productive, but since it lacked the qualities to compete with yellow-fleshed cultivars, it was the first cultivar slated for replacement.

After the 1919 growing season, the Experiment Station Administrators decided that the Vineland station could no longer be justified, and it was turned over to the Training School at Vineland. The peach breeding work continued at New Brunswick under the direction of Professor Connors, but in 1926 Connors became head of Ornamental Horticulture and Blake took responsibility for the peach breeding program.

In addition to producing new cultivars, researchers also realized that understanding the inheritance of various characteristics would facilitate cultivar development. One of the objectives of the first set of crosses made in 1914 was to study inheritance characteristics (Blake and Connors, 1936). From 1914 to 1917, 10 cultivars were used to make crosses, or they were selfed, resulting in a total of 1952 seedlings. Pits from the early-ripening cultivars 'Mayflower', 'Early Wheeler' and 'Greensboro' did not mature seed and were of no value as pistillate parents. In 1925 the first cultivars released from the first stage of breeding included the white-fleshed 'Cumberland' and the yellow-fleshed 'Eclipse', which were soon replaced by 'Raritan Rose' and 'Goldeneast' and 'Sunhigh'. In 1937 an open-pollinated seedling of an 'Elberta' x 'Greensboro' cross was named 'Golden Jubilee' but was replaced by 'Newday' and 'Triogem'. 'Summercrest' was introduced to replace 'Belle', and 'Afterglow' was released to replace 'Fox Seedling'. 'Pacemaker' was offered in 1939 to ripen after 'Summercrest'. Named cultivars obtained from selfing 'Belle' included 'Ambergem', 'Eclipse', and 'Meteor'.

Although the initial objectives of the program were met, the market demands were changing, and Blake understood that new cultivars were needed to replace those currently being grown. In 1920, a second stage of breeding utilized selections obtained from

Table 1. Peach and nectarine cultivars introduced by M.A. Blake.

Cultivar	Date[z]	Type of fruit	Parentage[y]
Oriole	1924	Yellow melting peach	Slappy x Admiral Dewey
Rosebud	1925	White melting peach	Carman x Slappy
Marigold	1925	Yellow melting peach	Lola x Arp
Sunbeam	1925	Yellow melting peach	Slappy x Arp
Massasoit	1925	Yellow melting peach	Slappy x Admiral Dewey
Cumberland	1925	White melting flesh peach	Belle x Greensboro
Eclipse	1925	Yellow freestone peach	Belle x Belle
Meteor	1925	Yellow freestone peach	Belle x Belle
Primrose	1925	Yellow melting freestone peach	Elberta x Belle
Buttercup	1925	Yellow softmelting semiclingstone peach	Lola x Arp
Delicious	1925	White semifreestone, melting peach	Belle x Greensboro
Radiance	1925	White flesh free-stone peach	Belle x Greensboro
Pioneer	1925	White melting freestone peach	Belle x Greensboro
Goldfinch	1925	Yellow melting semifreestone peach	Belle x Greensboro
Golden Jubilee	1926	Yellow flesh melting peach	Elberta x Greensboro OP
White Hale (N.J. 63)	1932	White freestone melting peach	Open pollinated J.H. Hale
Ambergem	1934	Yellow nonmelting clingstone peach	Belle x Belle
Garden State	1934	Yellow nectarine	Elberta O.P. x O.P.
Raritan Rose (N.J. 97)	1936	White melting freestone peach	J.h. Hale x Cumberlans
Golden Globe (N.J. 73)	1937	Yellow freestone peach	J.H. Hale x Marigold
Goldeneast (N.J. 87)	1937	Yellow melting freestone peach	Elberta x N.J. 38
Triogen (N.J. 70)	1938	Yellow melting freestone peach	J.H. Hale x Marigold
Sunhigh (N.J. 82)	1938	Yellow meltingfreestone peach	J.H. Hale x N.J. 40
Summercrest (N.J. 94)	1938	Yellow melting freestone peach	J.H. Hale x Cumberland
Afterglow (N.J. 84)	1938	Yellow melting freestone peach	J.H. Hale x N.J. 27116
Newday (N.J. 79)	1938	Yellow semicling melting peach	J.H. Hale x N.J. 40
Fireglow (N.J. 71)	1939	Yellow melting freestone peach	J.H. Hale x Marigold
Pacemaker (N.J. 99)	1939	Yellow melting semicling peach	J.H. Hale x Marigold
Redrose (N.J. 98)	1940	White melting freestone peach	J.H. Hale x Delicious
Laterose (N.J. 109)	1945	White melting freestone peach	J.H. Hale x Delicious
Early East (N.J. 134)	1946	Yellow semi-cling peach	J.H. Hale o.p. x (Slappeyx Dewey)
Jerseyland (N.J. 135)	1946	Yellow melting semicling peach	J.H. Hale o.p. x (Slappeyx Dewey)
Jerseyland (N.J. 135)	1946	Yellow melting semicling peach	J.H. Hale x (Slappy x Admiral Dewey)
Redcrest (N.J. 126)	1946	Yellow melting freestone peach	unknown
Constitution (N.J. 161)	1947	Yellow freestone peach	J.H. Hale x Eclipse
Fallate (N.J. 183)	1947	White freestone peach	J.H. Hale x Eclipse
Frostqueen (N.J. 185)	1947	White freestone peach	(J.H. Hale x Eclipse) x Berks
Nectarose (N.J. 9)	1947	White freestone nectarine	Garden State x [(GoldMine x Belle selfed) O.P.]
Nectaheart (N.J. 10)	1947	White freestone nectarine	Garden State x [(GoldMine x Belle selfed) O.P.]
Nectacrest (N.J. 8)	1947	White freestone nectarine	Garden State x [(GoldMine x Belle selfed) O.P.]
Nectalate (N.J. 4)	1947	White flesh nectarine	Garden State x N.J. 25032
Cherry Red (N.J. 129)	1947	Yellow nonmelting clingstone peach	(J.H. Hale x Goldfinch) O.P.
Goodcheer (N.J. 152)	1947	Yellow melting freestone peach	(J.H. Hale x Eclipse) x Laterose
Autumn (N.J. 145)	1947	Yellow freestone peach	(J.H. Hale x Eclipse) x Late Crawford
Wildrose (N.J. 118)	1947	White melting freestone peach	J.H. Hale x Delicious
Summer Rose (N.J. 101)	1947	White melting freestone peach	J.H. Hale x Delicious
Maybelle (N.J. 164)	1948	White melting semi-cling peach	Raritan Rose x (J.H. Hale x Goldfinch) o.p.

[z] Date of introduction.
[y] O.P. = open-pollinated.

the first series of crosses. Cultivars resulting from the second stage of the program included 'Primrose', 'Buttercup', 'Marigold', 'Delicious', 'Radiance', 'Pioneer', 'Goldfinch', 'Massasoit', 'Meteor', 'Rosebud', and 'Sunbeam' (Blake and Connors, 1936). Progeny varied in resistance to drought, insects, and diseases.

Based on more than 35 years of experience, Blake (1944) identified some obstacles that slowed peach cultivar development and he summarized methods for selecting and evaluating promising seedlings at an annual meeting of the American Society for Horticultural Science (Blake, 1944). He said the work must be on an extensive scale and pursued without interruption for at least 15 years; field observations must be combined with laboratory measurement of hardiness and fruit characteristics; breeders must understand how peach trees respond to environmental conditions; and a breeding program required a large germplasm collection. In 1926, Blake's collection included 334 cultivars, species, and types of peach and related species.

In addition to 'Elberta' and 'Belle', Connors and Blake made many crosses with 'J.H. Hale'. Based on crosses with 'J.H. Hale' in 1921, Connors (1922) reported that the pollen was sterile. This cultivar had good fruit quality, but trees were only moderately vigorous, lacked cold hardiness and were very susceptible to bacterial leaf spot. Also, for pollination 'J.H. Hale' needed to be interplanted with other cultivars, usually 'Elberta'. Since it had sterile pollen, self-pollination was not an issue, so trees were covered with netting to prevent cross-pollination, and this facilitated controlled pollination. From 1914 to 1928, 131 crosses with 77 cultivars and species were made on 'J.H. Hale' trees under covers. By observing progeny from these crosses, Connors (1928) reported that white flesh was dominant over yellow flesh, melting flesh was dominant over non-melting, large blossoms were dominant over small, reniform glands were dominant over eglandula. He also reported on inheritance of flesh adhesion, ripening dates, and pollen sterility. Later, progeny obtained from 13 of these crosses were described in detail (Blake, 1932; Blake 1933a; Blake 1933b). From these first two stages of the breeding program, Blake and Connors were able to characterize the inheritance of many traits, including flower sterility, blossom type, flesh color, freestone versus cling flesh, melting versus non-melting flesh, fruit shape and size, date of bloom and ripening, bud and fruit pubescence, tree growth habit, and cold hardiness. Based on inheritance characteristics, Blake concluded that 'J.H. Hale' was a combination of recessive characteristics and he hypothesized that 'J.H. Hale' was likely the progeny 'Elberta' self-pollinated.

In his early work, Blake described three types of peach flesh as "soft melting", "firm melting" and "non-melting" (Blake, 1933b), then he added a fourth category that he called "semi-melting". For the first time he observed genotypes that were both freestone and non-melting and he also described some crosses to determine the inheritance of red leaves, and ripening dates (Blake, 1937).

By 1927, Blake had a large collection of seedlings from 'Elberta' x 'J.H. Hale' crossed with other cultivars. In 1933, there were nine days in January with maximum temperatures exceeding 10 °C and on 13 February the minimum temperature was -29 °C. As a result, flower bud survival for 'Elberta' and 'J.H. Hale' was only 5%, and most seedlings of 'Elberta' had less than 12% bud survival, whereas many other commercial cultivars had bud survival exceeding 50% (Blake 1933a).

In 1933, the Peach Council asked for cultivars that ripened between 1 July and 1 August. The seeds of early ripening peaches did not germinate, so a method to germinate these non-viable seeds with embryo culture was developed (Davidson, 1934). Blake had previously reported that it was likely that progeny would ripen at about the same time as the parents, but he observed some progeny of 'Raritan Rose' x 'Duke of York' and 'Raritan Rose' x 'Mayflower' ripened in July, which was earlier than any of the parents (Blake, 1939).

Prunus kansuensis is closely related to peach. Since the two species are closely related, they were crossed easily and the F_1 generation was fully fertile. *P. kansuensis* trees bloomed about 10 days earlier than peach, the cold hardiness of flower buds is similar to the less cold hardy peach cultivars, but the flowers are more cold resistant than peach. Meader and Blake (1938) crossed two introductions of *P. kansuensis* from China with 'J.H. Hale' to better understand the inheritance of traits and described the F_1 progeny. The next year they described characteristics of the F_2 generation produced by crossing individuals of the F_1 generation (Meader and Blake, 1939b). Hybrids tended to bloom early but flowers of F_2 seedlings had considerable frost resistance. Only 11 of the 24 F_2 seedlings fruited, and fruits were small, soft, watery, clingstone, with high tannin and poor quality. Tree characteristics, fruit bud pubescence, bud hardiness, time of bloom, pollen fertility, and flower characteristics including cold tolerance were described.

In his last scientific paper, Blake (1947) described the process he used for breeding apples to reduce the time for selecting promising seedlings. He stated that at least 10 years were required from the time a cross is made to select and evaluate progeny that could be recommended for commercial planting. An additional 10 years was needed before a reasonable volume of fruit was harvested from commercial orchards. To shorten the evaluation time, he grew seedlings in the greenhouse the first year, to obtain seedlings that were 1.2 m tall and reduce the time to fruiting by a year. The trees were then set in the field at 6 x 6 m and were not pruned to induce early fruiting. Tree characteristics for apple were much more variable than for peach, making evaluation more difficult. He concluded that multi-year observations were necessary.

Cultivar classification. Blake obtained peach germplasm from around the world to use in his breeding program. But cultivars were often misidentified. Therefore, he desired a classification system that he could use to describe existing and new cultivars as he released them. Several papers were published to describe cultivar identification based on leaf characteristics. They obtained leaf samples from various locations in eastern North America and using a foliarmetric gauge that they developed (Meader and Blake, 1941a), measured width:length ratio, base angle, and apex angle to describe a leaf. Eventually a classification key was developed based on type of gland, leaf color, width-to-length ratio, cepal and base angles, and leaf conformation (Sefick and Blake, 1937). These results were extended with data from two more seasons and orchards in Maryland as well as New Jersey (Meader and Blake, 1939a; Meader and Blake, 1941b). Additional leaf traits included color of veins, type of leaf margins, and petiole length. In addition to leaf characteristics, other traits used to identify cultivars included tree vigor and growth habit, bark color, bud density, flower type, fruit characteristics, time of ripening, and size and sculptural patterns of pits.

Dr. Louis Edgerton worked as a research assistant with Blake during World War II before joining the faculty at Cornell University in 1946. Together they studied various characteristics to describe peach cultivars and used the best set of characteristics to describe 31 peach and one nectarine cultivar (Edgerton and Blake, 1946). The characteristics used to describe peach genotypes included flower bud density, dormant fruit bud hardiness based on controlled laboratory freezing, leaf shape and presence of glands and serration of leaf margins, conformation of leaf blades (flat, wavy, and crinkled) (Meader and Blake, 1939a), flower size and color, petal size and shape, fertile and sterile flowers, calyx size, sepal size and shape, color of the calyx cup, pedicel length, fruit shape based on longitudinal and transverse sections, fruit size, fruit pubescence, fruit skin and flesh color, flesh characteristics (melting, nonmelting, clingstone, freestone), uniformity of fruit ripening, eating quality (fruit tannin content and acidity), and stone characteristics (size, shape, and surface markings).

According to Ernie Christ (personal communication), Professor Blake died from a heart attack in December 1948 after work one evening as he left the Horticulture Building which in 1958 was renamed "Blake Hall". In 1953, the 'M.A. Blake' peach was named in his honor. 'M.A. Blake' (N.J. 117) resulted from a cross of 'J.H. Hale x 'Primrose' made by Blake. During his career Blake introduced 48 peach and nectarine cultivars and several of his selections were named by his successors, Drs. Catherine Bailey and Fred Hough. As a result of the work of M. A. Blake and his collaborators, New Jersey ranks fourth or fifth in peach production most years and New Jersey peach cultivars are the backbone of the peach industry in the Northeast and mid-Atlantic regions.

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