

College of Agriculture & Life Sciences
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KIWIFRUIT

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History

The kiwifruit (*Actinidia deliciosa*) is a large, woody, deciduous vine native to the Yangtze Valley of China. Seeds from China were taken to New Zealand and planted in 1906. Plants developing from these seeds first fruited in 1910. Commercial planting began in New Zealand in about 1940 and by 1970 there were 900 acres. Commercial planting in California began in the late 1960s. From 50 acres in 1970, the industry in California had grown to more than 8,000 acres by 1988 (University of California Cooperative Extension estimate). US kiwifruit production has been declining since the 1990s. Acreage in 2006 was reported as 4,300 by the California Kiwifruit Commission. In 1974 kiwifruit became the internationally accepted name, replacing Chinese gooseberry and kiwi.

In the eastern United States, kiwifruit vines have fruited at Virginia Beach, Virginia, and at several locations in South Carolina, and are part of evaluation programs in Alabama and Georgia. The first commercial shipments began in 1980 from a planting in South Carolina located about 30 miles north of Augusta, Georgia. In North Carolina, several vines were planted at a research farm near Raleigh in the early 1970s, but these did not survive the first winter. A 1979 planting at the Horticultural Crops Research Station near Wilmington was severely damaged when the temperature dropped to 2°F in early March of 1980. Almost half of the vines were

completely killed, and the other half were killed to the ground. Surviving plants sprouted from below the soil line and slowly reestablished vine growth in 1980. No vine damage occurred in the winter of 1980-81. Vine vigor increased during the summer of 1981, but severe trunk and arm cracking occurred in January, 1982, following a temperature of 5°F. Surviving vines only fruited twice in the following 9 years. Severe winter damage occurred about once every three years. As a result of poor survival and fruiting, the vines were removed in the fall of 1991.

Reducing Winter Damage

Several techniques, including planting on the north side of a building and piling pine straw around the base of the plant in the fall, have reduced damage. Damage is usually the most severe on the lower 18 inches of the trunk. If this area is not warmed by afternoon sun or is protected by pine straw prior to a freezing night, less damage has been observed. Another alternative is to plant a species of kiwifruit that is more winter hardy. These kiwifruit species are known as hardy kiwifruit because they can withstand temperatures below -10°F. However, even hardy kiwifruit require protection from frost injury in the form of overhead irrigation or another frost protection strategy when temperatures are expected to drop below 32°F after bud break. *A. arguta* is the most common of the winter hardy species that are offered by commercial propagators.

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Potential in North Carolina

Based on experience over the past 18 years, there is little reason to be optimistic about successful commercial kiwifruit production in North Carolina. However, the more positive results in several Virginia and South Carolina locations provide sufficient encouragement to continue kiwifruit trials on a limited scale. Vine establishment during years with less severe winters combined with increased cold tolerance of older vines may account for the success in Virginia and South Carolina. The information and suggestions in this leaflet were gathered from New Zealand, California, Oregon, Virginia, and South Carolina sources. The purpose of the information is to provide a basis for establishing trial or home plantings and not as tried and proven recommendations for commercial kiwifruit production in North Carolina.

Fruit and Vine Characteristics

A. deliciosa kiwifruit is about the size and shape of a large hen's egg with a fuzzy, dull-brown exterior. Inside, the flesh is emerald green with rows of black, edible seeds. Fruit texture is similar to strawberry and the flavor resembles a blend of strawberry and pineapple. Vines are very vigorous. Large, thick leaves combined with a fruit crop that may exceed 14,000 lb per acre contribute to a very heavy trellis load.

Hardy kiwifruit (*A. arguta*, *A. kolomikta*) are much smaller than *A. deliciosa* in size. Their size is similar to that of a grape and few are larger than a man's thumb. Instead of the fuzzy skin, *A. arguta* has a smooth, edible skin. On the interior, hardy kiwifruit resemble fuzzy kiwifruit in color, texture and flavor, though they are usually described as having more intense flavor and sweetness. From our experience, the fruit is best when soft-ripe at harvest and will only ripen during storage if harvested after the fruit reaches a stage of physiological maturity (after seeds turn black and sugar content [measured as soluble solids with a refractometer] reaches 8-14%). Storage life of the fruit is short. Variable fruit quality, dehydration, and short storage life seem to give *A. arguta* limited commercial potential. However, hardy kiwi is being grown and marketed as "baby kiwi" in Oregon and as "grape kiwi" in British Columbia. The primary cultivar is 'Ananasnaya,' sometimes shortened to 'Anna.' 'Ananasnaya' came to North America from the Russian breeding program of Ivan Michurin during the Stalin regime. 'Issai,' a less hardy *A. arguta* cultivar came from Japan in 1986. Based on recent research findings, 'Ananasnaya' in particular may be worthy of trial in North Carolina.

Adaptation

Classified as a subtropical plant, *A. deliciosa* kiwifruit will not tolerate winter temperatures much lower than 10°F. When the winter minimum temperatures decline gradually over a number of weeks with a few warm days interspersed, well hardened, mature vines have survived temperatures approaching 0°F with little damage. However, in the fluctuating temperatures of North Carolina, damage often occurs just below freezing. The long growing season required for fruit to mature can also limit production. A frost free period of at least 220 days is required for adequate fruit ripening. In southeastern North Carolina, the vines can be expected to leaf in mid-to late-March and flower in mid-May. Fruit should be sufficiently mature for harvest in late October or early November. Temperatures lower than 29°F between leafing and harvest can damage the leaves, blossoms and fruit. If new growth is damaged in the spring before blossoms develop, no blossoming will occur. *A. arguta* has been reported to tolerate winter temperatures as low as -25°F, but freeze damage to new growth in the spring is similar to the damage described for *A. deliciosa*. *A. arguta* fruit begins ripening in mid-August in southeastern North Carolina.

Culture

Kiwifruit plantings can be handled much like muscadine grapes, however, they are much more susceptible to wind damage and root-knot nematodes, and require more supplemental irrigation than muscadine grapes. Many soil types are suitable, provided they are well drained. The soil pH should be adjusted to 6.0 to 6.5 and nematodes controlled before planting.

Planting - Dormant plants from a nursery can be planted in the spring after there is little chance of freezing weather. Plant to the same depth as the plants grew in the nursery. After planting, prune the plant back to a single, healthy shoot 6-12 inches long.

Training and Trellising - See North Carolina Cooperative Extension Circular AG-94, *Muscadine Grape Production Guide for North Carolina*, for examples of training and trellising systems. Similar to grapes, commercially grown kiwifruit plants are trained to a permanent framework, either a T-bar (like a clothesline with 4-5 wires) or pergola (solid overhead canopy with wires going in both directions). Vines can also be trained to a simple single wire or double wire system. For ease of harvest, the wires of the trellis should be at least 6 ft above

the ground. Cross arms on the T-bar and double wire systems should be 5-6 ft long. Solid cross arms made from pressure treated 2- to 6-inch lumber attached to a treated post with a top diameter of at least 4 inches should support the vines if large (>6 inch), well-braced end posts are used.

Because kiwifruit vines are more vigorous than muscadine grape vines, more space should be allowed between rows. On a single wire the spacing should be 10-12 ft and with the double wire, 15-16 ft. The width of equipment to be used in the planting may influence row spacing. Space vines 18-20 ft apart in the row.

After growth begins on newly set plants, select a strongly growing shoot as the main leader to carry the vine up to the wire. Remove side shoots at least once a week for maximum growth of the main shoot. A bamboo stake is a convenient support for training the vine up to the wire. Follow the training instructions for muscadine grapes.

Pruning - With weekly attention to training, shoots that will develop into the permanent arms (cordons) will extend the length of the wire in 1 to 2 years. After cordons extend the length of the wires, lateral shoots (canes) are allowed to grow but may require thinning to maintain a distance of 8-12 inches between them on the cordon. Mixed buds that produce both flowers and vegetative growth will develop in the leaf axils of these side branches. The following spring these buds will develop into new shoots with flowers at the first 3 to 6 nodes.

Both summer and winter pruning are required to maintain a balance between vine growth and profitable fruit production. Excessive vine growth is removed during the growing season to keep the vines open and avoid shading of the fruiting wood. If summer pruning is neglected, the fruit will be smaller and of poorer quality and winter pruning will take considerably more time. During winter pruning, shoots that are less than a pencil width in diameter should be cut back as well as wood that fruited the previous year. New fruiting wood usually will have developed at the base of the previous year's canes.

Pollination and Varieties - A kiwifruit vine produces either male or female flowers. Plants of both sexes are essential for fruit production and they must flower at the same time to ensure pollination. Male vines are usually spaced every third vine in every third row and represent

10% of the planting. In California, 3 to 4 hives of honeybees are provided per acre.

A. deliciosa varieties grown in New Zealand are Abbott, Allison, Bruno, Hayward, and Monty. Large fruit size and excellent keeping quality are responsible for Hayward becoming the predominant commercial variety. The Chico or Chico Hayward plants available from U.S. nurseries are similar to the New Zealand Hayward or are a selection that is almost identical. Hayward females are successfully pollinated by Chico-male, Matua or Tomori in California. For earlier flowering female varieties such as Abbott, Allison and Bruno, the male variety Matua is a better choice.

Fertilization - Kiwifruit respond to high rates of fertilizer application. In California, 150 lb of nitrogen per acre is recommended on mature vines. New Zealand recommendations go as high as 200 lb of nitrogen per acre. Only nitrogen is generally applied in California, but a complete fertilizer with a ratio of about 3-1-2 is recommended.

On sandy soils in North Carolina, use repeated applications of small amounts of fertilizer to avoid injury. Several weeks after planting when rain or irrigation has thoroughly settled the soil around the roots, begin fertilizer application. Apply 1 oz of a complete fertilizer such as 10-10-10 uniformly within a circle 12 inches from the plant. Avoid concentrations of fertilizer around the plant base. Repeat these applications after 4 inches of rain or irrigation until mid-June. Later applications could increase winter damage by causing the plant to continue growth late in the season. During the second growing season, begin applications in early March following the first year schedule, but increase the rate to 2 oz per vine and increase the diameter of the application circle to 18 inches. Every other application, 2 oz of calcium nitrate or 1 oz of ammonium nitrate may be substituted for the 2 oz of 10-10-10. During the third year, follow the second year schedule but increase the rate to $\frac{1}{4}$ to $\frac{1}{2}$ lb per vine of 10-10-10, calcium nitrate or ammonium nitrate at each application within a 24- to 36-inch circle around the vine. From the fourth year on, broadcast the fertilizer over the entire area, increasing the amount gradually as production increases. In the fourth year, 200 lb per acre of 10-10-10 in early March, followed by 100 lb per acre of ammonium nitrate in early May and mid June should stimulate adequate plant vigor without contributing to increased

susceptibility to winter damage. Rates can be increased or decreased in subsequent years, depending on vine vigor. Please note: do not use fertilizer containing chloride (such as KCl) as kiwifruit vines are very sensitive to chloride.

Irrigation - In California, vines are generally irrigated weekly during the first three growing seasons. A combination of 1 inch to 1½ inches per week of natural rainfall and irrigation during the growing season would be desirable in North Carolina.

Sprinkler irrigation offers the potential for protecting from freeze damage to tender new growth in the spring and fruit in the fall as well as providing soil moisture.

Weed Control - Permanent sod is often maintained between plant rows. Frequent mowing reduces competition with the vines. Competition for moisture and fertilizer is further reduced by destroying all vegetation in a 4-6 ft band under the vines with a herbicide or shallow cultivation. Deep cultivation can seriously damage the shallow, fleshy kiwifruit roots.

Pests - Few serious insect and disease problems have been encountered by kiwifruit growers. Root-knot nematodes have been found on roots in all production areas as well as the trial planting in North Carolina. However, the nematodes do not seem to seriously reduce vine vigor. If a high population exists in the soil, fumigation prior to planting may be desirable. Japanese beetles occasionally feed on the foliage, but they prefer other plants. New pests can be expected as plantings increase. Close observation of the vines increases the chance for control of a new insect or disease before serious damage occurs.

Wind Damage - Spring winds can break the tender young shoots at their point of attachment to the arm. Wind rub while the fruits enlarge and mature can cause flesh bruising and unsightly blemishes on the skin. Use of a pergola trellis minimizes wind damage. Lombardy poplar (*Populus nigra* var. *italica*) has been used as a

windbreak in New Zealand and South Carolina. Plants are spaced 16-20 inches apart around the planting and perpendicular to the prevailing wind between every 4-6 kiwifruit rows.

Harvesting - In California, vines generally provide their first commercial crop in the fourth season. Full production is reached within 8-12 years.

A. deliciosa fruits reach almost full size in August but are not mature enough for harvest until late October or early November (after the seeds turn black and sugar content is >6.5%). Fruit will soften off the vine if harvested after the sugar content reaches 4%, but full flavor does not develop until the sugar content reaches 6-8% on the vine. Starch in the fruit is converted to sugar following harvest. When the fruit is ready to eat, it should contain 12-15% sugar.

Fruits are harvested by snapping the stem at the abscission layer at the base of the fruit. Commercially, kiwifruit vineyards are harvested all at one time, but in the home garden the largest fruit can be removed first and the smaller fruit allowed to develop more size.

Storage and Ripening - Mature *A. deliciosa* fruit can be stored for 4-6 months at 31-32°F if protected from dehydration. Storage life is substantially reduced if ethylene producing fruits such as apples or pears are present in storage. For maximum storage life, store kiwifruit alone. Fruit will ripen at room temperature when removed from cold storage. Ripening can be hastened by exposure to ethylene. This hastened ripening can be accomplished in the home by placing kiwifruit in a plastic bag with an apple.

From our experience, *A. arguta* is best when soft at harvest, but can be harvested firm (after seeds turn black and sugar content reaches 8-14%) and stored in vented plastic bags or clamshell packages under refrigeration for up to 6 weeks. Ripen at room temperature as for *A. deliciosa*. Soft, vine-ripe hardy kiwifruit will not store.