

‘Ananasnaya’ Hardy Kiwifruit

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‘Ananasnaya’ is the most widely grown cultivar of hardy kiwifruit [*Actinidia arguta* (Siebold & Zucc.) Planch. ex Miq] in the world. Hardy kiwifruit, *Actinidia* Lindl. Section *Leiocarpae* family Actinidiaceae [including *Actinidia arguta*, *A. kolomikta*, and *A. polygama* (Siebold & Zucc.) Maxim.] are vining, cold hardy, polygamodioecious (sometimes having unisexual and bisexual flowers, but tending to have separate male and female plants) plants native to China, Russia and Japan (8). Hardy kiwifruit may also be known or marketed under alternate names including “baby kiwifruit”, “grape kiwi”, “wee-kee”, and “cocktail kiwi”. In 2002, an estimated 42 ha (100 acres) of commercial ‘Ananasnaya’ were planted in Oregon (22). Williams et al. (26) estimated that about 100 ha of ‘Ananasnaya’ were grown commercially worldwide, in the United States (Oregon, Pennsylvania, New York, Washington), New Zealand, Canada (British Columbia and Ontario), Chile, Italy, France, Germany, and The Netherlands.

The popularity of ‘Ananasnaya’ can be attributed to plants growing well, it is easily propagated, produces a high yield, and is highly recommended in commercial nurseries – it is the cultivar of choice in nursery catalogues throughout North America. Fresh fruit of ‘Ananasnaya’ have been well received in the San Francisco and Los Angeles, California, markets and in Japan, fetching high prices (6, Mark Hurst, Hurst’s Berry Farm, Sheridan, Ore., pers. comm.); private industries are working on developing processed products.

Genetic background

Ivan Vladimirovich Michurin, Soviet plant breeder (1855 – 1935), developed and named five *Actinidia* cultivars (13) including ‘Ananasnaya’. One of the guiding principles of his work was, “We cannot wait for favours from Nature; we must wrest them from her.” He set himself “two bold tasks: to augment the assortment of fruits and berries in the central regions by adding high-yield varieties of superior quality, and to extend the area of southern crop cultivation far to the North.” The development of *Actinidia* as a commercial crop had potential for Russia and other northern regions because of the plant’s cold hardiness and the high vitamin C content of the fruit.

The pedigree for ‘Ananasnaya’ is likely *A. arguta* x *A. kolomikta* (4). The name is a Russian variant of the pineapple genus, referring to the perceived tart, pineapple-like flavor of the fruit. The clone of ‘Ananasnaya’ that was introduced into America from Russia may be a different genotype than that originally described by Michurin (15). The cultivar synonyms for ‘Ananasnaya’ include: ‘Michurin’s Ananasnaya’, ‘Michurin’s Pineapple’, and the sometimes used American shortened version, ‘Anna’.

Plant

The mature plant is very mid-winter hardy, tolerating temperatures of -30°C (-22°F) (26). The vines are vigorous and bear reliably. Young leaves are shiny green, entire with sharply serrate margins and acuminate

Special thanks to Gil Buller, Senior Research Assistant, NWREC, and Chantalak Tiyyayon, Maria Pescie, and Connie Landis-Fisk, former M.S. students (BCS). Partial funding support from ARS CRIS 5358-21000-033-00D for the preparation of this manuscript and the preservation of the genetic resources for ‘Ananasnaya’ and support from the Northwest Center for Small Fruits Research is gratefully acknowledged.

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tip. The petioles are red. Older leaves are coriaceous with undulate margins. Current season's summer shoot growth is light green with prominent white lenticels toward the base and on second-year wood. The wooded trunk develops exfoliating bark.

'Ananasnaya' has a relatively low chilling requirement and may be injured in late winter or early spring when warm weather precedes cold (20). Young kiwifruit shoots are very sensitive to frost and wind injury. Commercial growers install irrigation for frost protection to protect plants after budbreak. They also install windbreaks to reduce wind damage to shoots and fruit. About 150 frost-free days are required to ripen fruits (15). Three-year-old plants can produce a significant crop, but plants are mature at seven to eight years old.

Flowering

The flowers are small, being about 1 cm in diameter. 'Ananasnaya' has female flowers that bloom for about 10 days. Time of bloom has been recorded as late-May at the National Clonal Germplasm Repository, Corvallis, early to mid-June at commercial grower sites (14, 23) and the North Willamette Research and Extension Center (NWREC), Aurora, Oregon, and late May to mid-June in British Columbia, Canada (11). The flowers of 'Ananasnaya' must be cross pollinated for successful fruit production. Male selections of *A. arguta*, such as 127-40, Cornell, Meader, or 74-32, can serve as pollinizers. Male selections of *A. deliciosa* (A. Chev.) C.F. Liang & A.R. Ferguson may also be used as pollinizers, but are not considered sufficiently cold hardy to be recommended as males for commercial plantings in northern temperate areas (20). In commercial plantings, a planting ratio of one male vine for every 6 to 10 female vines is recommended for adequate pollination and fruit set (20). Honey bees are the predominant pollinators with from 8 to 10 hives recommended per hectare (20).

Flower bud initiation in hardy kiwifruit

occurs the year before flowering (25). The period two months prior to fruit harvest is an important time for initiation and adequate light exposure of shoots is necessary for maximum flower number per shoot in 'Ananasnaya' (23). Flowers are borne in leaf axils either singly but more commonly as three flowers in a small cyme (21).

In all *Actinidia* species, only one-year-old canes produce fruitful shoots. Volz et al. (24) suggested that flower number in *A. deliciosa* is likely to be lower in fruiting wood borne from older wood. However, Tiyayon and Strik (21) found that 'Ananasnaya' is very fruitful on one-year-old canes regardless of cane origin (from two-year or older wood) or length. The most productive part of the cane was generally from nodes 6 to 40, due, in general, to a higher percentage of budbreak and fruitful shoots. Snowball (18,19), in New Zealand, recorded 45-50% budbreak in *A. arguta*, with only 12-13% of the shoots flowering. In Oregon, percentage of budbreak has ranged from 24 to 34% in heavily shaded mature vines to 35 to 57% in immature vines (21). Percent flowering shoots ranged from 50 to 64% (21). Tiyayon and Strik (22) recorded 47% budbreak, with 85% of the shoots growing more than 15 cm long, and 83% of those shoots flowered.

Maximum percent budbreak occurred in the center of one-year-old canes with lower bud break occurring near the cane's base due to the presence of fruit at these nodes the prior growing season (21). In New Zealand, flowers of *A. arguta* were borne from nodes 1 to 26 on the current season shoot with node 14 being the most productive (18). In Oregon, 'Ananasnaya' flowers were located on nodes 6 to 12 on current season shoots (21).

'Ananasnaya' vines are very vigorous. Tiyayon and Strik (22) counted 2085 nodes per vine after pruning. The number of flowers per vine has ranged from 2000 to 10,508, depending on vine age or location, in Oregon (14, 22). Percent fruit set was 74 and there

was no relationship between yield per vine and return bloom the following year (22).

Fruit

The fruit of 'Ananasnaya' is a medium-sized, ovoid, 3.5 cm long x 2.5 cm wide (1.5 x 1 in.) berry. Fruit weight ranges from 2 to 14 g, averaging 6.9 g (14) or 7.3 g per vine (23). Average fruit size of kiwifruit at the NWREC is presented in Table 1; total yield was collected and average fruit weight of 100 berries on each of three vines. 'Ananasnaya' produces a green to red blushed berry with a smooth, edible epidermis. The smooth skin is bright green on immature fruit, develops a red blush later in the maturation phase, but particularly in sun-exposed fruit, with the green color darkening and fruit softening as it ripens. The calyx is persistent on the fruit. The flesh is light-green, juicy, and has a sweet-tart taste with a rich, aromatic flavor that has been compared to ripe pineapple, strawberries, bananas, European gooseberries, over-ripe pears, or rhubarb.

Fruit have 40 to 155 mg/100g Vitamin C, depending on cultivar (7, 11) and are known for their laxative content (17), but the active components have not been identified (7). There is interest in this fruit crop as a nutraceutical product. Some hardy kiwifruit contain actinidin a protease that can cause an allergic reaction in some individuals, perhaps 2-3% of the population (7). Also, fruit can be high in calcium oxalate. In fresh fruit, although these crystals are covered with a gelatinous material and thus are usually not noticeable, they may be evident in some processed products and be an irritant (7).

Fruit go through an initial phase (35 to 40 days after flowering) of rapid increase in fruit volume, followed by a period of reduced growth, which may coincide with seed hardening (from 35 to 50 days after flowering). Fruit thereafter increase in volume perhaps as a result of cellular expansion, and reach maximum size approximately two weeks to one

month prior to harvest, depending on harvest criteria (14). Hassall et al. (10) reported that *A. arguta* in New Zealand reached 80% of final size by 40 days after flowering. Fruit mature in late summer to autumn, 100 to 110 days after flowering, depending on region, with firmness decreasing in the later stages of ripening (11, 20). Kiwifruit are climacteric and are very sensitive to ethylene gas; in fact ethylene gas can be used to induce ripening.

Seed number per fruit in 'Ananasnaya' ranged from 7 to 219, with a mean of 70 seeds (14). Tiyaon and Strik (22) reported an average of 151 seeds/fruit and a linear relationship between seed number and fruit weight in 'Ananasnaya'. In contrast, Pescie and Strik (14) found a quadratic relationship between fresh fruit weight and seed number, likely because there were more fruit in their study that were small with relatively few seeds.

Fruit size and quality are the most important characteristics affecting price and marketing of kiwifruit. Variable fruit weight is a problem in hardy kiwifruit (22). The highest quality fresh market fruit are uniform in size and weigh more than 6 g; also, fruit that have a minimum diameter less than 1.7 cm are often considered unmarketable (Hurst, pers. comm.). From 11 to 18% of total yield may be unmarketable due to small size or fruit being too soft (14, 21, 22).

Fruit thinning of mature *A. deliciosa* 'Hayward' has reduced yield but improved fruit size and quality (1, 2, 3, 12, 16). The average yield of 'Ananasnaya' vines thinned to remove 50% of flower buds prior to bloom was significantly less than that of un-thinned control vines. However, marketable yield from vines thinned 15%, 30% and 50% was not significantly different from un-thinned, control vines. Thinning, regardless of severity, increased fruit volume by up to 27%, compared to control vines, but had no effect on percent soluble solids or seed number per fruit (14). Hand thinning, however, would not be economical in this fruit crop.

Yield

Total yield of 'Ananasnaya' ranged from 14 to 45 kg/vine in four to five-year-old commercial vineyards in Oregon (14, 21, 22). Vines are not considered mature until year seven or eight. Total yield of 'Ananasnaya' grown at the NWREC has ranged from 30.2 to 73.4 kg/vine (13 to 31 t/ha; 6 to 14 t/a; Table 1). Yield and fruit size are very much affected by pruning severity (Strik, unpublished).

Production Systems

Commercial production of this crop is relatively new and production practices for hardy kiwifruit have been adapted from those of *A. deliciosa* 'Hayward' with a little modification based on recent research and grower experience (20).

A. arguta is a vigorous, perennial, deciduous vine that must be trained to a support structure in commercial production. The most common trellis support used worldwide is the pergola; however, many growers feel that 'Ananasnaya' is more easily pruned when trained to a "T-bar" system (20). In heavily shaded canopies, growers have observed pre-mature fruit softening at a relatively low °Brix and fruit are thus unmarketable – this problem is much reduced when canopies are well pruned to improve light exposure to fruit (Strik, personal observation). Lighter shade

(45% shade cloth) did not impact fruit quality, although it did reduce flower bud initiation and thus next year's crop (23).

Plants are most commonly established at a spacing of 4.6 x 4.6 m (15 x 15 ft.) equal to 480 total plants and 425 female plants per hectare (172 plants/a). Commercial growers often plant hardy kiwifruit on raised beds to help avoid problems with phytophthora root rot (*Phytophthora cryptogea* Pethybr. & Laferty).

Commercially, fruit are generally once-over harvested by hand at an average percent soluble solids of 8-10% (20, 22). In New Zealand, new selections of hardy kiwifruit were found to be ideally harvested at 20% dry weight – fruit harvested earlier developed storage disorders and did not reach as high °Brix when ripened (26). Growers in Oregon sample fruit and use average °Brix to decide harvest date, which typically occurs in September. When harvesting at average 8-10 °Brix most fruit are still green and firm, although a small percentage (generally less than 4% of total yield) are very soft and unusable (22). Fruit cannot be harvested vine ripe as it is then too soft to handle or store and often the fruit tears at the pedicel-fruit juncture when harvested. At the NWREC, fruit reached a typical commercial harvest °Brix (8 to 10) on 21 Sept. However, vine-ripened fruit continued to

Table 1. Yield of hardy kiwifruit (*A. arguta*) at the North Willamette Research and Extension Center, Aurora, Oregon. Vines were all planted in 1990. (n=3; "na" = data not collected)

Cultivar	Yield (kg/vine)					Fruit weight (g)				
	1996	1998	1999	2001	2002	1996	1998	1999	2001	2002
<i>Actinidia arguta</i>										
Ananasnaya	23.0	73.4	48.0	30.2	33.1	11.4	6.6	7.2	7.4	10.7
Issai	13.1	47.5	na	27.6	na	5.6	3.2	na	7.5	na
74-49	na	63.7	na	na	na	na	6.1	na	na	na
<i>A. deliciosa</i>										
Hayward	na	43.8	na	na	na	na	72.8	na	na	na

increase in °Brix to 21 to 23%, depending on cultivar (Fig. 1).

Fruit are immediately cooled (to 1 to 2°C) after harvest and are sorted with culls (usually scarred fruit) removed and then remaining marketable fruit sorted for size. Packing varies by shipper, but typically clam shells are used. Low vent packages reduce desiccation of fruit compared to traditional, vented clam shells used for berry fruit (9). Fruit remain in cold storage, under relatively high humidity, with ethylene gases scrubbed to retard ripening. Before shipping to consumers, some treat fruit with ethylene to trigger ripening. However, fruit also ripen well when brought to room temperature after a period of refrigeration. Fruit can be stored for four to eight weeks, depending on the storage conditions (predominantly temperature, ethylene, and humidity). There has been little work on controlled atmosphere storage of hardy kiwifruit published.

The variable fruit quality (fruit size, °Brix, firmness, and subsequent flavor), relatively short storage life compared to 'Hayward',

short harvest season, and desiccation during shipping or in stores are the major problems related to fresh marketing hardy kiwifruit. Variability in fruit size can be reduced with good pruning and ensuring good pollination (20). In cases, where male vines were damaged by frost injury in spring while female vines produced flowers, commercial growers have used *A. deliciosa* pollen, available for purchase, to artificially pollinate the female flowers. Fruit harvested at 9° Brix and treated with an edible coating (SemperFresh™) had reduced weight loss and had a more favorable appearance or glossiness to the fruit (9).

Production problems

Phytophthora root rot, identified as *Phytophthora cryptogea* in Oregon, has caused death of mature vines, particularly in wet soils and plantings without raised beds. Fruit rot (*Botrytis cinerea* Pers. Fr.) has been observed in cases of less-than-ideal or longer-than-recommended storage conditions. No disease or insect pest has been found associated with shoot tip die-back that is observed in the sum-

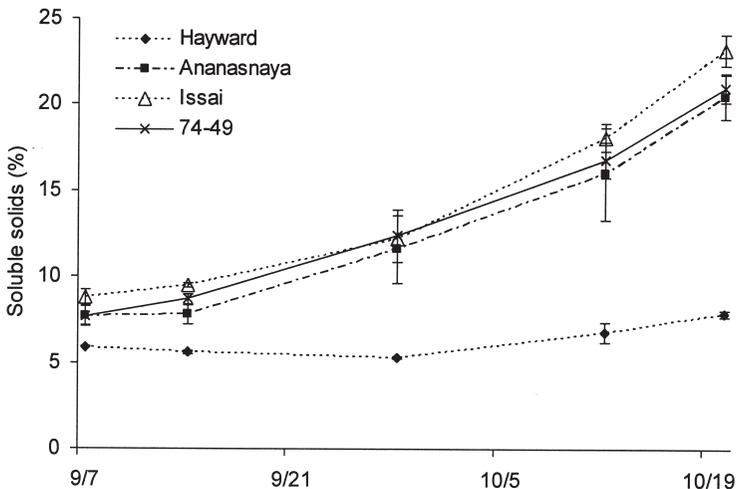


Fig. 1. Changes in percent soluble solids (°Brix) of *Actinidia arguta* ('Ananasnaya'; 'Issai'; 74-49) and *A. deliciosa* cv. Hayward at the North Willamette Research and Extension Center, Aurora, Oregon, 1994. Points are mean \pm SE (n=3).

mer. Most fruit scarring observed is likely related to mechanical or wind damage during fruit development. However, various species of thrips (*Franklinia* sp.) may cause scarring of fruit also.

Plant availability

‘Ananasnaya’ is available from more than 16 nurseries (5) throughout North America. The US Department of Agriculture, Agricultural Research Service, National Clonal Germplasm Repository at Corvallis, Oregon, preserves this cultivar. Limited quantities of scionwood are available for research by request from the curator (K. Hummer).

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