

The Chinese Gooseberry (*Actinidia chinensis*) in New Zealand

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The Orient is the home of numerous plants which are basic foods for many people, and it has provided many interesting and unusual fruits to add variety to our diets. Such a fruit is the Chinese gooseberry, *Actinidia chinensis* Planch., or Yang Tao as it is known in China, its native land. Though long known and widely distributed in China, the Chinese gooseberry has become available to the occidental world only in comparatively recent times (3, 8). Details of the spread of this fruit in China and its introduction to other parts of the world are as yet not well-known or documented, but from various reports in the literature it would seem that it has been tested and can be grown with varying degrees of success in parts of England (33, 35), Japan, Belgium, France (15), India, Germany, Russia (27), the United States, and New Zealand. Nowhere in the occidental world, however, has the Chinese gooseberry attained the degree of commercial development and general acceptance that it presently enjoys in New Zealand. In 1964 there were about 210 acres of Chinese gooseberries under commercial cultivation in New Zealand, producing 840 tons of fruit in that year. There is reason to believe that the industry will continue to expand steadily.

Actinidia chinensis was first introduced into New Zealand, probably by Mr. Allison of Wanganui, who obtained seed from a friend in China about 1906. Seedling vines from this source produced their first fruits in 1910, and all the varieties or strains at present utilized in New Zealand originated by selection from these fruits. Pioneer growers, including W. Wightman, Fred Walker, N. Gorton, Frank Mason, and espe-

cially Bruno Just, raised many seedlings from which several superior fruiting types were selected and first propagated about 1930 (31). These better clones included several of the presently important varieties.

The potential of the Chinese gooseberry as a commercial fruit crop was seriously considered about 1940 when several plantings came into production in the North Island. Development of the industry was slow during the next few years with war efforts diverting these interests to other problems. With the resumption of normal trade after the war, interest in the fruit was renewed and further attempts were made to exploit the plantings already developed. The center of activity in this endeavour was, and still remains, in the Te Puke area of the Bay of Plenty on the eastern coast of the North Island about 160 miles from Auckland. The majority of the larger commercial plantings and the major production are now centered along No. 3 Road, Te Puke, but there are many other smaller plantings centered throughout the North Island, particularly near Auckland and again in the North at Kerikeri in the Bay of Islands on the eastern coast. Most of the plantings are small areas ranging from 1 to 10 acres, usually grown in conjunction with citrus or other subtropical fruits such as tree tomatoes. (*Cyphomandra crassifolia*—syn. *C. betacea*) and passion-fruit (*Passiflora edulis*) (12).

The locations, especially the Bay of Plenty, where Chinese gooseberries are being grown in New Zealand appear to be climatically very well suited for this fruit. In winter (July) mean daily minimum temperatures range from 40-42°F and mean daily maximum temperatures from 57-60°F. In summer (February) mean daily minimum temperatures range from 56-57°F and mean daily maximum temperatures from 75-77°F. Rainfall is generally well distributed and

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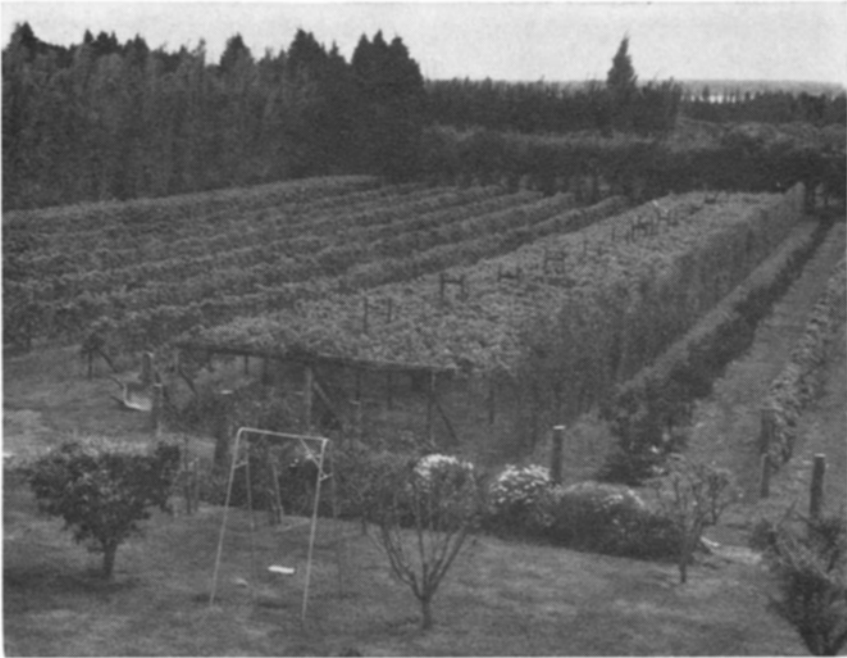


Fig. 1. *Actinidia chinensis*, Chinese gooseberry, trained on vertical trellis (left) and on pergola type support (right), New Zealand.

averages from 51-64" per year. Annual relative humidity varies about a mean of 76% to 78% and there are about 2000-2300 hr of bright sunshine per year. Although the vines are deciduous and can withstand hard winter frosts, their young spring growth is very tender and is readily injured by even light frosts which may reduce or prevent setting of fruit. Even moderately light frosts will also damage and spoil fruit maturing on the vines in winter.

History

Actinidia chinensis was probably discovered by Robert Fortune who brought herbarium specimens to Europe about 1847 upon return from his extensive travels in China on behalf of the Royal Horticultural Society. This same expedition resulted in the introduction to Europe of numerous other species including many citrus fruits and the famous kumquat *Fortunella japonica* which name honours this great plantsman. The introduction of the species into cultivation in England in 1900 is credited to E. H. Wilson (33). A report of the Royal Horti-

culture Society in 1904 indicated "it grows freely in England." The earliest record of the species in the United States may be that of 1904 when the United States Department of Agriculture listed the introduction of seed (2). The species was in fruit in California in 1910 (9, 10). Other botanical relatives were introduced into the United States prior to 1900, such as *A. kolomickta*—1855, *A. arguta*—1874, *A. polygama*—1866, and somewhat later, *A. callosa*—1907. David Fairchild the famous American plant explorer produced in 1923 a hybrid between *A. arguta* female using *A. chinensis* pollen (11). Since that time only occasional reports record the presence of *Actinidia* spp. in various northeastern states and in California. A collection of these species and seedlings of *A. chinensis* has been maintained at the United States Department of Agriculture Introduction Station, Chico, California, for many years. Successful fruiting of the vines has been observed at this station and at several other localities in California since their introduction in 1910. Recently the more important varieties of *A. chinensis* from



Fig. 2. Pergola training of *Actinidia chinensis* showing vertical (wall) leaders and horizontal (roof) branches in leafingout stage.

New Zealand have been established in California for trial.

Actinidia chinensis has been grown successfully in Washington, D. C., and its close botanical relative *A. arguta* has proved hardy in New England (14). Temperatures of -30°C have been tolerated by the dormant vine and winter survival of -16°C is reported in France.

Among the several species of *Actinidia* which have been introduced into Europe and the United States for trial, only *A. chinensis*, *A. arguta* and *A. kolomickta* have proved of much promise because of their edible fruit. Fruits of the other species appear to be inferior, but their vines have ornamental value.

Description of the Species

Actinidia chinensis is a vigorous deciduous vine or twining shrub, covered with multi-cellular hairs which are bright red on the young leaves and branches, becoming brown on the mature plant parts, including

the fruit. The pith is solid. The alternate broad orbicular oval or cordate long stalked leaves are somewhat coriaceous to firm in texture, glabrous and green above and whitish beneath. The winter buds are encased in the swollen base of the petiole.

The very attractive flowers, $1\frac{1}{2}$ to 2 inches across, are cream-coloured and borne in axillary cymes in groups of three or sometimes singly. The plants are essentially dioecious. Each flower has five or six imbricate sepals and five or six convolute petals. The fruit, a berry, develops from a central, many celled, superior ovary. On staminate vines the flowers have a vestigial ovary which is surrounded by numerous stamens. On pistillate vines the ovary is also surrounded by numerous stamens, but in New Zealand no viable pollen has ever been found to develop from these stamens. Occasionally a few staminate type flowers may also be found on pistillate vines, but no viable pollen has been found in such flowers. Wind and insects appear to be important in the pollination of Chinese



Fig. 3. Standard vertical trellis training of *Actinidia chinensis*, Te Puke, New Zealand.

gooseberries. The genus name *Actinidia* is derived from *Aktec* (Gr. = ray) referring to the numerous radiating divisions of the style which terminates the pistil and which is rather persistent throughout the development of the fruit.

Taxonomy

The genus *Actinidia* is presently placed in the family Actinidiaceae (18). There are some 20 species in the genus, all of East Asian origin extending from Java up into the Himalayas. Perhaps seven species are commonly cultivated in different parts of the world for their attractive vines and at least three for their edible fruit.

Members of the genus *Actinidia* have been identified in tertiary vegetation of 60-70 million years ago (22). *Actinidia polygama*, as well as *A. foveolata* (now extinct), has been associated with Tiglian deposit from Kroszowka, Poland. *Actinidia arguta*, which produces an edible fruit, was described in 770 A.D. (23). This species, commonly called Vover Actinidia or Tara vine, has a sweet greenish yellow fruit about one inch long. It

has been cultivated in Europe and other countries for more than a century. *Actinidia polygama*, the silver vine, produces a small yellow fruit of poor quality, about one inch long. *A. kolomickta* is another climber with a greenish fruit about one inch long. While several of the species are utilized for their attractive ornamental foliage, only two, *A. chinensis* and *A. arguta*, are presently grown primarily for their fruits.

The Chinese gooseberry has been used as a common name for the fruit of *Actinidia chinensis* Planch. Other vernacular names are Kiwi berry, or in the Orient, the Yang Tao. The names sheep peach, monkey peach and occasionally Ichang gooseberry have been applied to this fruit. The name Mao-erh-tao is used in Szechuan. There is currently some dissatisfaction and confusion concerning a suitable common name but apparently "Chinese gooseberry" may become the most widely acceptable.

While *Actinidia chinensis* has received some attention in recent taxonomic and economic studies, it actually was described in



Fig. 4. Single young vine of *Actinidia chinensis* on trellis, Te Puke, New Zealand.

old Chinese literature, Chiu Huang Pen T'sao, in the 15th Century (26).

Varieties

Until a few years ago, considerable confusion existed in New Zealand concerning the identity of different Chinese gooseberry strains, which were generally propagated and sold under descriptive names such as large-fruited, giant, large, long, etc. In 1958 (20), following a comprehensive survey of Chinese gooseberry plantings throughout the country, variety names were published for types which showed most promise for commercial production. The main varieties named and described were Abbott, Bruno, Hayward, Allison, and Monty, but several others have also been included for study in a variety collection by Fruit Research Divi-

sion, Department of Scientific and Industrial Research, Auckland.

Hayward is an extra large-fruited variety which is also superior in flavour and keeping quality to any other types at present available. Because of these qualities, this variety is becoming the most popular for planting despite a tendency for it to produce lighter crops than other varieties. Hayward is now used exclusively for export shipments of Chinese gooseberries from New Zealand to the United States.

Propagation

Propagation of *Actinidia* by seed provides progeny plants which are highly variable in character. Many of the early plantings in New Zealand were from seed and showed great diversity of character. Certain plants

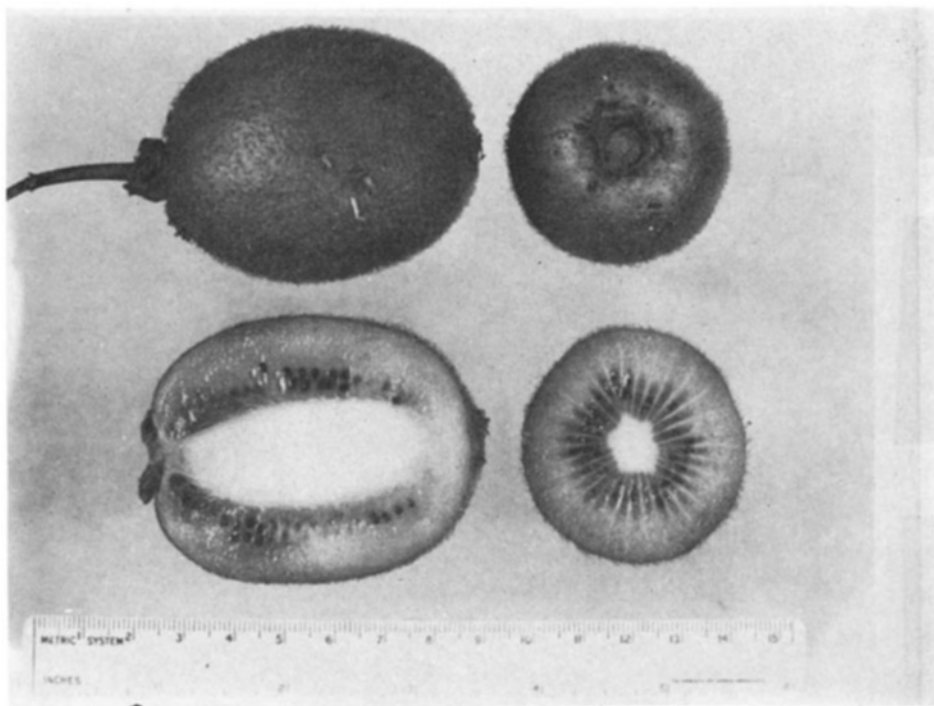


Fig. 5. Fruit of *Actinidia chinensis*.

among this highly heterogeneous group of seedling vines were soon noted to have superior quality fruit and bearing behaviour; hence, seedling selection was pursued which has resulted in the production of the major varieties so widely propagated in New Zealand and other areas today. Seedling propagation is no longer recommended for production of fruiting varieties but is still a suitable source for root-stock material on which selected and superior varieties can be grafted.

Layering of selected plants is sometimes used successfully for reproducing superior types. The use of softwood or hardwood cuttings is possibly more suitable for more economical and rapid multiplication of some varieties.

Top-working of old seedling vines is commonly practiced to increase a given variety or to change old and less adequate varieties to improved or new types. The use of cleft grafts has been found successful. Top-working is frequently done to establish stam-

inate limbs on old pistillate vines in order to improve the chances for pollination. Appropriate pollen-bearing clones must be selected which coincide in their bloom and anthesis with the pistillate clone. Several such pollinator clones are now available.

Training

The vines are generally planted in rows and growers normally employ either of two training procedures. The single, double, or treble wire vertical trellis is commonly employed in which the branches are trained along a single wire in both directions from the vertical main plant stem (6, 7, 24). This requires tying the vine at intervals along the wires and occasional pruning or directing by hand of the vigorous shoots which otherwise fall to the ground. The trellis rows are spaced at 10 to 15 ft and may be up to 200 yards in length. This fence or trellis type of training is more suitable for large areas and yields of 10 tons per acre are commonly obtained with this system.

The second type of training employs a flat-topped pergola to support the vines. Usually pergolas are about 20 ft wide and about 6 ft high and they must be solidly constructed to support the weight of the vines and heavy crops. The vines are planted about 25 to 30 ft apart in a row down the center line of the pergola. Training consists of bringing the vines up on a single stem until they reach the top of the structure; then one or two main leaders are trained lengthwise along the center of the pergola. From these leaders, laterals, spaced at intervals of about 2 ft, are then trained at right angles along parallel wire supports towards the sides of the pergola. Fruiting spurs are allowed to develop from the roof laterals, but excessive foliage and vigorous suckers are kept under strict control by constant pruning to prevent overcrowding. The heavy, pendulant fruit hangs from the ceiling of vines and is picked from inside the pergola.

To ensure adequate pollination, staminate laterals are grafted onto each vine in the ratio of one for every two pistillate laterals covering the pergola roof. This type of training has proved very effective and provides excellent production from a limited area. Annual production of 800 lb of fruit per vine is common, and a yield of 1500 lb per vine of the Abbott variety has been recorded.

Pruning

Annual winter pruning of Chinese gooseberry vines is essential for regular crops of good quality fruit (24). If pruning is neglected, the result is a tangled, twisted mass of growth, producing small inferior fruit of little value.

Chinese gooseberry fruits are produced only from the first three to five buds on new shoots of the current season's growth, and in pruning the bearing vine each winter the aim is to remove as much as possible of the old horizontal canes which have borne fruiting laterals and replace them with suitable new canes which developed in the previous season. Complete replacement is seldom possible as the vines do not always send out suitable new canes from, or near, main stems. It then becomes necessary to thin out laterals that have arisen from the portion of



Fig. 6. Fruit clusters of Bruno variety, *Actinidia chinensis*.

the old cane that cannot be replaced and to shorten the laterals selected to two buds beyond where the last of the previous season's fruit was borne. One of these buds develops into growth which fruits in the new season.

During summer some shortening of fruit bearing shoots is desirable to prevent tangling and overcrowding. Vigorous growth suitable for replacement canes should be selected during the summer and tied down temporarily, and any unwanted new canes should be suppressed.

A 'spur' pruning system is more often practiced on pergola trained vines and sometimes on fences. Essentially, this method consists of training a carefully spaced system of more or less permanent leaders and sub-leaders over the pergola or fence and continually representing the growth of laterals developing from these leaders during the growing season to form fruiting spurs. As the spurs increase in size over several seasons, they are replaced from time to time by cutting back to basal buds during winter pruning. This system requires a lot of time and constant attention during the growing

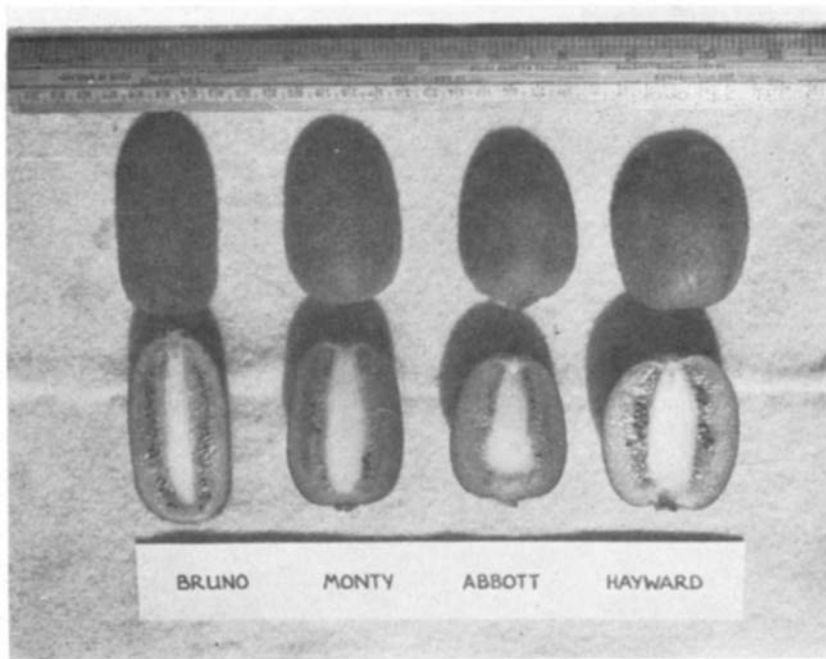


Fig. 7. Horticultural varieties of *Actinidia chinensis* grown in New Zealand.

season and is only practicable for small, intensively cultivated areas.

Orchard Nutrition and Soil Management

In New Zealand, Chinese gooseberries seem to prefer the deep, naturally well-drained, light-textured soils of the Bay of Plenty, but they will succeed on any well-drained soil. Like many other fruit trees, Chinese gooseberry vines are sensitive to excessive soil moisture, and poor drainage, if prolonged, will kill the vines.

The main soils used for Chinese gooseberries in New Zealand are naturally deficient in available plant nutrients and organic matter, and fairly heavy applications of fertilizer are applied to maintain the vigorous prolific vines in good condition and to produce large good quality fruit. On mature vines, nitrogen is applied at rates of up to 200 lb per acre annually. Phosphoric and potassium fertilizers are also commonly applied at rates of about 90 lb P_2O_5 per acre and 50 lb K_2O per acre. Normal practice is to apply fertilizers in two equal dressings in

spring and early summer.

To maintain the organic content of the soil, cover crops such as blue lupines or oats may be sown, but more generally a natural weed cover is allowed to develop through the autumn and winter. Many orchards are maintained in permanent sward kept well mown during the summer. Mulching is also often employed, especially with pergola trained vines.

Supplementary irrigation is not common but is applied in some areas. Without ample soil moisture during summer, fruit size of Chinese gooseberries can be seriously reduced.

Diseases and Pests

As with many newly introduced crops, the *Actinidia* plant and fruit is presently remarkably free of serious pests and diseases. Reports of occasional fungi found on *Actinidia* species have been made in Russia and Japan (1, 16, 17), and crown gall is reported to attack the plant in New Zealand (5). Control measures are sometimes necessary in New Zealand against leaf roller caterpillar *Ctenopseustis obliquana* to prevent damage



Fig. 8. Standard New Zealand commercial pack of *Actinidia chinensis* fruit for the export market.

to the fruit, but no other serious insect pests have been reported to bother the fruit or vine.

Harvesting and Handling

It usually takes 3 or 4 years for a Chinese gooseberry vine to start bearing worthwhile crops. In New Zealand the first fruits of the season are normally ready for picking early in May, and harvesting continues until early July when winter pruning of the vines must be started. The berries are still hard when harvested and must be allowed to ripen and soften for eating off the vine, in much the same way as with pears.

Chinese gooseberries have excellent keeping quality. Wastage from fungal rots is rare. Losses during storage are mainly due to over-maturity and fermentation breakdown. The fruit can be held for up to 8 weeks in good condition in common storage in a cool draught-free place and for more than four months in cool storage at 31-32°F and 90% relative humidity (13, 21). Fruit harvested between mid-May and mid-June

has been found to have the longest storage life. Optimum storage is obtained by holding Chinese gooseberries alone in a chamber. Storing the fruit with apples or pears has been found to drastically reduce its storage life—probably due to ripening effects of ethylene given off by the apples.

Chinese gooseberries are normally packed and marketed locally in wooden 'half-cases' containing about 20 lb of fruit. For the export trade to Britain, Australia and North America, a single layer wooden tray containing about 7 lb of fruit encased in a polythene liner is normally used. In 1964 more than 80 tons of fruit were exported to markets in these countries where it has generally been well received.

Biochemistry

Several biochemical studies on *Actinidia* fruits and plant parts (4, 19, 25) have revealed the presence of oxidative enzymes of considerable interest. A proteolytic enzyme, actinidin, which prevents jelling, has been purified from ripe fruit of *A. chinensis*



Fig. 9. Flowers of *Actinidia chinensis*, staminate (left) and pistillate (right).

(4). This substance has the properties of tenderizing meat by attacking the fibrous protein. It remains active as a powder extract, hence, has potentialities as a commercial meat tenderizer.

Analyses from several different sources indicate that the fruit is generously supplied with ascorbic acid or Vitamin C, in some cases up to 300 mg per 100 g of fruit which is higher than most citrus fruits. Other general analyses indicate that the fruit contains 9.0-10.2% total sugar, 1.29% acid, 1.6% protein, 0.95% tannins and 18% dry

matter. Some of the species have medicinal properties in their plant parts. Mucilage is obtained from the inner bark of *A. rufa*.

A very interesting substance which attracts cats and other feline animals, including lions and tigers, has been isolated and described from several species of *Actinidia* (28, 29). The leaves of *A. polygama* in particular contain two substances, actinidine, a base, and another lactone equal to isidomyrmecin. The chemical structure of these substances has been determined and some of the properties described. The feline

animals will sometimes destroy small plants and seriously injure large plants in an attempt to obtain this irresistible substance from the leaves and bark.

Utilization

The most prevalent current use of the fruit is as a dessert fruit in the fresh form (30). The brown, pubescent skin is removed and the fruit sliced and served alone or with cream. Fruit salads are enhanced in flavour and attractiveness by the brilliant green colour of the diced or sliced fruit segments. One particular use of sectioned Chinese gooseberry fruit in New Zealand is as a topping decoration for the celebrated dessert 'Pavlova,' the delicious *pièce de résistance*, a delightful meringue with whipped cream for which this country is noted.

Preserved whole fruit or segments in glass or cans has provided a most attractive product for use in many culinary decorations.

Various products and by-products are obtained from the fruit. These include wine, liquor, and a highly aromatic jam. An attractive marmalade and a fruit paste also have been manufactured.

Local uses of the plant, particularly in China, its native home, have included that of rope and string made of the scraped vine (32). A satisfactory paper can be made from the bark and leaves. Small sections of the bark are removed intact, placed in hot ashes, and then used as pencils. A decoction of branches and leaves has been used for cure of mange in dogs.

The ornamental value of the vine has sometimes been utilized in landscape design. Proper pruning of vines will allow them to be cultivated in comparatively limited areas. When allowed to develop uncontrolled, however, a vigorous vine may easily envelop a small or medium-sized tree or may cover a small house completely.

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