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'Cortland' Apple

ROGER D. WAY AND SUSAN K. BROWN[1]

'Cortland' is one of the few apple cultivars of hundreds originating from controlled apple breeding programs early in the 20th century that was good enough to become extensively grown on a commercial scale. In 1923, it was awarded the silver Wilder Medal by the American Pomological Society (58). By 1965, 50 years after its introduction, 'Cortland' had become the third most important cultivar grown in New York State, which was then the second most important apple state in the U.S.; 'McIntosh' and 'Rhode Island Greening' being the two leading cultivars. Although its importance declined in the latter half of the century, in mid-century it was the most important apple cultivar introduced from Geneva; later, 'Jonagold' and 'Empire' surpassed it.

Origin.

'Cortland' was bred and introduced at the New York State Agricultural Experiment Station, Cornell University, Geneva, NY. It was released from the extensive apple breeding program that began there in 1895 and has now continued for more than a century (60). 'Cortland' resulted from the cross, 'Ben Davis' X 'McIntosh', made by S.A. Beach in 1898, and was selected in 1911 from a population of 11 seedlings. 'Cortland' was introduced in 1915 along with five other apple cultivars. It was the first product of this apple breeding program. It was named for Cortland County, New York.

The breeding work that led to the origin of 'Cortland' was described by Hedrick and Wellington (28), and the introductory descriptions of 'Cortland' were first published by Hedrick (24, 25, 27). Nursery trees were first distributed to fruit growers in 1915 (24). In 1952, 'Cortland' was briefly described in the Register of New Fruit and Nut Varieties (12).

Tree.

Shaw (52) described in minute detail the vegetative characteristics of young 'Cortland' nursery trees so they could be distinguished from other cultivars.

Mature 'Cortland' trees are large, vigorous, spreading, drooping, medium dense, round-topped, annual bearing, and very productive. The trunk is stocky, brownish gray, and uncommonly smooth, with very little shaggy bark. Because of its terminal bearing habit, many forked shoots occur, and the twigs are long and thin, almost willowy. As a result of this willowy growth habit, 'Cortland' trees are more difficult to prune than trees of most other apple cultivars.

Winter Hardiness and Frost Resistance.

'Cortland' trees are resistant to severe winter cold. In New York, following the severe winter of 1933-34, trees of 'Cortland', like its parent 'McIntosh', survived without injury (1, 2). At Ottawa in the same winter, 25% of the branches on 'Cortland' trees were killed by the severe cold (9). In eastern Canada, 'Cortland' had a total winter injury of 83%, compared with 80% for 'McIntosh' and 97% for 'Early McIntosh'(9).

During the November, 1940 cold period when many fruit plants were severely damaged in the Plains States, 'Cortland' trees escaped without injury in Illinois (33); in Kansas where 200 apple cultivars were evaluated for injury (46), trees of 'Cortland' were less hardy

[1]Department of Horticultural Sciences, New York State Agricultural Experiment Station, Cornell University, Geneva, NY 14456.

than 'Milton', but showed 70 to 90% recovery. Following the severe 1947-48 winter in Minnesota (11), bud and spur killing was 29% on 'Cortland', compared with 61% on 'McIntosh'.

After a severe freeze in British Columbia in 1966, fruit spurs of 'Cortland' were classified as hardy, while those of 'McIntosh' were very hardy (36). Because of its very winter hardy tree, 'Cortland' is a popular cultivar in very cold regions such as Quebec and New Brunswick. It can be grown in USDA hardiness zones 4 through 6.

'Cortland' blossoms were markedly more resistant to cold injury than those of 'Delicious' or 'Wealthy' in one study (49).

Pollination.

'Cortland' blooms in mid-season (30, 56) with 'Delicious'. It is diploid (34 chromosomes) and its pollen is viable (63).

Knowlton (35) found that 'Cortland' produced smaller quantities of pollen (1,900 pollen grains per anther) than 11 other cultivars. 'Delicious' was the most prolific with 9,675 grains. It cannot be concluded from this, however, that 'Cortland' is a poor pollen donor.

MacDaniels and Burrell (41) reported that 'Cortland' pollen resulted in satisfactory fruit set, but was less effective than 'Delicious' pollen. In other tests, 'Cortland' lacked the capacity to set fruit when self-pollinated but was interfertile with 'McIntosh'; 75% of 'Cortland' pollen germinated, compared with 89% of 'Delicious' and 9% of 'Baldwin' pollen (42).

Using 'Cortland' pollen, MacDaniels and Heinicke (42) found the following percentages of commercial crop were set, a rating of 100% being a good, heavy commercial crop of fruit: 'Cortland' X 'Cortland', 5%; 'Cortland' X 'Delicious', 130%; 'Rhode Island Greening' X 'Cortland', 150%; and 'McIntosh' X 'Cortland', 137%. Thus, 'Cortland' pollen on 'McIntosh' gave satisfactory fruit set and resulted in an average of 5.3 seeds per fruit (14).

Although 'Cortland' is self-unfruitful, it is cross-compatible with its parent, 'McIntosh', and its half sibs, 'Milton' and 'Macoun' (37). Self-incompatibility in apples is almost universal but one of the few known cases of pollen cross-incompatibility between two apple cultivars is 'Cortland' X 'Early McIntosh' and the reciprocal (62). In this study, 'Cortland' was again found to be cross-compatible with 'McIntosh', 'Melba', 'Milton', and 'Macoun', all related to 'Cortland'.

'Cortland' trees are precocious and annual in bloom, making them good pollinizers for many cultivars. In New England, 'Cortland' is used mainly as a pollinizer for 'McIntosh' and 'Delicious' (47).

Oversetting of 'Cortland' blossoms can be prevented by applying thinning sprays within 3 weeks after full bloom using 35 to 50 parts per million of naphthalacetamide (23). Today, naphthaleneacetic acid is more commonly used than naphthalacetamide.

Fruit.

The average ripening date for 'Cortland' at Geneva, NY, is October 7 or 3 days earlier than 'Delicious'. The average number of days from full bloom to harvest is 142.

Unlike 'McIntosh' fruits, which drop severely just before they ripen, few 'Cortland' fruits abscise at maturity, even after they become overripe (40). Most commercial fruit growers who grow 'Cortland' also grow 'McIntosh'. Since the two cultivars ripen at about the same time, they should be harvested at the same time. However, because 'McIntosh' drops and 'Cortland' does not, growers tend to harvest 'McIntosh' before 'Cortland'. Thus, 'Cortland' fruits are often not harvested until overripe, and therefore do not store well. Continued marketing of large volumes of overripe 'Cortland' fruits for many years has resulted in the decline in popularity of this excellent cultivar.

The physical characteristics of 'Cortland' fruits, including fruit size, shape, skin, flesh, core and others, have been described in detail (61).

Dayton (19) found that the epidermal layer of 'Cortland' fruit skins has 60 to 95% of its cells pigmented. He also found that 99% of the cells in the outer hypodermal layer are pigmented (20).

The color requirements for 'Cortland' fruits in U.S. grades are U.S. Extra Fancy, 50% red; U.S. Fancy, 33%; and U.S. No. 1, 25% (38).

The Vitamin C content of 'Cortland' is intermediate between that of its two parents, 'Ben Davis' and 'McIntosh' (10). In one test (31), 'Cortland' contained 11 mg ascorbic acid per 100 gm fruit, compared with 37 for 'Calville Blanc' and 4 for 'McIntosh'.

Productivity.

'Cortland' is one of the most consistently productive of all important apple cultivars. In a comparative yield test on standard rootstocks in the Hudson Valley, NY (15), the average annual yield per tree in the 16th through the 20th year was 7.3 bushels, compared with 6.8 for 'McIntosh' and 2.3 for 'Wealthy', a biennially cropping cultivar.

In Ohio, yields of 31 apple cultivars on two types of tree frames were measured for a 21-year period and calculated as total yield per inch of trunk circumference (32). 'Cortland' ranked sixth in productivity, being surpassed only by 'Melrose', 'Turley', 'Staymared', 'Red McIntosh', and 'Golden Delicious'.

However, 'Cortland' fails to crop well in the UK(13). Nectria canker on trunks and limbs is a problem there. This illustrates how some cultivars are better suited for some areas than others.

Storage.

'Cortland' fruits keep rather well. However, bitter pit sometimes develops during storage. Storage life is about 120 days when held at 31° F. This can be greatly lengthened in controlled atmosphere (CA) storage, using 5% carbon dioxide and 3% oxygen (54). Lower oxygen levels (1.5%) are being used today for CA storage of many cultivars. Scald and sometimes carbon dioxide injury can occur in CA storage. Scald on 'Cortland' apples can be controlled by post-harvest dips of 500 ppm diphenylamine (53). Before DPA became available, 'Cortland' could not be stored in CA because of scald. Vapors from other ripe apples blown over preclimacteric 'Cortland' apples at 33° F did not stimulate their respiration or rate of softening (55).

Fruit Processing.

'Cortland' is unique among apple cultivars in that its flesh surface does not turn to a light brown color when it is exposed to air; it remains snow white. Thus, it is excellent for the making of apple salads. It is recommended by home economists for culinary and dessert purposes (22).

However, it rates low for processing quality (3). Nevertheless, many thousands of bushels are processed annually in New York because it is an inexpensive cultivar to produce and growers bargain with processors to purchase their 'Cortlands' along with high quality processing cultivars.

Diseases.

'Cortland' fruits and leaves are very susceptible to apple scab. Leaves are also highly susceptible to powdery mildew, especially in areas with mild winters. In a German study of this disease (50), 'Cortland' was severely attacked, while 'Lodi' was resistant. 'Cortland' is more susceptible to fire blight than 'McIntosh' but less susceptible than 'Rhode Island Greening' (29).

Crowell (16) compiled reports of the relative susceptibility of many apple cultivars to cedar-apple rust as grown at several experiment stations. 'Cortland' was slightly susceptible.

'Cortland' trees are resistant to collar rot (6) and they are also resistant to the oak wilt fungus (7).

Symptoms of the dapple apple virus have been observed on 'Cortland' (43).

Genetic Mutations.

A dark red sport of 'Cortland' was induced by Bishop (8) by treating dormant scions with thermal neutron radia-

tion. It was named 'Red Cortland' and is sometimes called 'Nova Red Cortland' (48). It is not commercially acceptable because many fruits have deep sutures on one side.

'Redcort', a red-fruited mutation discovered in the Hudson Valley, NY, in 1983 (5), is patented and is being planted in commercial orchards, to the exclusion of standard 'Cortland'. Its fruits are very similar to 'Cortland' but more of the skin is colored and the shade of color is much darker red.

'Spur Cortland', a spur type mutation, was discovered by a grower in Orleans County, NY, in 1974. However, its fruits are distorted in shape and trees are unproductive, thus it is not commecially useful.

Breeding Behavior.

In breeding experiments at Ottawa (57), 'Cortland' was a valuable parent for large fruit size, low acidity, yellow flesh, yellow ground color, and for fruit ripening in late October. 'Cortland' was only a moderately good parent for good overcolor, quality, and late keeping. In inheritance studies (34), 'Cortland' tended to transmit large fruit size, oblate shape, and mostly fair to good quality. In other breeding studies (17, 18), 'Sandow' X 'Cortland' seedlings were promising for late keeping cultivars.

In a Swedish breeding program (45), the cross, 'Zuccalmaglios Reinette' X 'Cortland', produced promising seedlings which were late ripening with good keeping quality, scab immunity, and cold hardiness.

Commercial Usefulness.

Nursery trees of 'Cortland' were sold by the New York State Fruit Testing Association, Geneva, NY, from 1921 to the early 1990s. In the 1960-68 period, 'Cortland' trees were sold by 57 nurseries — more commercial nurseries than any other Geneva apple introduction during this period. This is evidence of its widespread acceptance.

The average annual production of 'Cortland' in the U.S. in the 1947-50 period was 2,500,000 bushels, rising to 3,800,000 bushels in 1962-65. The National Apple Institute ranked 'Cortland' as the 10th most important U.S. apple cultivar in 1964 (4) and 11th in 1966 (21). In 1995, 80 million pounds (nearly 2 million bushels) of 'Cortland' were produced in New York (51), making it the 6th most important apple cultivar in the State. In descending order of importance, the other 5 were 'McIntosh', 'Rome', 'Delicious', 'Rhode Island Greening' and 'Empire'. 'Cortland' production is regional with most of the crop being produced in the Northeast. Michigan growers, for example, produce few 'Cortlands'. According to E.C. Wilcox, the 1952 'Cortland' crop was 75% from New York and Pennsylvania and 13% from New England; Ohio and California were other important producers that year (59).

Compared with 'McIntosh', 'Cortland' fruits ripen a little later, hang on the tree much more tenaciously, keep longer in storage, bruise less in handling, are larger, and are brighter in color (26). Because of these outstanding attributes, 'Cortland' is still recommended for planting in New York and New England and is still popular with growers and consumers over 80 years after its introduction. It is a variety that has withstood the test of time.

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Improving Skin Color of 'Fuji' Apple in Japan

T. KIKUCHI[1], O. ARAKAWA, AND R.N. NORTON[2]

Abstract

Poor red coloration is often a serious problem in the culture of 'Fuji' apple. To overcome this situation, introduction of red sports and the practice of fruit bagging are widely carried out in Japan. This paper describes the selection procedures of red sport strains of 'Fuji' and the current tendencies of popular selections of them. Details of bagging are described along with information on some physiological characteristics of 'Fuji' fruit as related to its poor coloration behavior and responses to bagging.

'Fuji' is the predominant apple cultivar in Japan, accounting for about 50 percent of the total annual production (5). The high popularity of 'Fuji' is due to its good taste and excellent keeping quality. Unfortunately, however, 'Fuji' does not color well, which can be a serious problem, particularly in regions where weather conditions are not favorable for skin color development.

Increased red color can be accomplished by: (1) selection of naturally occurring, spontaneous sports or radiation-induced mutations; (2) a practice known as "paper bagging," which inhibits chlorophyll development in the skin and allows for anthocyanin development once the bag is removed several weeks before harvest; and (3), as with most other cultivars, management practices, e.g., irrigation, fertilization, pruning, thinning, etc. This paper will address the first two of these aspects — color sports or mutations and paper bagging practice and also the physiological bases for red color development in 'Fuji' apple.

Selection of Color Sports

'Fuji' was bred in 1939 from a crossing between 'Ralls Janet' and 'Delicious' at the Morioka Branch of the Fruit Tree Research Station in Aomori Prefecture. It was not until 1958 that the selection was made available for trial planting by growers. In 1962, it was registered and given the name 'Fuji' (10).

[1]Faculty of Agriculture, Hirosaki University, Hirosaki, Aomori-ken 036, Japan.
[2]AppleCorps, 700 13th Street N.E., East Wenatchee, WA 98802.