

QUALITY IMPROVEMENT IN APPLE BREEDING IN JAPAN

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ABSTRACT

In 1939, a systematic apple breeding programme began at the Morioka Branch, Fruit Tree Research Station from which the cultivars Fuji, Akane, Hatsuaki, Kitakami, Himekami and Iwakami have been produced. Fuji is much improved over Ralls Janet and has been widely planted in place of Ralls. It now occupies about 40% of the fruit growing area of Japan. Akane is of much better quality than McIntosh Red and has been renamed Primrouge in France and Prime Red in the USA.

In 1969, a cooperative project was initiated between DSIR in New Zealand and the Morioka Branch. Dr D.W. McKenzie made 13 cross combinations and 2439 seedlings were planted out at Morioka and eight promising early maturing hybrids were selected.

KEYWORDS

Japan, apple breeding, apple quality, appearance, improvements, fruit colour.

APPLE CULTIVARS IN JAPAN

The Modern Japanese apple industry is thought to have developed from 75 western cultivars which were imported from the USA in 1872. Until recently we have been wholly dependent on foreign cultivars such as Ralls Janet, Jonathan, American Summer Pearmain, Starking Delicious and Golden Delicious (Yoshida and Mink, 1974).

Ralls Janet and Jonathan were two leading apple cultivars between 1872 and 1965. Fuji and Starking Delicious became the leading apple cultivars in 1983 (Fig. 1).

BREEDING PROGRAMMES AT MORIOKA

In 1939, the first breeding programme was established to improve fruit quality and resistance to diseases. Forty two crosses were made among 18 varieties and 4656 hybrid seedlings were raised. In 1958 Tohoku #7 was selected from 596 fruit-bearing hybrids of Ralls Janet x Delicious. This variety was named Fuji and was registered by the Ministry of Agriculture and Forestry in 1962 (Sadamori, 1963).

Fuji is round-oblate or oblong, resembles Delicious in colour but is not as attractive. The flesh is very firm, very juicy, has a pleasant aroma, and like the Delicious is low in acid. The quality is excellent for dessert. Fuji matures in early or mid-November and often has a water core. It keeps well until late April in cool storage. Fuji has been widely planted in place of Ralls Janet and covers the greatest area (Fig. 1).

Akane was selected from the hybrid seedlings of Jonathan x Worcester Pearmain in 1970 (Sadamori, 1973). The average weight of Akane fruit is 180-200 g and the shape varies from round oblate to oblate. The colour is an attractive solid, bright red and the flesh is white, firm, juicy and sub-acid. The quality is excellent for eating and for canning. Akane matures in early to mid-September which is the McIntosh Red. Akane is recommended as a commercial replacement for McIntosh in Japan because of its superior appearance, quality and shelf life. However, Akane is not commercially cultivated in Japan because of its small size and acidity. It has been renamed Primrouge in France and Prime Red in the USA.

One selection, Hatsuaki, raised from Jonathan x Golden Delicious was registered as an early-middle season cultivar in 1976 (Yoshida, 1978). Fruit weighs 250-300 g. The colour is pale yellow with a bright rose red wash and dull red flecks. There is some rough russet around the basin. The flesh is yellowish white, firm, very juicy and crisp with a good texture. It has a pleasant, mild aromatic flavour and is sub-acid. Its dessert quality is excellent, and it is also useful for processing, especially as canned nectar. In Morioka, Hatsuaki matures at the end of September, just after Redgold and before Jonathan. It keeps for one month in cool storage. Hatsuaki is not cultivated in Japan because of its russet surface and rather high acidity.

The second breeding programme started in 1959, and produced 4665 hybrid seedlings from 144 crosses. Kitakami was registered in 1981 (Yoshida, 1982), and Himekami and Iwakami cultivars in 1985 (Yoshida, 1985 a, b).

The third breeding programme started in 1969 using New Zealand and Australian cultivars as cross parents. The objective was to breed an early-maturing cultivar. About 5180 hybrid seedlings were produced from 67 crosses. Part of this apple breeding programme is a co-operative project with DSIR in New Zealand. We sent apple pollen of

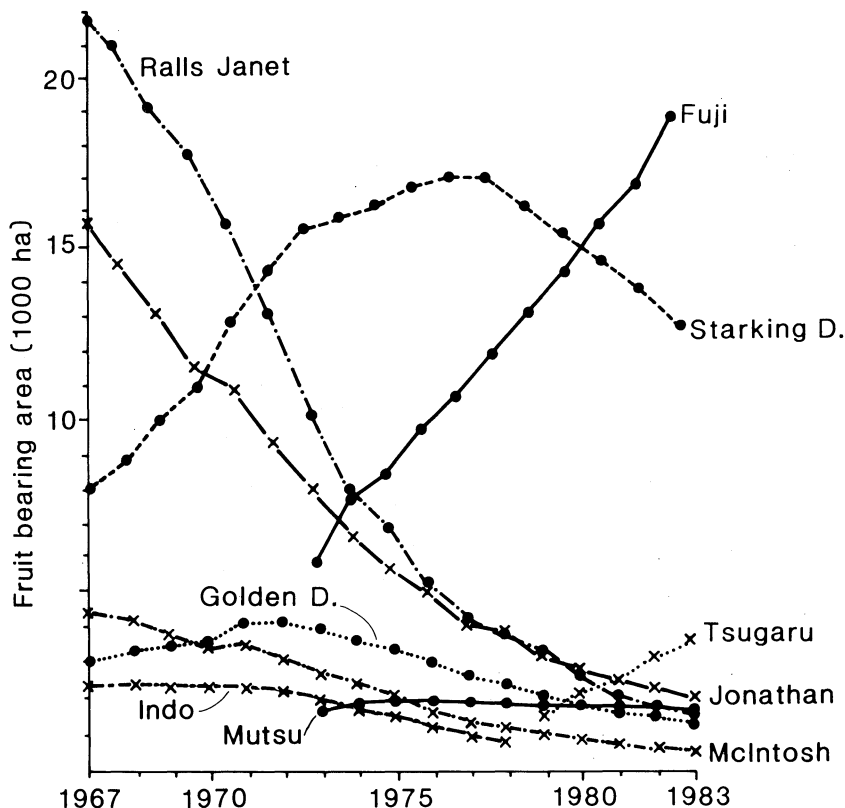


Figure 1. Changes in fruit bearing area of apple cultivars in Japan.

Japanese cultivars to Dr D.W. McKenzie and he made several crosses using the New Zealand cultivars as female parents. He sent back hybrid seeds to Morioka and we planted 2439 hybrid seedlings from 13 crosses. In 1977 Dr McKenzie stayed in Morioka for three months and selected several promising cultivars. We selected eight promising hybrids which ripen at the end of August and early September in Morioka. They were distributed for trial to experimental stations in each of the apple growing districts of Japan.

The fourth programme was initiated in 1976, and aimed at the improvement of Hatsuaki, using Hatsuaki as both the male and female parent.

The fifth breeding programme began in 1985 to improve Fuji.

QUALITY IMPROVEMENT

Quality includes many characteristics of the fruit flesh such as texture, hardness, juiciness, sugar and acid content, keeping quality, etc. Japanese like sweet apples like Fuji and do not like sour apples such as Akane, Hatsuaki,

Jonathan, McIntosh Red, Granny Smith, etc. Therefore, we must select sweet and big, brilliant coloured cultivars for breeding in Japan.

APPEARANCE IMPROVEMENT

The Japanese like a brilliantly coloured large apple such as Sekai-ichi (greater than 350 g). To produce big and brilliant apples unusual orchard management techniques are practised.

Pollination and thinning

Hand pollination is sometimes used to improve fruit set and fruit size. Hand thinning begins about 10 days after petal fall and may continue until early July in years of heavy fruit set. One central fruit every four to five terminal buds is left to make a big fruit.

Paper bagging

Paper bagging was first used to prevent disease and insect damage but it is now used mainly to produce fruit with a fine finish and a somewhat different or improved

colour. Paper bagging of certain cultivars begins as soon as thinning is finished. Bags are finally removed about one month before harvest. An average worker can bag about 3000 fruit per day.

Muslin tents

Just before paper bags are removed whole trees are covered with a muslin tent to prevent sunscald and to improve fruit colour.

Fruit rotation

To obtain a uniform colour, fruits are rotated periodically by hand to expose those areas shaded by branches or spurs.

Leaf thinning

Another common practise in Japanese orchards is leaf thinning before harvest to improve the red colour. Leaves that shade individual fruits are removed by hand.

Reflection of sunlight

Aluminum or silver foil strips are placed on each side of the tree rows to reflect light into the trees. This improves fruit colour.

Ground ripening

McIntosh Red and Tsugaru apples are often picked early because they tend to drop prematurely, and the final ripening is done on mats of rice straw on the ground. The fruits are placed on rice straw mats and sprinkled with water two or three times per day to accelerate ripening.

Bagged fruits and colour-improved fruits sell for premium prices. However, many horticulturists and growers alike, feel this practice should be discontinued not only because it produces generally poor quality fruit, but also because of the labour costs involved. The quality of the large brilliant Japanese apple is high at harvest time, but this rapidly falls when it reaches the consumer and the quality is very poor compared with apples in other countries.

Table 1. Sugar and acid content in leading apple cultivars.

Cultivar	Index of refractometer (%)	Malic acid content (%)	Location
Gala	13.4	0.33	Morioka
Granny Smith	13.9	1.01	Aomori
Jonathan	13.2	0.68	Aomori
McIntosh	10.2	0.91	Morioka
Cox's O.P.	12.9	0.93	Morioka
Fuji	15.1	0.45	Morioka
Akane	12.4	0.63	Morioka
Hatsuaki	13.5	0.63	Morioka
Kitakami	12.5	0.52	Morioka
Himekami	14.1	0.55	Morioka
Iwakami	14.0	0.71	Morioka

Therefore, we must breed a cultivar which colours easily without bagging, leaf thinning, etc. We must also breed a somewhat larger fruit with an average weight of 300 g which is sweet and low in acid (Table 1).

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SYMPOSIUM DISCUSSION

Dr R.M. Davison, Division of Horticulture & Processing, DSIR

Would Dr Yoshida tell us about the changing consumer patterns in Japan, in relation to age group and region?

Yoshida

Older people like somewhat acid apples like Jonathon, but the young people prefer sweet ones. Jonathon is decreasing in popularity, and Sekai-ichi increasing.

At our research station, we are selecting higher acidity cultivars, because we intend to use them for processing into apple juice and for cooking. Akane, for example is somewhat high in acid and is not acceptable in home market orchards.

Dr Alston, East Malling Research Station

You pointed out that one of the major demands of your market is a large fruit of about 300 g. Would you consider seeking triploid derivatives of Fuji to attain that aim?

Yoshida

I do not intend to — triploid cultivars have too great a tendency to abort.

Mr L. Decourtye, INRA

Earliness is often associated with quick ripening. Which parent in Akane brings earliness combined with long shelf-life?

Yoshida

Akane is bred from Jonathon and Worcester Pearman. These characteristics are probably from Worcester Pearman.