Commercial Varieties and Differentiation of Cropping Types of Strawberry (*Fragaria* × *ananassa* (Duch.) Hort.) in Japan

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Japan is one of the three major strawberry producing regions in the world and produces a large amount of strawberry fruit as in America and Europe. In 1973, the planted area of strawberry was 13,600 ha and the production was 184,400 tons. Compared with 10 years ago, the acreage increased 1.5 times and the production increased 2.5 times. The strawberry fruit in Japan is mostly fresh market berries, while the ones in America and Europe are mostly preserves and freezings.

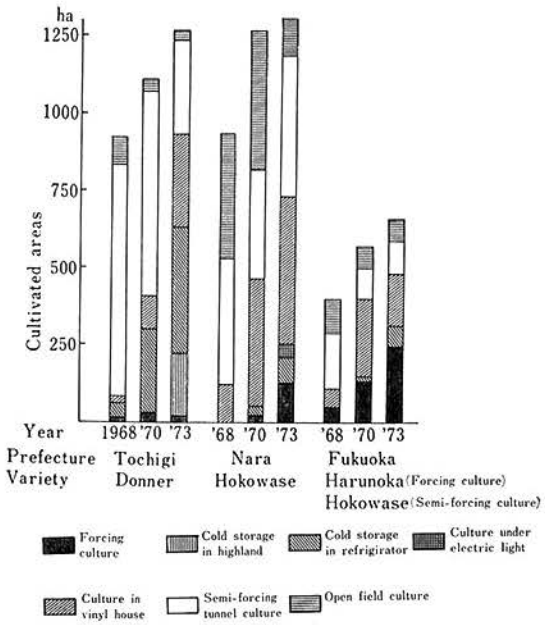

Fig. 1. The change of cultivated areas by cropping types of strawberry

Today the strawberry fruit is produced all year round in Japan due to the development of new cropping types with the development of vinyl film and other horticultural materials. Recent changes in cropping types in Tochigi, Nara, and Fukuoka Prefectures where new varieties have been bred or introduced and new cultural technology has been developed, are shown in Fig. 1. In these prefectures, taken as an example, it is apparent that more and more sophisticated cropping types have been developed, i.e., starting from the open field culture, the culture under the vinyl tunnel and further the culture in the vinyl house were deviced. Then, these semiforcing cultures

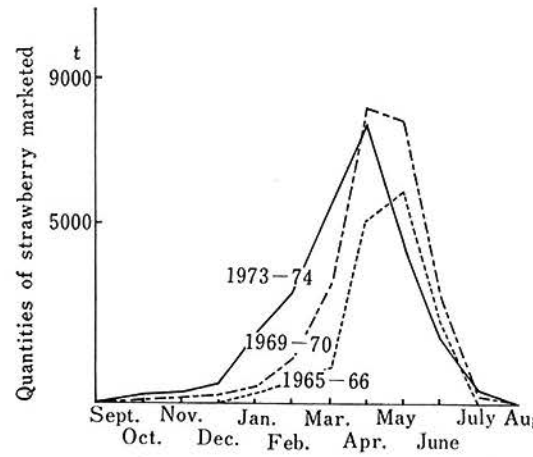

Fig. 2. The monthly fluctuations of quantities of strawberry at Tokyo Central Wholesale Market

were diversified to those using cold storage of stocks, seedling raising at cold highlands or using electric light illumination, and finally the forcing culture by means of promoting flower bud differentiation. Consequently, the harvest season of strawberry has been widened to an earlier date. This tendency is reflected to the seasonal trend of marketing; at the Tokyo Central Wholesale Market, the quantity marketed during a period from November to March has increased markedly, particularly the quantity during a period from December to February has increased 5–9 times of that of 10 years ago, while the quantity in the period from April to June tended to decrease (Fig. 2).

Commercial varieties

Basic cropping types of strawberry in Japan are open field cultures and forcing cultures. Varieties 'Kogyoku', 'Takane', and 'Yachiyo', etc., for open field cultures were developed at national and prefectural experiment stations as well as at commercial firms, based on the varieties with deep dormancy that were mostly introduced from the United States of America. Today, two commercial varieties are predominantly used for open field cultures; one is 'Donner', which was bred in America in 1945 and introduced to Japan in 1952, and the other is 'Hokowase', which was bred at Hyogo Prefectural Experiment Station[1]. These two varieties occupy about 85% of the total planting area and about 80% of the total products in Japan. In recent years, yields of these two varieties are decreasing due to diseases, a virus disease for 'Donner' and Fusarium wilt for 'Hokowase'. Taking the place of these varieties, a new variety, 'Himiko', which was bred at the Kurume Branch of the Vegetable and Ornamental Crops Research Station in 1975 is increasing its planting area[5].

On the other hand, 'Fukuba', 'Benizuru', 'Hotta-wander' 'Hogyoku', 'Harunoka', etc. were bred as varieties for the forcing culture. 'Fukuba' was drived from seedlings of a variety introduced from France about 80 years ago, and it is grown now only in a limited area. 'Benizuru', 'Hotta-wander', 'Hogyoku' are grown in some districts. In 1967, a new variety, 'Harunoka' was selected at the Kurume Branch of the Horticultural Research Station. This variety has very low chilling requirement and can be harvested successively for a period from December to June. As a labor-saving and high-yielding variety, this variety has spread widely in the warm region of the country[4]. In addition, because of its good tolerance to transportation, 'Harunoka' fruit can be shipped from Kyushu to Kanto and even to Hokkaido. At present, this variety occupies 10% of the total area of strawberry, and 15% of the total production, with a tendency still to increase. Its excellent characters like low dormancy, early maturity and high yielding potential are utilized in the recent strawberry breeding program and a new variety with powdery mildew resistance combined with superior characters of Harunoka is now under way of breeding.

Differentiation of cropping types

Cropping types of strawberry in Japan are divided into four groups: the forcing culture, the semi-forcing culture, the open field culture and the retarding culture (Fig. 3).

1) The forcing culture

In this type of culture, seedlings are covered by vinyl house as early as possible after the differentiation of flower-buds to accelerate the harvesting time, regardless of the degree of dormancy of varieties. The leading varieties adapted for this cropping type are a less dormant variety, Harunoka, and a medium dormant variety, Hokowase. To promote the flower-bud differentiation, the following treatments are given to seedlings:

(1) The low temperature treatment by (a) raising seedlings at highland, (b) putting seedlings in 10°C refrigerator for 15 days, (c) shading with black lawn, etc.;

(2) The short-day treatment to keep 10 hr of day-length by using silver or black

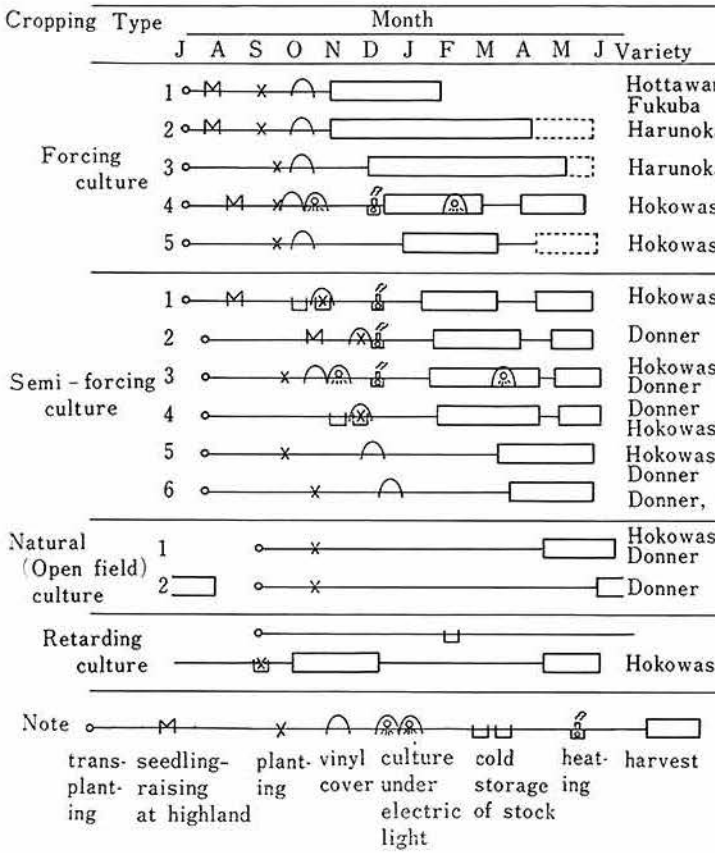

Fig. 3. Different cropping types of strawberry culture in Japan

polyethylene film cover from the evening to the next morning; and

(3) The plant nutrient regulation by root-prunning[4].

When the air temperature goes down below 17°C after setting, seedlings are covered by vinyl film to keep warm. In some cases, gibberellin or artificial light is applied to seedlings to promote the budding, inflorecence, and thickening and ripening of fruits. In case of a variety, Hokowase, with a medium dormancy, an artificial light is applied, before the plants enter into the dormant stage, to inhibit the dormancy. The stone wall culture which is the primary type of the forcing culture is practiced only at the south-facing slopes at the seacoast of Kuno district of Shizuoka Prefecture, by taking advantage of high temperature on the stone walls in winter. The varieties for this particular culture are Fukuba and Hottawander, which produce about 1 ton of fruits per 10 are from November to January. Harunoka yields about 4 to 5 tons per 10 are from November to May, and about 3 tons of good fruit can be harvested until March. Hokowase yields about 1.5 tons per 10 are from late December to early March and about 1.0 to 1.5 tons per 10 are from mid-April to late May.

2) The semi-forcing culture

This is the culture which accerelates growth of plants and harvesting of fruit under vinyl covers by breaking the dormancy after the plants entered into the dormancy (though actually the dormancy is not broken down completely). Main varieties used for this culture are the medium dormant variety Hokowase and highly dormant variety Donner. The degree of dormancy is expressed by the chilling requirement in terms of accumulated hours at the temperature below 5°C (above −2°C). Hokowase requires about 450 hr and Donner requires about 700 hr[3]. It is usual that the seedlings are covered by vinyl film after the dormancy is broken down under the natural condition, but artificial breaking of dormancy is also practiced by the following methods: (1) the cold storage of stocks at 0°C in refrigerator for a period to meet the chilling requirement[7]; (2) the transfer of stocks to highland with low temperature; (3) the treatment of 16 hr of day-length for 100 days by electric light[2]; (4) the gibberellin treatment to suppress the dwarfing of plants. In the semi-forcing culture seedlings are usually covered with vinyl in January and methods of warming are simple, so that the differentiation of flower-buds is not promoted, but sometimes nitrogenous fertilizers are applied to prevent the occurrence of unseasonal flowering. In areas where the heating is made in houses, there is a case to promote the differentiation of flowerbuds by raising seedlings at highland. The harvesting time of the semi-forcing culture is about from March to May and the yield is about 1.5 tons per 10 are. The cold storage of stocks or the light culture gives two times of harvest: about 1.5 tons per 10 are from late January to early March, and about 1 ton per 10 are from late April to late May.

3) Open field culture

Plants are grown in open fields under the natural condition. Varieties adapted for this cropping type are Hokowase, Donner, both suitable for fresh market berries, and America, Chiyoda, Morioka 16, which are suitable for preserves. Fields are mulched with polyethylene film or straw, and the harvesting is made usually in May, but a little late in cold regions. This type of culture is liable to be influenced by weather, yielding about 1 to 2 tons per 10 are.

4) The retarding culture

This cropping type is as follows: Seedlings which originally reach the harvesting stage in the spring season are uprooted in February when their growth is suppressed under the natural condition, and then put in the refrigerator over a long period. When the harvest under natural condition comes to an end they are planted in open fields. The variety adapted for this cropping type is Hokowase. The fruit can be harvested at two seasons for

one cropping: The first harvest comes from flower-buds which are differentiated in autumn and mature in fall, and the second harvest from flower-buds which are differentiated during the period of the first harvest, and mature in the next spring. The yield is about 1 ton per 10 are for one cropping.

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