Potato Breeding in Japan—Breeding For Adaptability to Warm Region

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Introduction of Potatoes to Japan

Potatoes were introduced to Japan from the end of the 16th century to the beginning of the 17th century and it is said that they were brought first to Nagasaki by a Dutchman from Java. However, not much is known about how potatoes spread in this country after they were introduced as we have only few records left about it. It seems that potato as a food did not fare so rapidly as that of the sweet potatoes which were imported about the same time.

It was around the end of the 19th century that potatoes were cultivated regularly and its acreage and yield reached noticeable amounts as a result of the widely expanded cultivation conducted mainly in the northern regions of Japan.

Potato cultivation of two crops per year means raising it twice in a year. Under this system, potatoes are planted usually from the end of February to the beginning of March and harvested in the middle of June. The next planting takes place from the end of August to the beginning of September and harvested in the middle of December.

It is not clear when this system was adopted first, but it seems to have been carried out for a considerably long time in some districts of Nagasaki Prefecture. Today this practice has been widely followed in the southwestern regions of Japan.

At its inception, there were two varieties of potatoes—Nagasaki-aka with reddish skin color and Nagasaki-ki with yellow skin and yellow flesh colors. The former was exported principally to Hongkong and the Manila regions, and the latter to Singapore where they had gained a good reputation.

The export of these varieties commenced at the termination of the 19th century and a considerable amount of export trade had continued though it was hit by its ups and downs until before the outbreak of World War II. After the war, potato consumption decreased for some time as shown in Fig. 1 but with the good result of the breeding of new potatoes attained in 1950, which is to be described later, the planted acreage and the yield per acre were greatly increased.

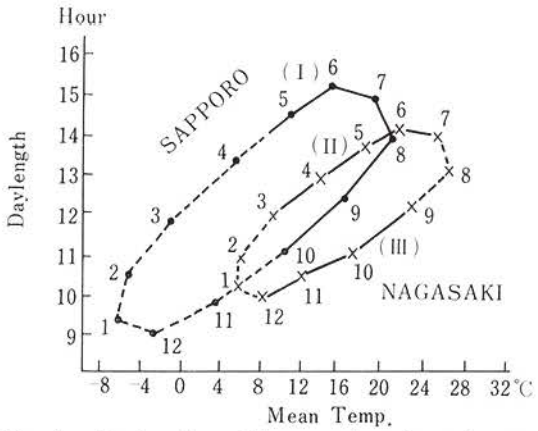


Fig. 1. Daylength and temperature in each crop.
1) Spring crop in cool region
2) Spring crop in warm region
3) Fall crop in warm region

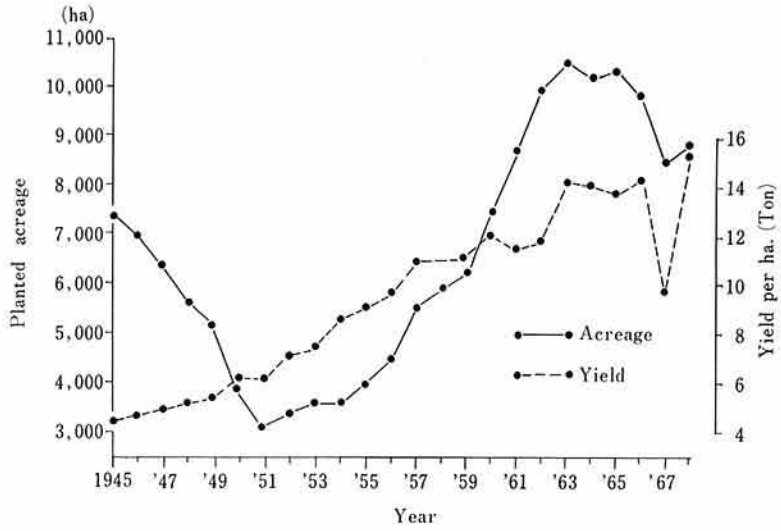


Fig. 2. Planted acreage and yield of fall crop potato.

Breeding objectives and methods of potato breeding in the warm regions of Japan

1) Breeding objectives of potato

In the two-crop per year cultivation in the warm regions, potatoes are raised during short periods in spring and in autumn in order to avoid the hot summer season so that severe breeding conditions are required compared with the breeding in the summer crop region. The most important conditions in the two-crop breeding are as follows:

a) Short dormancy

Since the period from planting to harvest is short, as already mentioned, it is impossible to cultivate the variety that has a normal dormancy period because the second planting has to be done before the end of the dormancy period of the first crop. Therefore, a short dormancy period is one of the most important conditions, and a desirable dormancy period is about 75 days for spring crop and about 120 days for fall crop.

b) Sensitivity to temperature and day-length

It is generally known that the growth of potato tubers is accelerated under the short-day conditions. Potato breeding in the warm region, however, has to be carried out under the rising temperature and long day in spring and under the falling temperature and short day in autumn, in quite contrary conditions. It is required, therefore, that the potato must be insensitive to temperature and daylength.

c) Disease and insect tolerance

Disease and insect tolerance is an important character in potatoes wherever they are raised. A special importance is placed on resistance for late blight *Phytophthora infestans* (Montage) *de Bary* because the growth period of spring crop in the warm region appears in the rainy season. Owing to warmth, damage from many kinds of diseases and insects is found. Among them are the 28-spotted lady beetle *Epilachna Sparsa Orientalis Dieke,* potato tuber worm *Phthorimaea operculella zeller,* tuber root-leion nematode disease *Pratylenchus coffeae zimmermann,* root knot nematode *Meloidogyne hapla chitwood,* common scab *Streptomyces scabies (Thaxter) Waksman* and the powdery scab *Spongospora (Walloth) Lagerheim.*

As to the diseases such as powdery scab, tuber root-leion nematode disease and root knot nematode, it is clearly known that tolerance to these diseases differs with the varie-

Table 1. Comparison of characteristics between new and common varieties

Variety	Season	Date of sprouting	Yield per individual (g)	No. of tubers per individual	Mean weight of one economical tubers (g)	Specific gravity
UNZEN	Spring	Apr. 10	442	3.6	96	1,080
	Fall	Sept. 24	386	3.4	103	1,078
TACHIBANA	Spring	Apr. 10	393	4.4	89	1,074
	Fall	Sept. 20	409	3.2	127	1,078
SHIMABARA	Spring	Apr. 3	407	4.7	89	1,075
	Fall	Sept. 20	376	3.2	91	1,078
CHIJIWA	Spring	Apr. 11	380	4.1	89	1,080
	Fall	Sept. 21	407	4.3	94	1,088
NORIN No. 1	Spring	Apr. 9	367	4.6	80	1,088
	Fall	Sept. 19	366	3.9	96	1,087
BINTJE	Spring	Apr. 11	361	5.6	64	1,083
	Fall	Sept. 23	288	4.9	59	1,082
GINEKE	Spring	Apr. 24	200	3.7	51	1,080
	Fall	Oct. 2	238	3.8	58	1,082
KATAHDIN	Spring	Apr. 20	284	3.2	87	1,074
	Fall	Oct. 6	188	2.6	71	1,077
KENNEBEC	Spring	Apr. 16	346	3.7	82	1,078
	Fall	Oct. 14	197	2.8	59	1,077

Table 2. Properties of new varieties

Variety	Parent	Maturity	Stem	Flower	Tuber		Cooking Quality
					Skin color	Flesh color	
UNZEN	Norin No. 1 ×Katahdin	Medium Late	Light Green	White medium in number	Slightly Brownish yellow	White	Medium
TACHIBANA	Norin No. 1 ×Katahdin	Late	Green	White numerous	Light yellowish white	White	Not good
SHIMABARA	Norin No. 1 ×Gineke	Medium Late	Green (Light reddish purple tinge in lower part)	White usually no flowering	Light yellow	Light yellow	Good
CHIJIWA	54042-15 ×Unzen	Late	Green (Brownish purple tinge)	White numerous	Light yellow	Yellow	Good

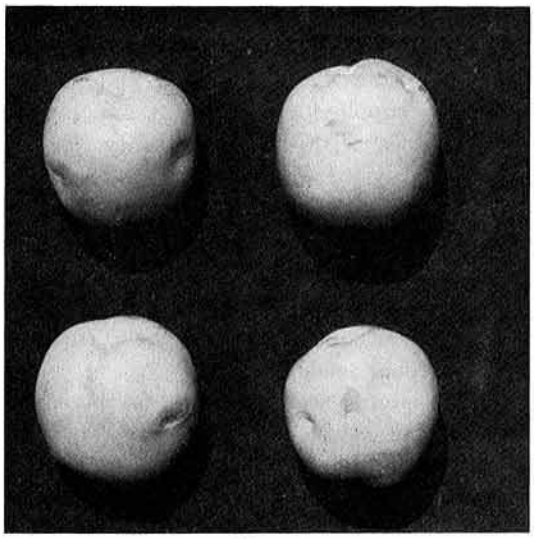
ties, but as to the reaction to insects, studies are not yet sufficiently made.

d) Good quality

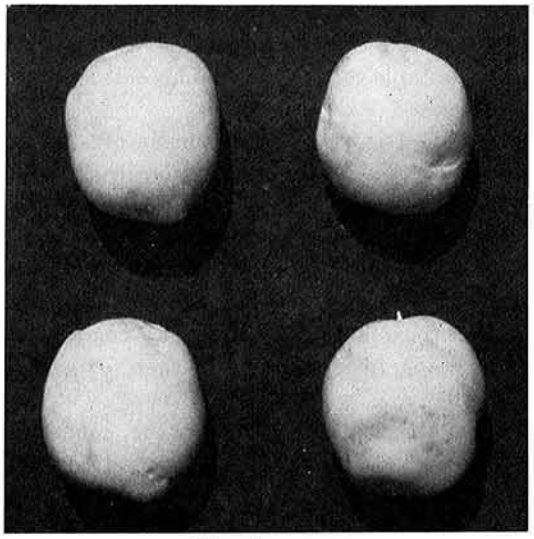
Since the potatoes raised in the warm region are chiefly used for food, the requirement for good quality is, above all, strict. Taste is the first condition in the quality, and outward appearance is also one of the important conditions. Taste is not easy to judge because of the variety in sensuous requirements and this becomes much more complicated due to the different judgments according to various cooking methods. At present, the potatoes of 1.08~1.09 in specific gravity and in good taste are considered as breeding objectives for good potato.

2) Breeding method

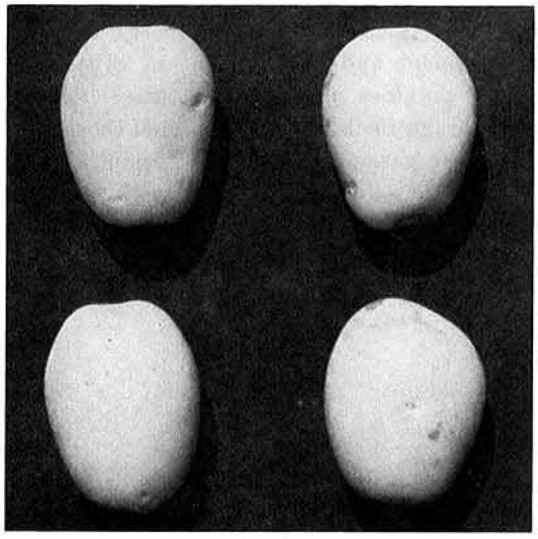
It is just 20 years since the Breeding Test Station was established at the present address (Aino-cho, Nagasaki Prefecture, situated approximately in 32° 47′ N, 130° 9′ E). During those years, the station has succeeded in the breeding of new potato varieties Unzen, Tachibana, Shimabara and Chijiwa. Among them, Tachibana is especially productive and widely



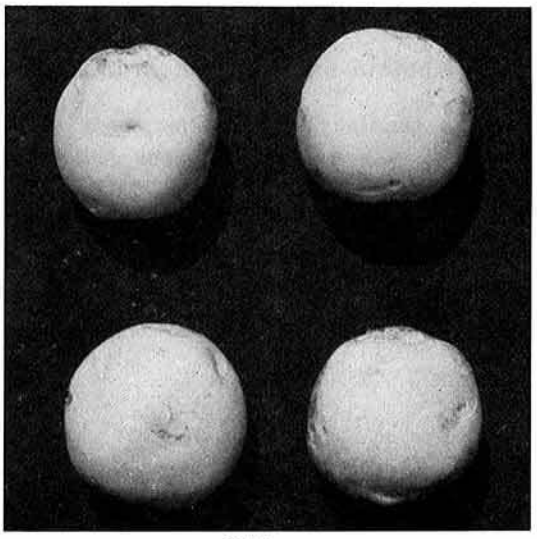
Unzen



Shimabara



Tachibana



Chijiwa

cultivated by farmers.

In case of the two-crop cultivation in the warm region, there are some bad conditions for flowering and fruiting such as the short growth period, too high temperature for spring crop and too low temperature for fall crop in the latter half of the growth period.

For that reason, the breeding test had been carried out by using the true seeds or the tubers after they were derived from true seeds which were sent from the Hokkaidō National Agricultural Experiment Station for several years after the commencement of the test. At present, however, it has become possible for this station to produce seeds by controlling daylength, eliminating stolons and after-ripening of fruits, and performing all the works consistently from crossbreeding to selection.

About 20,000 true seeds are planted for each spring and fall crop respectively and selection is made while the potato breeding is

carried out repeatedly for 5 to 7 years thereafter. During these years, the varieties that are adaptable to the two-crop breeding naturally survives.

Selection is made on the basis of the character with small yearly variation in skin color, appearance and specific gravity, and the selection in regard to the yield is made in the latter period, which is the same with the cases of other crops. As for the reaction to diseases, examinations are being conducted in joint cooperation with another experiment station.

The attached table shows the comparison made between the new varieties which have been bred up to the present and the well-known varieties. This table substantiates the fact that the new varieties are very excellent and suitable for the two-crop per year region.

Seed potato breeding system in Japan

It is generally known that most of the potato diseases are derived from the primary infection of seed potatoes and it is the first condition for potato cultivation to obtain seed potatoes of good quality. It is, of course, very important to supply good seed potatoes free of diseases. After World War II, an excellent system of seed potato production was established in Japan and every year the farmers have been supplied with perfect and healthy seed potatoes with high reliability for the quality.

The origin of this system is the National Farm for Foundation Potato Seeds which possesses vast farms with skilled researchers and produces foundation seeds under a strict test every year to supply them to the farmers to breed certified seeds.

The registered seeds are bred as the second step and the certified seeds as the third step by the farmers possessing high technical skill who are selected from among a number of farmers. On their farms they raise seed potatoes which have passed the inspection of the plant protection commissioner of the Ministry of Agriculture and Forestry on their management and environment in cultivation.

The potatoes produced by these farmers and storage facilities are inspected thoroughly and those passing the test are commended as seed potatoes for sale. Owing to this system, farmers in general can obtain good, healthy seeds without any anxiety.