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CULTIVATION AND EVALUATION OF FRUIT TREE PGR

TECHNICAL ASSISTANCE ACTIVITIES FOR GENETIC RESOURCES PROJECTS

JAPAN INTERNATIONAL COOPERATION AGENCY

Published

REF. NO. 1	Preservation of Plant Genetic Resources
REF. NO. 2	Exploration and Collection of Plant Genetic Resources Part I Seed-propagated Crops
REF. NO. 3	Exploration and Collection of Plant Genetic Resources Part II Vegetatively Propagated Crops
REF. NO. 4	Evaluation and Classification of Plant Genetic Resources
REF. NO. 5	Utilization of Plant Genetic Resources for Crop Improvement
REF. NO. 6	Cryopreservation of Plant Genetic Resources
REF. NO. 7	Cultivation Methods for the Evaluation of Characteristics of Genetic Resources and Evaluation of Genetic Resources (Cereal, Pulse and Root Crops)
REF. NO. 8	Cultivation and Evaluation of Vegetable PGR

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Chuo-ku, Tokyo 103, JAPAN

CONTENTS

Introduction

In 1994, we published PGR manual No.7 which described the methods for the cultivation and evaluation of characteristics of genetic resources of cereals, pulses and root crops , and, in 1995, we published PGR manual No.8 which described the methods for the cultivation and evaluation of characteristics of genetic resources of vegetables.

For 1996, the editorial board of GPR REF sponsored by Japan International Cooperation Agency (JICA) decided to publish PGR manual REF. No.9 to outline the methods for the cultivation and evaluation of characteristics of genetic resources of fruit trees.

The editorial board held consultations with Dr. Shichiro Tsuchiya, Director of Department of Plant Breeding, Fruit Tree Research Station (FTRS). Dr. Tsuchiya selected ten representative fruit trees as follows: apple, Japanese pear, peach, apricot, persimmon, grape, chestnut, citrus, loquat and pineapple.

There are many other important fruit trees in tropical and sub-tropical areas where JICA is engaged in cooperative activities on genetic resources. However, since the staff members of FTRS who are conducting experiments mainly on fruits of the temperate zone are not familiar with subtropical and tropical fruit trees, only fruits of the temperate zone except for pineapple are described.

As in REF. No.7 and No.8, each descriptor is divided into three classes, primary, secondary and tertiary and also categorized into essential or optional items. Thus, descriptors appear in a systematic order.

In the next volume of this series, methods of cultivation and descriptors of forage crops will be dealt with.

Torao Goto
AFFTIS

I. Apple

I-1. Cultivation of Apple Genetic Resources for Evaluation of Characteristics

I-2. Evaluation of Characteristics of Apple Genetic Resources

by

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I-1. Cultivation of Apple Genetic Resources for Evaluation of Characteristics

1. Land preparation

Subsoiling is necessary for soil with hardpan. In case of heavy soil, tilling is practiced. In the year prior to planting, nutritional status and pH of orchard soil should be checked. When apple orchards are renewed, fallowing for more than one season is necessary after removal of old apple trees. Before planting, soil is fumigated to control soil-borne pests and pathogens: parasitic nematodes and root-rotting fungi.

2. Nursery tree production

Rootstocks raised from stool beds, cuttings or seeds are planted in nurseries in early spring. The scion varieties are budded in late summer or subjected to veneer-grafting to rootstocks in spring. Scions should be taken from virus-free trees. After grafting, shoots from scions are allowed to grow for one to two years in nurseries prior to transplanting.

3. Planting lay out

Nursery trees are usually planted in spring. High density planting (3.0 meters between trees and 5.0 meters between rows) with grafting on dwarfing rootstocks is recommended to maintain a large number of PGR. Trees are supported by wooden posts, bamboos or galvanized trellis wires.

4. Field management

1) Training and pruning

In high density planting, trees are usually trained into a slender/free spindle system or central/ vertical axis system. Apple trees are usually pruned during the dormancy period, while summer pruning is occasionally practiced. Pruning is necessary for removing excessive growth, maintaining the tree shape and size, and securing continuous growth and fruiting. There are various methods of pruning: heading-back, thinning-out, and spur pruning.

2) Pollination

Since most apple cultivars are self-incompatible, cross-pollination is necessary to secure fruit setting. If the number of natural bees in orchards is insufficient for pollen transfer, the introduction of beehives is essential for fruiting. Beehives are set in orchards when about 10% of the flowers opened.

3) Thinning

Thinning of excessive flowers at blooming or young fruits a few weeks after blooming improves the size, color and fresh eating quality of fruits, and prevents alternate bearing. By thinning to obtain a distance of 15 to 25cm between fruits (one fruit remaining for 3 to 5 spurs), fruits with adequate size and quality can be obtained for table varieties. Fruit thinning is carried out by hand or by using some chemicals such as Carbaryl (Sevin).

4) Irrigation

Orchards in dry areas need an adequate amount of irrigation. Trickle irrigation and sprinkler irrigation systems are usually adopted.

5) Nutrition

Nutritional level of plants which allows an optimum balance between vegetative and reproductive growth is essential for sustenance of fruit production. The amount of fertilizer required varies depending on orchards; recommended rates of N, P and K range from 50 to 150, 20 to 50, 30 to 100kg/ha, respectively. Fertilizer is usually applied once or twice a year in spring or fall. To determine the amount of fertilizer, it is necessary to observe carefully visual symptoms of nutrient deficiency.

6) Weed control

Rows are weeded by tillage, herbicide application or mulching. Application of herbicides two or three times in a year is commonly practiced. However, to reduce the application of chemicals, mulching is recommended. Intrarow spacing is grassed by using cover crops and by mowing three or four times during the growing season.

7) Control of diseases and pests

Apple trees are severely damaged by a number of diseases and insect pests especially in humid regions. Blossom blight, powdery mildew, rust, scab, alternaria blotch, canker, fireblight, and root rot are serious diseases. Aphids, comstock mealybug, apple leafminer, tortricid moths including codling moth and several fruit moths, leafrollers, fruit flies, scale insects, and mites attack apple trees.

For controlling diseases and pests, fungicides and insecticides are applied depending on the location after planting. Through integrated pest management, minimum spray of chemicals becomes possible.

5. Harvest

A set of maturity indices is used to determine the time of harvest of each cultivar. Flesh firmness and flesh color, skin color, starch content and ethylene evolution of fruits are used as indices for maturity. To determine the time of harvest accurately for each cultivar, maturity of fruits are periodically tested.

I-2. Evaluation of Characteristics of Apple Genetic Resources

For the accurate and reliable evaluation of characteristics, observation should be made for at least two plants. Traits of dormant one-year-old shoots are observed in winter. Characteristics of flowers are observed for 10 terminal (king) flowers. Characteristics of leaves are observed in summer, for fully unfolded leaves at the fourth to sixth positions counted from the tip of five vigorous current shoots outside of the tree crown. For the observation of fruits, 10 typical fruits are sampled from each tree.

1. Primary characters

<TREE>

Color of dormant one-year-old shoot

Surface color of dormant one-year-old shoots is classified into 1: green, 2: grey, 3: brown, 4: brownish red. Granny Smith is classified into 1, Fuji into 3, Akane into 4.

<LEAF>

Leaf size

Leaf area is estimated by the calculation of π ab / 4 (a denotes the length of the leaf blade, and b, the width of the leaf blade) and classified into 3: small (≤27cm²), 5: intermediate (28-39cm²), 7: large (≤40cm²). Refer to Fig.1.

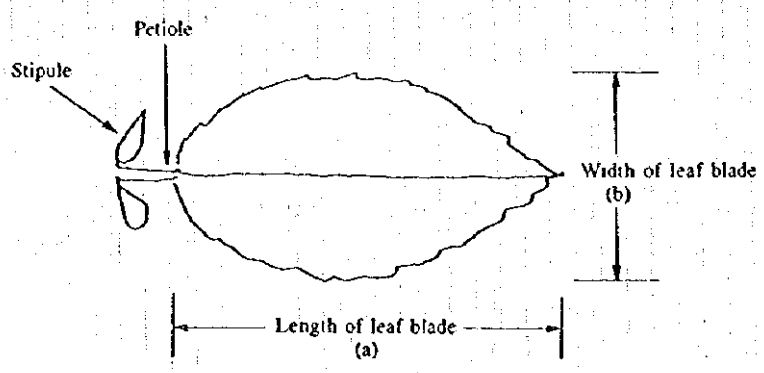

Fig. 1. Apple leaf morphology.

Length of leaf blade

Length of leaf blade is classified into 3: short, 5: intermediate, 7: long. Court Pendu Plat is classified into 3, Cox's Orange Pippin into 5, Bramley's Seedling into 7.

Width of leaf blade

Width of leaf blade is classified into 3: narrow, 5: intermediate, 7: broad. Cox's Orange Pippin is classified into 3, Golden Delicious into 5, Bramley's Seedling into 7.

Lobation of leaf margin

Lobation of leaf blade margin is classified into 1: absent, 9: present. Fuji is classified into 1, Brucknell into 9.

Shape of serration

Incision of margin of leaf blade is classified into 1: entire, 2: crenate, 3: serrate, 4: biserrate. Jonathan is classified into 2, Fuji into 3. Refer to Fig.2.

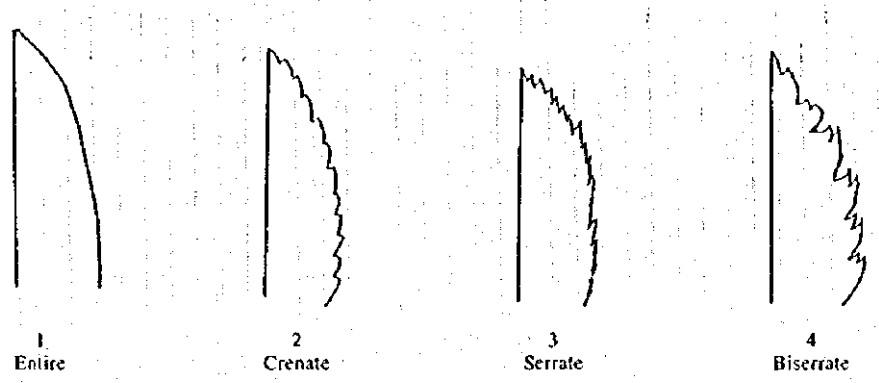

Fig. 2. Shape of serration.

Pubescence of mature leaf

Pubescence on the reverse side of mature leaf is classified into 1: absent, 3: scarce, 5: intermediate, 7: dense. Tsugaru is classified into 3, Cooper's Market into 5, Jonathan into 7.

Shape of stipule

Shape of stipule is classified into 1: round, 2: intermediate, 3: long-round, 4: sickle-shaped. Cellini is classified into 1, Bismarck into 2, Chelan Red into 3, Borodovka into 4.

Length of petiole

Length of petiole is expressed by the ratio of petiole length / leaf blade length, and classified into 3: short (≤0.25), 5: intermediate (0.26-0.34), 7: long (≥0.35).

<FLOWER>

Flower size

Diameter of 10 normal flowers is measured and, flower size is classified into 3: small (≤4.1cm), 5: intermediate (4.2-5.4cm), 7: large (≥5.5cm).

<FRUIT>

Fruit size

Weight of 10 ripe fruits is measured, and fruit size is classified by the weight of fruit into 1: very small (≤10g), 3: small (11-100g), 5: intermediate (101-200g), 7: large (201-300g), 9: very large (≥301g).

Fruit shape

Fruit shape is classified into 1: flat, 2: globose, 3: ellipsoid, 4: short-globose-conical, 5: conical, 6: long-conical, 7: globose-bias, 8: oblong, 9: oblong-waisted. Refer to Fig.3.

Length of stalk

Length of stalk is classified into 1: very short, 3: short, 5: intermediate, 7: long, 9: very long. Egremont Russet is classified into 1, Jonathan into 3, Tsugaru into 5, Spencer into 7, Golden Delicious into 9.

Fruit color at maturity

The pigmentation due to the presence of anthocyanin on the fruit skin is observed and classified into 1: green, 2: orange, 3: red, 4: purple, 5: brown. Granny Smith is classified into 1, Golden Delicious into 2, Jonathan into 3, Spartan into 4, Lord Burghley into 5.

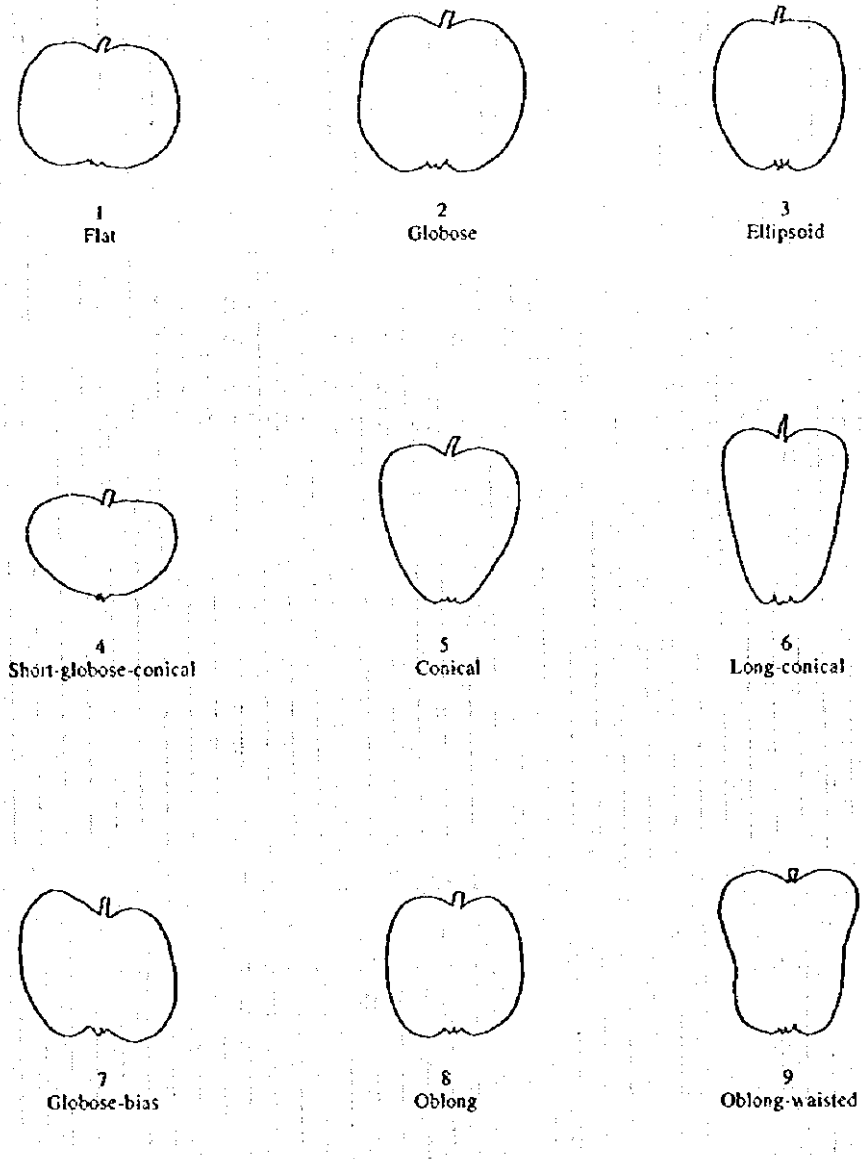

Fig. 3. Shape of fruit.

2. Secondary characters

<TREE>

Tree habit

Tree habit is classified into 1: fastigiate, 3: upright, 5: spreading, 7: drooping, 9: weeping. Refer to Fig.4.

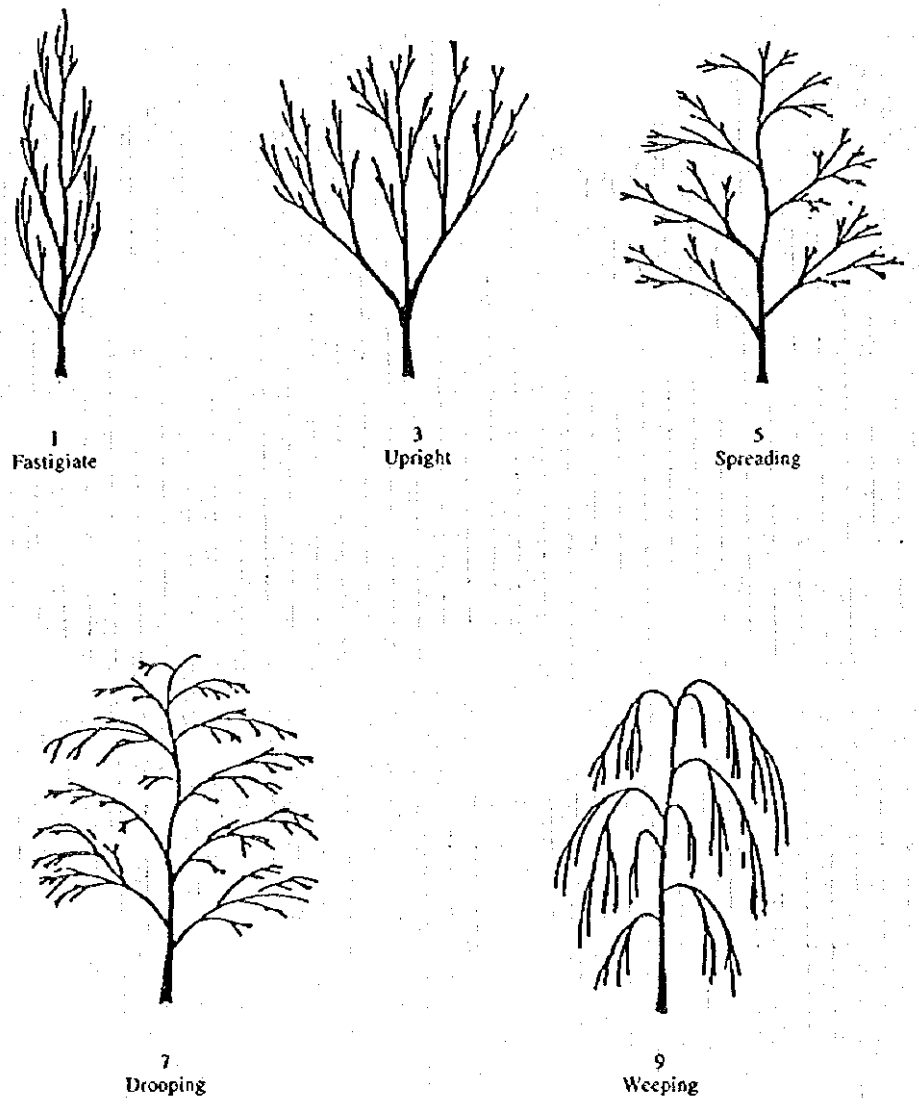

Fig. 4. Tree habit.

Vigor of tree

Vigor of tree is classified into 3: low, 5: intermediate, 7: high. Akane is classified into 3, Golden delicious into 5, Fuji into 7.

Spur formation

Degree of spur formation is classified into 3: low, 5: intermediate, 7: high. Senshu is classified into 3, Fuji into 5, Golden Delicious into 7.

Time of sprouting

The date when more than 3 terminal buds have sprouted is recorded as time of sprouting, and classified into 1: very early (more than 7 days earlier than Fuji), 3: early (3-6 days earlier than Fuji), 5: intermediate (same with Fuji), 7: late (3-6 days later than Fuji), 9: very late (more than 7 days later than Fuji).

<FLOWER>

Time of full bloom

The date when 70-80% of terminal flowers opened is recorded as time of full bloom, and classified into 1: very early (more than 4 days earlier than Fuji), 3: early (2-3 days earlier than Fuji), 5: intermediate (same with Fuji), 7: late (2-3 days later than Fuji), 9: very late (more than 4 days later than Fuji).

<FRUIT>

Time of maturity

The date when fruits ripened for fresh eating is recorded as time of maturity, and classified into 1: very early, 3: early, 5: intermediate, 7: late, 9: very late. Close is classified into 1, Jerseymac into 3, Golden Delicious into 5, Fuji into 7, Granny Smith into 9.

Ground color of fruit skin

Ground color of fruit skin is observed at maturity if it is visible, and classified into 1: yellow, 2: whitish yellow, 3: green yellow, 4: whitish green, 5: green. Golden Delicious is classified into 1, Cox's Orange Pippin into 3, Granny Smith into 5.

Position of russetting of fruit skin

Position of russetting of fruit skin is classified into 1: around eye basin, 2: around stalk cavity, 3: on cheeks, 4: entire skin.

Degree of russetting of fruit skin

Degree of russetting of fruit skin is classified into 1: absent, 3: low, 5: intermediate, 7: high, 9: entire skin.

Size of lenticels of fruit skin

Size of lenticels of fruit skin is classified into 3: small, 5: intermediate, 7: large. Beauty of Bath is classified into 3, Cox's Orange Pippin into 5, Reine des Reinettes into 7.

Bloom on fruit skin

Presence or absence of bloom on fruit skin is categorized into 1: absent, 9: present. Golden Delicious is categorized into 1, McIntosh into 9.

Color of fruit flesh

Color of fruit flesh is classified into 1: white, 2: cream, 3: yellowish, 4: pink, 5: greenish. Spartan is classified into 1, Jonagold into 2, Cox's Orange Pippin into 3, Pink Pearl into 4.

<RESISTANCE TO DISEASES AND PESTS>

Resistance to alternaria blotch

Resistance to alternaria blotch caused by *Alternaria mali* is determined based on artificial inoculation or natural infection and classified into 3: low, 5: intermediate, 7: high. Delicious is classified into 3, Fuji into 5, Jonathan into 7.

Resistance to powdery mildew

Resistance to powdery mildew caused by *Podosphaera leucotricha* is determined based on artificial inoculation or natural infection and classified into 3: low, 5: intermediate, 7: high. Jonathan is classified into 3, Fuji into 5, Delicious into 7.

Resistance to rust

Resistance to rust caused by *Gymnosporangium yamadae* is determined based on artificial inoculation or natural infection and classified into 3: low, 5: intermediate, 7: high. Fuji is classified into 3, McIntosh 5, Akane into 7.

Resistance to scab

Resistance to scab caused by *Venturia inaequalis* is determined based on artificial inoculation or natural infection and classified into 3: low, 5: intermediate, 7: high. Fuji is classified into 3, Sansa into 5, Prima into 7.

Resistance to fruit spot

Resistance to fruit spot caused by *Mycosphaerella pomi* is determined based on artificial inoculation or natural infection and classified into 3: low, 5: intermediate, 7: high. Jonathan is classified into 3.

Resistance to aphids

Resistance to aphids is determined based on natural infection and classified into 3: low, 5: intermediate, 7: high.

<RESISTANCE TO PHYSIOLOGICAL DISORDERS>

Resistance to internal bark necrosis

Internal bark necrosis is a physiological disorder caused by excess manganese. Resistance to this disorder is determined by dipping cut shoots in manganese solution or by the observation of the symptoms in the field, and classified into 3: low, 5: intermediate, 7: high. Delicious is classified into 3, Jonathan into 5, McIntosh into 7.

Resistance to bitter pit

Incidence of bitter pit is observed and the degree of resistance is classified into 3: low, 5: intermediate, 7: high. Egremont Russet is classified into 3, Reine des Reinettes into 5, Spartan into 7.

Drop of young fruit (June drop)

Degree of June drop is classified into 3: low, 5: intermediate, 7: high. Fuji is classified into 3, Tsugaru into 5, Delicious into 7.

Fruit drop at maturity

Degree of fruit drop at maturity is classified into 3: low, 5: intermediate, 7: high. Fuji is classified into 3, Jonathan into 5, Tsugaru into 7.

3. Tertiary characters

<FRUIT QUALITY>

Firmness of fruit

Firmness of pulp is measured using a penetrometer with a plunger 7/16 inch in diameter. Measurement is taken at the center of the opposite cheeks of each fruit after removing a disk of peel 2 to 3 cm in diameter.

Soluble solids content

Refraction of filtrate of juice squeezed from mature fruits is measured with a refractometer to determine the soluble solids content of fruit juice.

Titratable acidity

Filtrate of juice squeezed from mature fruits is titrated with 0.1N NaOH to the end point of pH 7.0. Acidity is expressed as % of malic acid.

Texture

Texture of fruit is classified into 1: extremely coarse, 3: coarse, 5: intermediate, 7: fine, 9: extremely fine. Ralls Janet is classified into 3, Fuji into 7, Senshu into 9.

Juiciness

Degree of juiciness of fruit is classified into 3: low, 5: intermediate, 7: high. Indo is classified into 3, Jonathan into 5, Fuji into 7.

Astringency

Astringency of fruit is classified into 3: low, 5: moderate, 7: high.

Flavor

Flavor of fruit is examined by sensory test and classified into 3: weak, 5: moderate, 7: strong.

Watercore at maturity

Degree of watercore development of fruit at maturity is classified into 3: low, 5: intermediate, 7: high. Tsugaru is classified into 3, Jonathan into 5, Fuji into 7.

Core breakdown

Incidence of breakdown and molding of core is classified into 1: absent, 3: slight, 5: intermediate, 7: severe.

Mealy breakdown

Degree of mealy breakdown of fruit flesh after storage is classified into 3: low, 5: intermediate, 7: high. Fuji is classified into 3, Mutsu into 5; Delicious into 7.

Greasiness of skin

Greasiness of skin is classified into 1: absent, 9: present. Fuji is classified into 1, Jonagold into 9.

Storability of fruit

Fruits are stored in a room with or without refrigeration. Storability is evaluated based on the change of fruit firmness, and maximum storability is expressed in days.

Browning of flesh

Browning of the flesh after storage is observed, and classified into 1: absent, 3: slight, 5: intermediate, 7: severe.

<YIELD>

Yielding ability

Yield per unit area of cultivars is tested at the same site, in trees grafted on the same kind of rootstock, and with the same management system, and yielding ability is classified into 1: extremely low, 3: low, 5: intermediate, 7: high, 9: extremely high. Discovery is classified into 3, Cox's Orange Pippin into 5, Golden Delicious into 7.

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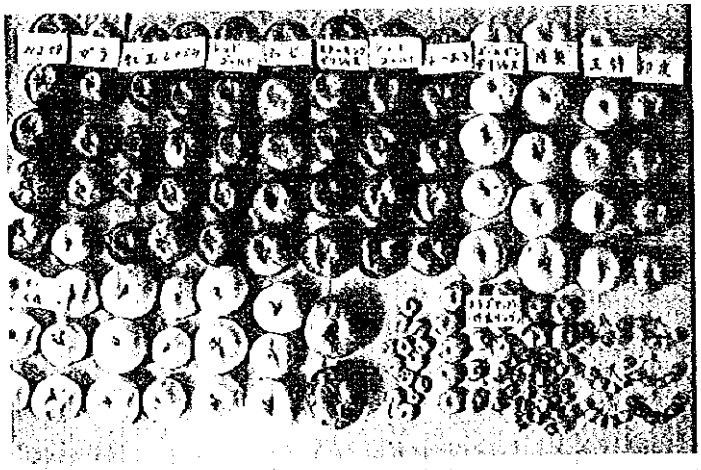

Photo. 1. Variation in apple fruit morphological characteristics at maturity.

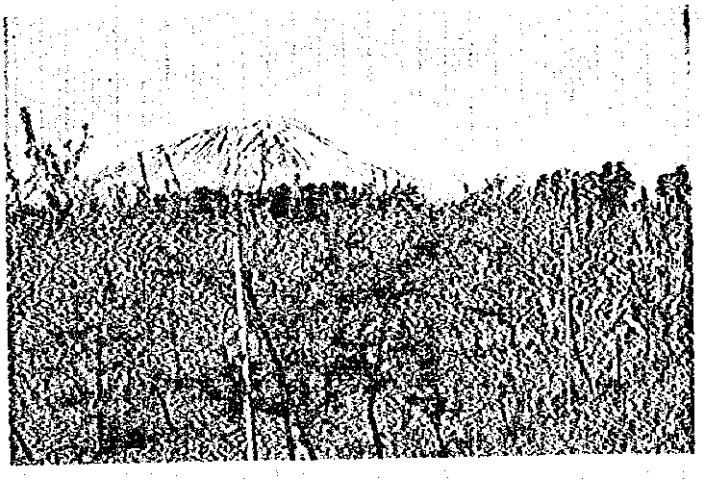

Photo. 2. Preservation of apple genetic resources for evaluation.

II. Japanese Pear

II-1. Cultivation of Japanese Pear Genetic Resources for Evaluation of Characteristics

II-2. Evaluation of Characteristics of Japanese Pear Genetic Resources

by

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II-1. Cultivation of Japanese Pear Genetic Resources for Evaluation of Characteristics

1.1. General properties

Trees are upright, vigorous especially at the young stage. Genus *Pyrus* which is considered to have originated in mountainous areas in western and southwestern China consists of more than 30 species. There are no wild species in North and South America and Australia.

This genus is classified into two types based on flavonoid producion. One of the types, to which East Asian pears and Japanese pears belong, produces flavonoids while, the other, to which West European pears and West Asian pears belong, does not produce flavonoids.

European pears and West Asian pears require afterripening for table eating, unlike Japanese pears.

2. Propagation

Raising of rootstocks

Seedlings of Japanese pear cultivars or those of wild pears are commonly used for rootstocks. Seeds are collected from mature fruits and washed. After sterilization and drying, seeds are kept in polyethylene bags at 5°C and sowed in spring.

Preparation of scions

In veneer-grafting, scions are collected from fully dormant one-year-old shoots from the end of January to February in Japan. After being covered with sheets of paper (usually old newspapers), scions are covered with polyethylene bags and are kept at 5°C.

Grafting

Veneer-grafting method is usually applied for Japanese pears from March to April. Scions are grafted at the height of 5~10cm above ground.

Management of nursery

During the growing season, grafted nursery plants are tied to poles to protect graft unions from wind damage. Weed control and removal of suckers are important to obtain healthy growth of grafted nursery plants. Grafting tapes must be removed before they cut into graft unions. Chemicals are sprayed for the control of diseases and pests.

3. Planting (Transplanting)

Nursery plants are usually transplanted one year after grafting. Planting density for Japanese pears varies depending on the vigor of the cultivar/rootstock combination, soil type, and training system. In Japan, where pear trees are trained almost exclusively by pergola system, planting space ranges from 7.5 × 7.5 meters to 9 × 9 meters. Sufficient spacing is necessary for efficient interception of light. Transplanting is carried out in two seasons

from October to December and from February to early March. After transplanting, nursery plants are fully watered and mulched with straw to promote the development of the root system and are tied to poles to protect them from wind damage.

4. Preparation of cultivation field (Site selection and orchard design)

Cultivation field is plowed at a depth of 60 ~ 100cm. Planting holes are prepared one or two months before transplanting. Farmyard manure and fertilizer should be mixed with the surface soil.

5. Training and pruning of trees

Japanese pear trees are usually trained in the form of two to three primary scaffold branches. It is important to select tree-training systems based on the physiological requirements of trees and environment of orchard (outside Japan, the modified central leader system is most common). Each primary scaffold branch produces two or three secondary scaffold branches. Pruning of trees is carried out usually in winter for the development of tree form, expansion of tree crown, and renewal of fruit-bearing shoots in the dormancy period. Summer pruning is carried out to remove non-utilized water sprouts and to supply enough sunshine for the remaining shoots, and to promote efficient branching.

6. Thinning of flowers and fruitlets

Two ~ three flowers are left for one fruiting cluster and the other flowers are removed. All the flowers around the tips of shoots should be thinned to promote vigorous growth of shoots. Thinning of fruits starts about 30 days after full bloom. Excessive fruit bearing causes poor growth of fruit. Particularly, early thinning is effective for the growth of fruit. In the standard practice of fruit thinning, one fruit is left for three clusters.

7. Soil management

In the Japanese sod culture system, immediately after leaf fall, seeds of any kind of grass are sown between trees for soil improvement. Clean culture system is practiced only near the tree trunks below tree crowns. Weed mulch and sod-mulch system is effective to prevent soil erosion in sloped fields.

8. Fertilization

Usually nitrogen, phosphate and potassium are applied as basal fertilizer. Ratio of N : P : K is 10:6:8 for Nijiseiki. Japanese pears require a larger amount of fertilizer than other pears. Amount of fertilizer is determined based on the soil fertility, growth stage of shoots and condition of trees. Fertilizer is basically applied three times, in November ~ December, June and September. The total amount of nitrogen is usually about 20 ~ 25kg per 1000m^2. In split application, 20 ~ 30% is applied for September to October, and 80 ~ 70% for November to December, usually with no application in summer.

9. Pest and disease control

Serious pests of Japanese pears include mites, moths species, stink bug and mealy bangs and aphids. The predominant pests vary from region to region depending on the climatic conditions and population of host plants. If insects or mites are found, careful precaution should be taken to prevent spreading of these pests to the neighboring orchards. Pest management system which integrates biological, chemical, and physical ways of pest control into a single management strategy has been recently practiced. Serious diseases of Japanese pear include black spot, scab, rust, *Physalospora* canker, white root rot. To protect pear plants from pests and diseases, spray of chemicals on trees is necessary.

10. Harvest

When the Japanese pear becomes ripe, the soluble solids content increases, the flesh becomes soft, and the skin color also changes. Table eating quality of fruits becomes best at harvest. Although the quality of fully ripe fruit is optimum, harvest is practiced just before full maturity. Harvest time is usually determined based on the color of the skin, Brix value, table eating quality, days after flowering date, etc.

11. Storage

Suitable temperature for storage of fruits is 0 ~ 5°C. Fruits are wrapped in polyethylene film and kept in a cold storehouse.

II-2. Evaluation of Characteristics of Japanese Pear Genetic Resources

1. Primary characters

<Essential items>

Density of pubescence on one-year-old shoots

Density of pubescence is observed for 10 normally growing one-year-old vegetative shoots, and is classified into 0: absent, 1: extremely low, 3: low, 5: intermediate, 7: high.

Shape of serration

One leaf is sampled from the 8th to 10th internode of each shoot of normal growth with about 20 newly unfolded leaves. Shape of serration is observed for these 15 leaves, and classified into 1: round, 3: crenate, 5: dentate, 7: serrate (Fig.1).

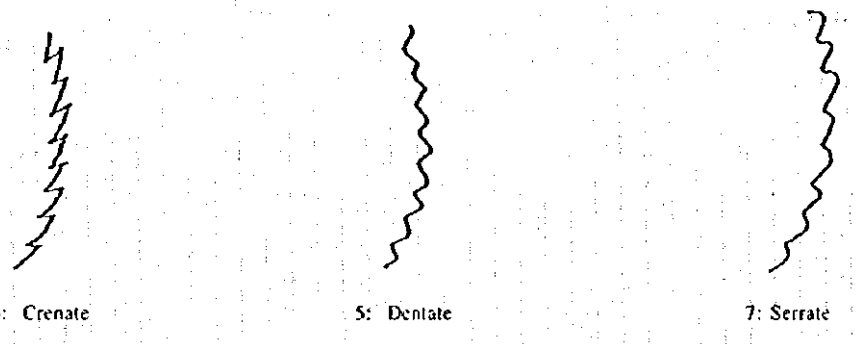

Fig. 1. Shape of serration.

Size of leaf blade

Size of leaf blade is observed for 15 leaves, based on the value of blade length (cm) × leaf blade width (cm), and is classified into 1: very small (surface ≤ 29cm²), 3: small (30 ~ 59cm²), 5: intermediate (60 ~ 89cm²), 7: large (90 ~ 119cm²), 9: very large (≥ 120cm²).

Shape of leaf

The length / maximum width ratio of leaf blades is measured to indicate shape of leaf for 15 leaves, and shape of leaf is classified based on the ratio into 1: ≤ 1.1, 3: 1.4 ~ 1.5, 5: 1.8 ~ 1.9, 7: 2.2 ~ 2.3, 9: 2.6 ~ 2.7.

Color of young leaf

Color of young leaf is observed for 15 leaves just after leafing, and classified into 1: yellow green, 3: greenish brown, 5: brown, 7: red brown.

Diameter of flowers

Diameter of flowers is measured for 5 flowers just after flowering.

Shape of petals

Shape of petals is observed for 10 flowers just after flowering, and is classified into 1: round, 3: ovate, 5: elliptical, 9: heart-shape.

Shape index of fruit

Shape index of fruit is calculated for 10 fully mature fruits based on the height / width ratio.

Location of maximum width of fruit

Location of maximum width of fruit is observed for 10 fully mature fruits, and is classified into 1: near peduncle, 2: near center, 3: near calyx end.

Suberization of fruit surface

Suberization of fruit surface is observed for 10 fully mature fruits, and is classified into 1: absent, 3: about half of fruit, 5: all fruit.

<Optional items>

Color of pubescence of one-year-old-shoots

Color of pubescence of one-year-old-shoots is observed for 10 normally growing vegetative shoots, and is classified into 1: no color, 2: white, 3: yellowish.

Pubescence on the back of mature leaf

Pubescence on the back of mature leaf is observed for 15 mature leaves, and is classified into 0: absent, 1: scarce, 3: thick.

Waving in leaf margin

Waving in leaf margin is observed for 15 mature leaves, and is classified into 3: scarce, 5: intermediate, 7: prominent.

Amount of pubescence on the back of young leaf

Amount of pubescence on the back of young leaf is observed for 15 newly unfolded leaves at flowering time, and is classified into 0: absent, 1: scarce, 9: present.

Spines of shoots

Spines of shoots are observed for 10 shoots, and classified into 0: absent, 9: present.

Color of flowering buds

Color of flowering buds is observed for 10 flowering buds, and classified into 1: orange red, 3: white, 5: light pink, 7: pink.

2. Secondary characters

<Essential items>

Vigor of tree

Vigor of tree is determined based on the elongation of newly sprouted shoots, and classified into 3: weak, 5: intermediate, 7: strong.

Number of branches

Number of one-year-old branches is counted for 2 trees, and classified into 3: few, 5: intermediate, 7: many.

Number of axillary fruit buds

Number of axillary fruit buds is counted for 10 one-year-old shoots, and classified into 3: few, 5: intermediate, 7: many.

Number of spurs

Number of spurs is counted for 10 fruiting branches, and classified into 3: few, 5: intermediate, 7: many.

Date of germination

Date of germination is determined for 2 trees at the time when 20 to 30% of all the buds have germinated, and classified into 3: early, 5: intermediate, 7: late.

Defoliation time

Defoliation time is determined for 2 trees when 20 to 30% of all the leaves fell, and classified into 3: early, 5: intermediate, 7: late.

Amount of pollen

Amount of pollen is observed for 2 trees at flowering time, and classified into 0: absent, 9: present.

Full bloom stage

Full bloom stage is observed for 2 trees when 80% of total flowers have flowered, and classified into 3: early, 5: intermediate, 7: late.

Harvest time

Harvest time is observed for 2 trees when half of total fruits were harvested, and classified into 1: very early, 3: early, 5: intermediate, 7: late, 9: very late.

Resistance to black spot

Resistance to black spot is determined for 2 trees, and classified into 1: low, 5: intermediate, 7: high.

<Optional items>

Number of petals

Number of petals per flower is counted for 20 flowers just after flowering, and classified into 5: intermediate, 6: large number, 7: very large number.

Color of anthers

Color of anthers not yet dehisced is observed for 20 flowers just after flowering, and classified into 1: white, 3: light pink, 5: deep red, 7: dark red, 9: deep orange.

3. Tertiary characters

<Essential items>

Fruit size

Weight of 10 fully mature fruits is measured for 10 fruits at harvest, and the size is classified into 1: very small (weight ≤ 24g), 3: small (25 ~ 199g), 5: intermediate (200 ~ 399g), 7: large (≥ 400g).

Fruit shape in longitudinal section

Fruit shape in longitudinal section is observed for 10 intact fruits at harvest, and classified into 1: oblate, 2: round, 3: broad elliptical, 4: spindle-shaped, 5: broad ovate, 6: obovate (Fig. 2).

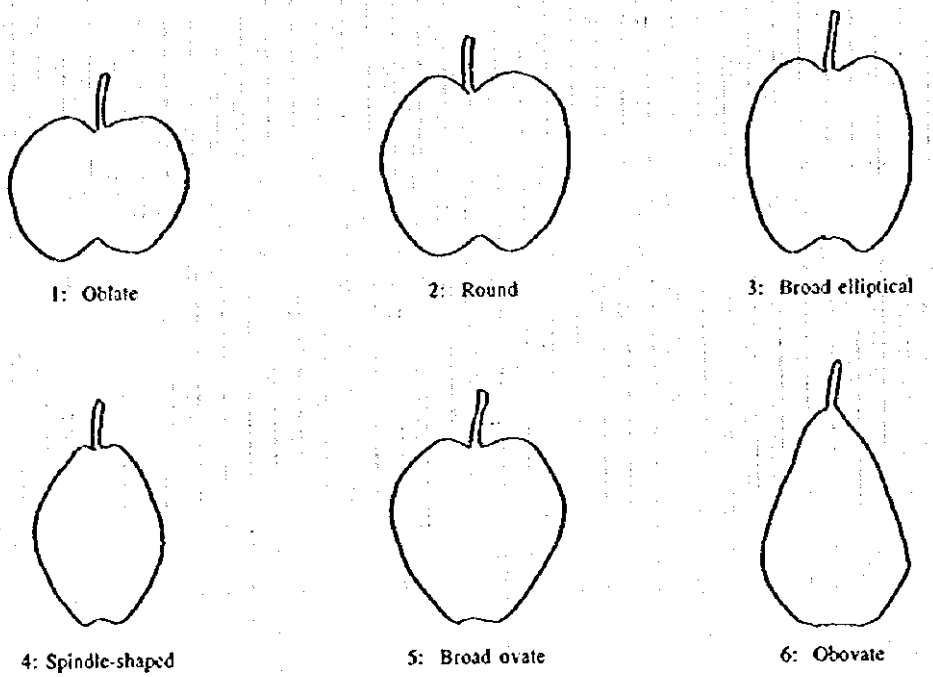

Fig. 2 Shape of fruit.

Presence of calyx

Presence of calyx is observed for 10 fully mature fruits at harvest, and classified into 3: in some absent and in others present, 9: present.

Color of flesh

Color of flesh is observed for 10 fully mature fruits at harvest in cross section, and classified into 3: snowy white, 5: white, 7: yellow white.

Firmness of flesh

Firmness of flesh is measured in cross section for 10 fully mature fruits at harvest using Magness-Taylor pressure tester (10 pound type with, 5/16 inch plunger), and classified into 3: soft (≤ 4.9 pounds), 5: intermediate (5.0 ~ 6,9 pounds), 7: firm (≥ 7.0 pounds).

Total soluble solid content

Total soluble solid content is determined for 10 fully mature fruits based on the refractometer index, and classified into 3: low (≤ 10.4%), 5: intermediate (10.5 ~ 12.4), 7: high (≥ 12.5%).

Acidity content

Acidity content is measured for 10 fully matured fruits with a pH meter, and classified into 3: low (≥ pH 4.7), 5: intermediate (pH4.4 ~ 4.6), 7: high (≤ pH4.3).

Astringency

Astringency is determined for 10 fully mature fruits based on sensory test, and classified into 0: absent, 9: present.

Aroma

Aroma is evaluated for 10 fully mature fruits based on sensory test, and classified into 0: no aroma (Shinsui), 1: extremely weak, 2: weak (Kousui, Chojuro), 9: strong (Ya-li).

Table eating quality

Table eating quality is determined for 10 fully mature fruits based on sensory test in terms of flavor, texture, etc., and classified into 1: extremely low, 3: low, 5: intermediate, 7: high, 9: very high.

<Optional items>

Core browning

Core browning is observed for 10 fully mature fruits just after harvest based on the degree of browning, and classified into 1: absent, 3: light, 5: moderate, 7: strong, 9: very strong.

Water core

Water core is observed for 10 fully mature fruits, and classified into 1: absent, 3: slight, 5: intermediate, 7: pronounced, 9: very pronounced.

Photo. 1 Variation of size of pear cluster and flowers.
Left: wild species, right: Japanese cultivated species (Kosui).

Photo.2 Field preservation of *Pyrus* genetic collection.

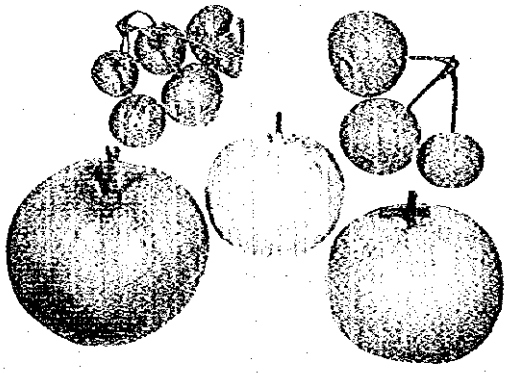

Photo. 3 Variation of size of pear fruits.
Above right and left: wild species, below: Japanese cultivated species
(left: Hogetsu, center: Nijisciki, right: Chojuro).

III. Peach

III-1. Cultivation of Peach Genetic Resources for Evaluation of Characteristics

III-2. Evaluation of Characteristics of Peach Genetic Resources

by

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III-1. Cultivation of Peach Genetic Resources for Evaluation of Characteristics

1. General properties

Peaches belong to *Prunus persica*; there are some other closely related wild species, *Prunus davidiana, Prunus amygdalus, Prunus mira,* etc. Peaches originated in northwestern China where the climate is dry and temperate, while some wild forms are found in temperate and subtropical areas. As a result, a wide range of variation in the degree of chilling requirement is found among peach genetic resources. Peaches from areas at low latitudes require a low degree of chilling and they are early blooming, while those from areas at high latitudes require a high degree of chilling and are late blooming, and sometimes normal blooming fails in subtropical areas.

2. Propagation

Rootstock

Peach seedlings are generally used as rootstocks. Stones are collected from a late maturing variety and washed well. They are kept in polyethylene bags at 5°C until spring. Germinated seeds are sown in nurseries in spring. When no refrigerator is available, stones are put in humid and cool soil until spring.

Preparation of scions

Two methods, budding and veneer-grafting, are applied for peach propagation.
In case of budding, semi-hard shoots are collected. All the leaves are removed from the scions, and used for budding immediately, because they become dry rapidly.
In case of veneer-grafting, one-year-old shoots are collected at the dormancy stage and stored in polyethylene bags in a refrigerator at 5°C. When scions become dry, grafting fails.

Budding and grafting

Budding is carried out from the end of summer to the beginning of autumn, late August to early September in Japan. New growth of shoots starts in the next spring.
Veneer-grafting is carried out in early to mid-spring, the beginning of February to mid-April in Japan. Grafting is practiced before bud break of scion and after late spring frost since spring frost might damage shoots of scions.

Management of nursery

Shoots are supported by poles to protect them from wind damage. Weed control and irrigation are necessary for raising nursery stocks. To prevent dryness, mulching with grasses or polyvinyl chloride sheets is efficient. Application of N, P, K fertilizers is necessary.

3. Planting (Transplanting)

Transplanting is carried out in the dormancy season, from December to early March in Japan. Half of the tips of plants and roots is cut back to accelerate the growth of shoots and rooting. Stocks are supported by poles. Irrigation is supplied adequately. Grass mulching is useful under dry conditions.

4. Preparation of cultivation field (Site selection and orchard design)

Well-drained and light soil is suitable for peach cultivation. Since strong wind causes spreading of bacterial shot hole, construction of shelter belts is necessary.

Fields for stock planting are thoroughly plowed at a depth of 60 to 100 cm, and compost and fertilizer are applied two or three months before planting. If the pH of the soil is lower than 5.0, soil acidity is corrected by applying $CaCO_3$, CaO or $Ca(OH)_2$. Stocks are planted at a spacing of more than 3 × 5 meters.

5. Training and pruning of trees

Center leader system is suitable for early fruiting. When trees are less than five years old, cutting back of fruiting shoots is not necessary. Only strong shoots longer than 100cm are cut in summer, and thinning of shoots is carried out in winter. For trees older than five years, pruning of shoots and scaffolds is practiced to maintain the tree vigor.

6. Thinning of flowers and fruits

The standard yield of peach is two to three tons per 10 a. Since trees bear a large number of flower buds (twenty to thirty times the number of final fruits), thinning of flower buds and fruits is necessary. Standard thinning involves one fruit per four to five short spurs, one fruit per medium length twig (20 to 40 cm), and two fruits per long fruiting shoot.

7. Soil management

Sod culture system is practiced among tree rows, while clean cultivation or mulching system is practiced under tree canopies.

8. Fertilizer application

N, P, K fertilizer is applied to maintain the vigor of the trees. Standard amount of N, P, K is 18 to 20 kg of N, 10 to 12 kg of P_2O_5 and 18 to 20 kg of K_2O. This amount is adjusted depending on the vigor of the trees. Dormancy season or early spring is suitable for fertilizer application. Fertilizer is scattered within a radius of two to three meters around the tree trunks. When the soil is dry, irrigation is applied.

9. Pest and disease control

Serious diseases of peach are as follows;

Diseases caused by fungi: brown rot, leaf curl, canker, blister canker, scab.

Chemicals are effective for the control of these diseases.

Diseases caused by bacteria: bacterial shot hole, crown gall.

To control bacterial shot hole, construction of shelter belts is necessary where strong wind blows, and it is also necessary to spray antibiotics in spring and Bordeaux mixture in autumn. Since crown gall is easily transmitted by soil, infected fields should not be used for nurseries. Scions from infected trees should not be used for grafting to avoid the transmission of bacterial diseases.

Diseases caused by viruses: prunus necrotic ring spot virus, prune dwarf virus.

Since these viruses are transmitted by grafting, seedlings should be used for rootstocks. In collecting scions, healthy trees should be selected. Since pollen transmission of viruses has been reported, infected trees should be isolated.

10. Harvest time

Harvest time is determined by the ground color of fruit skin and firmness of flesh. Generally, harvest time corresponds to the time when the ground color of skin turns greenish-yellow and the flesh becomes slightly soft. In the cultivars with nonmelting or stony hard, flesh harvest time cannot be easily estimated based on the onset of softening. In these cultivars, change of ground color of fruit skin is a good index.

III-2. Evaluation of Characteristics of Peach Genetic Resources

1. Primary characters

<Essential items>

Color of one-year-old shoots

Color of one-year-old shoots is observed for ten shoots with medium length at the dormancy stage, and classified into 3: green, 5: greenish red, 7: red.

Color of leaf

The color of leaf is observed from April to July, since the red color of leaf disappears after summer, and it is classified into 3: yellowish-green, 5: green, 7: red.

Shape of leaf

Shape of leaf is observed for two or three leaves sampled from the middle part of shoots with an average length in June. The length of 15 leaves is measured, and classified into 1: very short (≤ 12 cm), 3: short (12.1~14.0 cm), 5: intermediate (14.1~16.0 cm), 7: long (16.1~17.0cm), 9: very long (≥ 17.1cm).

Shape of petiole gland (Nectaries)

Shape of petiole gland is observed for 15 leaves from April to June, since nectaries sometimes disappear from old leaves, and classified into 1: no glands, 3: globose, 5: intermediate between globose and reniform, 7: reniform.

Flower type

Flower type is observed for 10 flowers at flowering time, and classified into 3: showy (rosaceous), 7: non-showy (campanulate). Showy indicates the normal type, and non-showy indicates the presence of very short petals.

Color of petal

Color of petal is observed just after blooming for 10 flowers, and classified into 2: white, 3: pale pink, 4: pink, 5: deep pink, 6: vermilion, 7: scarlet

Number of petals

Number of petals is observed just after blooming for 10 flowers, and classified into 3: single (5 petals), 5: semi-double (6-9), 7: double (≥10).

Fertility of pollen

Fertility of pollen is estimated as follows: pollen-fertile cultivars show yellow pollen grains when anthers are mashed by fingers. Observation is made just after the dehiscence of anthers for 10 flowers, and fertility is classified into 0: absent, 1: present.

Fruit shape

Height and width of fruits are measured at the firm ripe stage for 30 fruits with a typical shape and the ratio of height/width is calculated. Fruit shape is classified into 2: very flat (ratio ≤ 0.69), 3: slightly flat (0.7 ~ 0.94), 5: rounded (0.95 ~ 0.99), 6: ovate (1.0 ~ 1.04), 7: oblong (1.05 ~ 1.09), 8: elongated (≥ 1.1) (Fig. 1).

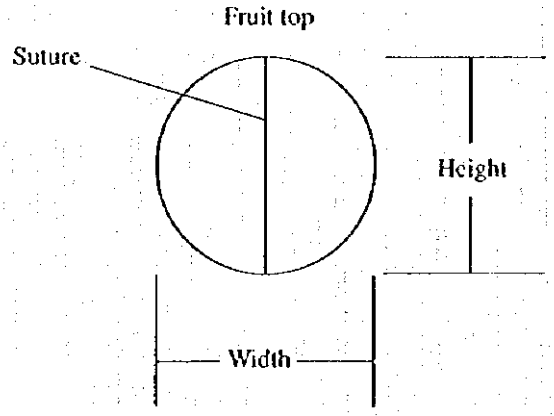

Fig. 1 Position for determination of fruit shape.

Ground color of fruit skin

Ground color of fruit skin is observed for 30 fully ripe fruits in the part which does not show red blush, and classified into 1: greenish-white, 2: white, 3: cream, 4: greenish-yellow, 5: yellow, 6: deep-yellow, 7: red.

Flesh color

Flesh color turns brown rapidly after cutting. Flesh color is observed for 30 fully ripe fruits just after cutting flesh, and classified into 1: greenish-white, 2: white, 3: creamy-white, 4: cream, 5: pale yellow, 6: yellow, 7: orange-yellow, 8: orange, 9: red.

Stone adherence to flesh of fully ripe fruit

Stones of the freestone type can be easily separated from the flesh, while in the clingstone type of stones it is difficult to separate them from the flesh. In the semi-freestone type, stones are partially separated from the flesh. Stone adherence is observed for 10 fully ripe fruits, and classified into 1: freestone, 3: semi-freestone, 5: semi-clingstone, 7: clingstone.

Shape of stone

Shape of stone is observed for 10 stones from fully ripe fruits, and classified into 1: very flat, 2: flat, 3: rounded, 5: ovoid, 7: elongated, 8: very elongated (Fig. 2).

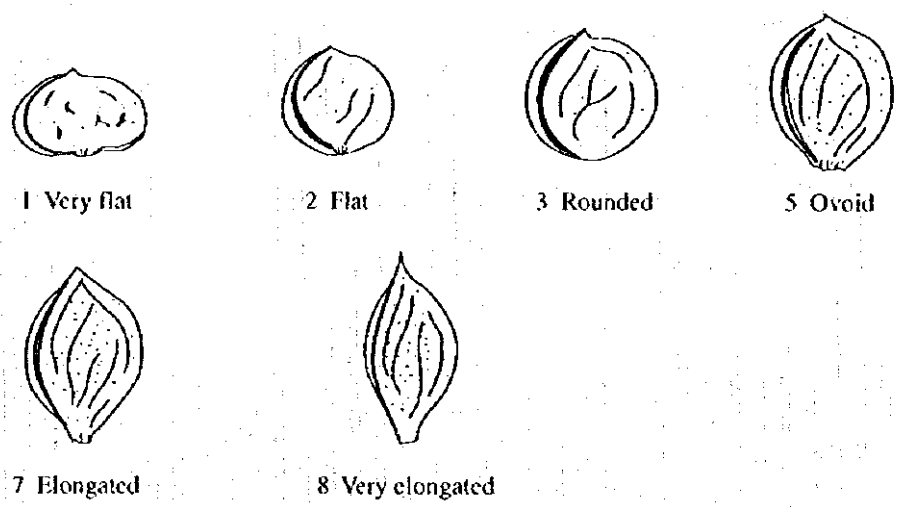

Fig. 2 Stone shape (lateral view).

2. Secondary characters

<Essential items>

Tree habit

Tree habit is determined by the observation of tree height and crotch angle of branches, and classified into 1: extremely upright (pillar type), 3: upright, 5: intermediate, 7: spreading, 9: weeping (Fig. 3).

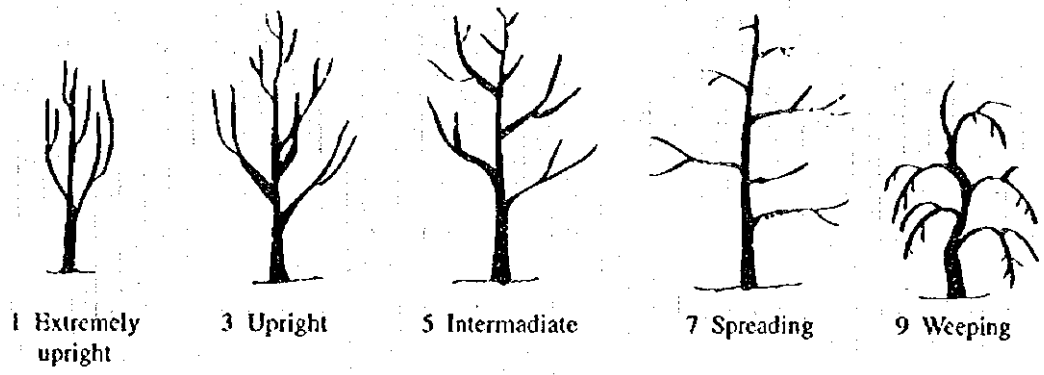

Fig. 3 Tree shape.

Tree vigor

Tree vigor is determined by the observation of shoot length and canopy size, and classified into 3: low, 5: intermediate, 7: high.

Number of flower buds

Number of flower buds is observed for 10 shoots at the dormancy stage, and classified into 3: few (≤ 5 /10cm), 5: intermediate (6 ~ 10 /10cm), 7: many (≥ 11/10cm).

Flowering time

Flowering time is estimated based on the date of full blooming when more than 80 % of the flowers opened, and classified into 1: extremely early, 3: early, 5: intermediate, 7: late, 9: extremely late.

Harvest season

Harvest season is determined based on the fruit developing period, days from full bloom to the middle of harvest, when half of the fruits are harvested, and classified into 1: extremely early (less than 70 days from full bloom), 3: early (71 to 100 days from full bloom), 5: mid-season (101 to 130 days from full bloom), 7: late (131 to 150 days from full bloom), 9: extremely late (more than 151 days from full bloom).

Degree of physiological fruit drop

Degree of physiological fruit drop is determined based on the ratio of number of harvested fruits / number of fruits just after thinning, and classified into 3: low (> 90%), 5: intermediate (71 to 90%), 7: many (≤ 70%).

Season of defoliation

Season of defoliation is determined by the observation of two trees on the day when 80 % of the leaves fell, and classified into 3: early, 5: mid-season, 7: late.

Susceptibility to bacterial shot hole

Susceptibility to bacterial shot hole is evaluated for two trees by field observation of the extent of infected leaves and fallen leaves, and classified into 3: low, 5: intermediate, 7: high.

<Optional items>

Productivity

Productivity is determined by the total weight of harvested fruits, and classified into 3: low, 5: intermediate, 7: high.

Resistance to *Meloidogyne* spp.

Seedlings are planted in *Meloidogyne*-infected fields, and the degree of root knot is observed in the dormancy season. The resistance to *Meloidogyne* spp. is classified into 3: low, 5: intermediate, 7: high, 9: very high (immune).

3. Tertiary characters

<Essential items>

Fruit size

Fruit size is expressed by the weight of fully ripe fruit of standard size. Measurement is made for 10 fruits and the fruit size is classified into 0: extremely small (weight ≤ 25 grams), 1: very small (26 ~ 50 grams), 3: small (51 ~ 100 grams), 4: slightly small (101 ~ 150 grams), 5: intermediate (151 ~ 200 grams), 6: slightly large (201 ~ 250 grams), 7: large (251 ~ 300 grams), 8: very large (≥ 301 grams).

Uniformity of fruit

Uniformity of fruit is determined based on the observation of size and shape of 10 fully ripe fruits, and classified into 3: low, 5: intermediate, 7: high.

Blushing (Red coloration of fruit skin)

Degree of blushing is determined based on the ratio of blushed area/non blushed area of fruit skin. Degree of blushing is evaluated for 10 fully ripe fruits, and classified into 0: absent, 1: very weak, 3: weak, 5: intermediate, 7: strong.

Pubescence of skin

Pubescence of skin is determined for 10 fully ripe fruits, and classified into 0: absent, 3: sparse, 5: intermediate, 7: abundant.

Susceptibility to skin cracking

Susceptibility to skin cracking is determined based on the skin cracking occurence of 10 ripe fruits, and classified into 1: no crcking, 3: low, 5: intermediate, 7: high.

Firmness of flesh

Firmness of flesh is determined based on the organoleptic test of 5 fully ripe fruits, and classified into 3: soft, 5: intermediate, 7: hard, 9: very hard.

Flesh texture

Flesh texture is determined based on the organoleptic test of 5 fully ripe fruits, and classified into 3: coarse, 5: intermediate, 7: fine.

Juiciness of flesh

The juiciness of flesh is determined based on the amount of juice extracted from 5 fully ripe fruits, and classified into 3: little, 5: moderate, 7: juicy.

Red coloration of flesh

Red coloration of flesh is observed for 5 fully ripe fruits, and classified into 3: low, 5: intermediate, 7: high.

Red coloration around stone

Red coloration around stone is observed for 5 fully mature fruits, and classified into 3: low, 5: intermediate, 7: high.

Sweetness of juice

Sweetness of juice is determined based on the refractometer index for 10 fully ripe fruits, and classified into 1: very low (≤ 8.0 % in Brix value), 3: low (8.1 ~ 10.9%), 5: moderate (11.0 ~ 12.9%), 7: high (13.0 ~ 14.9%), 9: very high (≥ 15.0%).

Acidity of juice

Acidity of juice is measured with a pH meter for 10 fully ripe fruits, and classified into 2: very low (pH ≥ 4.6), 3: low (pH 4.0 ~ 4.5), 5: moderate (pH 3.9 ~ 3.8), 7: high (pH 3.7 ~ 3.6), 9: very high (pH ≤ 3.5).

Quality of fruit

Quality of fruit is generally evaluated by the appearance, eating quality and flesh texture of fruits, and classified into 3: low, 5: intermediate, 7: high.

Shelf life of fruit

Shelf life of fruit is evaluated by the duration from the beginning of the test to the time when half of 20 ripe fruits kept at room temperature became too soft and damaged. It is classified into 3: short (≤ 2 days), 5: intermediate (3 ~ 4 days), 7: long (≥ 5 days).

Split-pit frequency

Split-pit frequency is determined based on the number of fruits with split pit per 10 fruits, and classified into 1: no split pit, 3: low (1 ~ 2), 5: intermediate (3 ~ 4), 7: high (≥ 5).

<Optional characters>

Astringency

Astringency is determined based on the organoleptic test for 10 fully ripe fruits, and classified into 1: no astringency, 3: low, 5: moderate, 7: high.

Browning of flesh

Browning of flesh is evaluated by the observation of the degree of browning one hour after cutting, and classified into 3: low, 5: intermediate, 7: high.

Processing suitability

Processing suitability is assessed based on the quality of canned peach or peach juice. Evaluation is based on the appearance, taste and ease of handling, and classified into 3: low, 5: intermediate, 7: high.

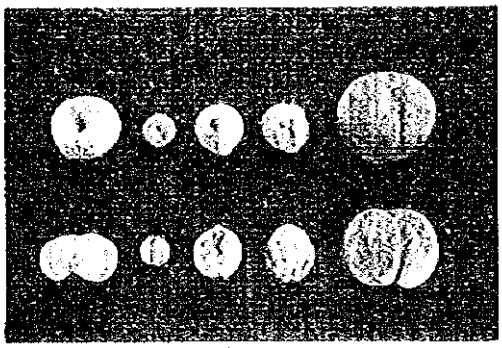

Photo 1. Fruits of wild and cultivated peaches.
From left: Flat peach, Ohatsumomo, Akita wild peach, Noto native peach, Kawanakajima hakutou.

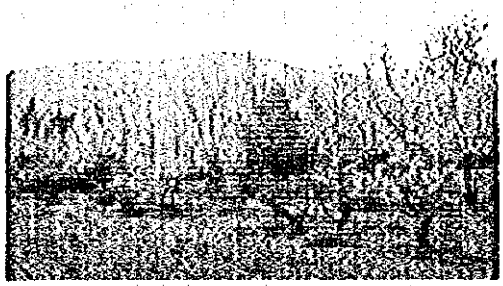

Photo 2. Flowering of ornamental peaches.

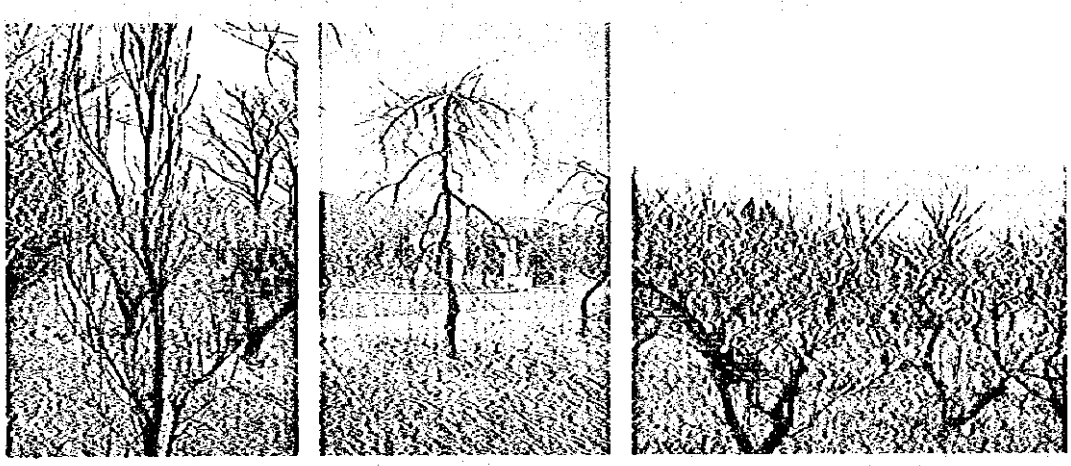

Photo 3. Shape of peach trees.
From left: pillar type, weeping type, dwarf type.

IV. Apricot

IV-1. Cultivation of Apricot Genetic Resources for Evaluation of Characteristics

IV-2. Evaluation of Characteristcs of Apricot Genetic Resources

by

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IV-1. Cultivation of Apricot Genetic Resources for Evaluation of Characteristics

1. General properties

Apricot belongs to the species *Prunus armeniaca*. *P. sibirica*, *P. mandshurica* and *P. mume*, etc. are closely related species. Apricot cultivars are classified into six eco-geographical groups: Central Asian group, Irano-Caucasian group, European group, Dzhungar-Zailij group, North Chinese group and East Chinese group.

Apricot trees are upright and vigorous, especially at the young stage. However, trees sometimes suddenly die since they are sensitive to canker and fluctuations of temperature in winter.

Most of the fruiting flowers are produced on spurs. The rate of fruit set varies since flowering occurs in early spring and is sensitive to frost damage.

As the quality of ripe fruits deteriorates easily on trees, the harvest season is short. Rain during the harvest season causes fruit cracking and diseases, especially in cultivars which originated from dry areas, and do not grow readily in a humid climate.

2. Propagation

1) Raising of rootstocks

As rootstocks, apricot seedlings are commonly used, while seedlings of peach, plum and mume can also be used.

Stones are collected from fully ripe fruits and washed well. These stones are kept in polyethylene bags to break the dormancy at 5°C until spring. To accelerate germination, seeds are taken out from stones before sowing.

2) Preparation of scions

In veneer-grafting, scions are collected from one-year-old shoots at the dormancy stage. Scions are covered with paper, and put into polyethylene sheets to prevent them from drying, and then, stored at 5°C until grafting.

In budding, scions are collected from semi-hard shoots and all the leaves are removed immediately. Grafting must be carried out as soon as possible since scions are sensitive to drying.

3) Grafting and budding

In Japan, veneer-grafting is carried out from early to mid-spring, namely from the beginning of March to mid-April. In Japan, budding is carried out from the end of summer to the beginning of autumn, namely from late August to the beginning of September.

4) Management of nursery

In the growing season, grafted nursery plants must be supported by poles to protect graft unions from wind. Weed control and the use of cutting suckers are important to accelerate the growth of grafted nursery plants. In dry areas, mulching with grasses or polyvinyl

chloride sheets is effective. Grafting tapes must be removed before biting into graft unions.

3. Planting (Transplanting)

Transplanting is carried out in the dormancy season from autumn to spring. Tips of plants, top roots and damaged roots are cut back to accelerate the growth of shoots and rooting. After planting, plantlets must be irrigated. Grass mulching is effective to prevent plants from drying.

4. Preparation of cultivation field (Site selection and orchard design)

Areas where late frost damage occurs must be avoided, because apricot trees bloom early in spring and they are sensitive to low temperatures before and after flowering. Fields with a high level of ground water must be also avoided because apricot roots need a high supply of oxygen.

Fields for planting are well plowed at 60 to 100 cm depth, and compost and fertilizer should be applied before planting.

5. Training and pruning of trees

Apricot trees develop fruits mostly on spurs, which play an important role in fruit production. For the maintenance and renewal of spurs, training and pruning are carried out so that abundant sunshine penetrates inside the crown.

6. Thinning of flowers and fruits

Since apricot trees produce too many flowers, removal of flowers or small fruits (thinning) is necessary to secure adequate production of fruits.

Thinning of flowers and fruits is effective not only for the production of fruits with a marketable size, but also for the maintenance of the tree vigor, since this practice prevents the waste of reserve nutrients. Thinning of fruits is usually carried out 20~25 days after full bloom. However, in a year with early flowering, thinning of fruits is practiced rather late to avoid late frost damage.

For cultivars with medium-sized fruits, the adequate number of leaves per fruit is 15~20, at 3~5 cm intervals between fruits. For cultivars with large-sized fruits, the adequate number of leaves per fruit is 25~30, at an interval of 5~10 cm between fruits.

7. Soil management

Sod culture is practiced among trees, and clean culture or mulch culture is practiced under tree crowns. Sod culture is effective in the prevention of soil erosion in hillside fields.

8. Fertilization

Compost is necessary to maintain the tree vigor. Nitrogen, phosphorus and potassium are applied as basal fertilizer, in the ratio of 10:5:8~10. Micronutrients are applied to prevent microelement deficiency such as boron deficiency.

9. Pest and disease control

Serious diseases caused by fungi are as follows: brown rot (*Monilinia laxa, M. fructicola*), scab (*Cladosporium carpophilum*), canker (*Leucostoma persoonii*).

Serious diseases caused by bacteria are as follows: bacterial shot hole (*Xanthomonas campestris* pv. *pruni*), bacterial canker (*Pseudomonas syringae* pv. *morsprunorum*).

Cherry tree borer (*Synanthedon hector*), oriental fruit moth (*Grapholita molesta*) and aphid are important insect pests.

Spraying of chemicals is necessary to protect apricot plants from these pests and diseases.

10. Harvest

During the ripening period of apricot fruits, soluble solids content of fruits increases, acid content decreases, firmness decreases and skin color changes. At the harvest stage, ground color of fruits at stem end turns yellow.

Since the quality of mature fruits easily deteriorates so that the harvest period is short, it is important to harvest adequately mature fruits and to avoid bruising of fruits.

IV-2. Evaluation of Characteristics of Apricot Genetic Resources

1. Primary characters

<Essential items>

Color of dormant shoots

Color of 10 one-year-old shoots with an average size is observed at the dormancy season, and classified into 3: grayish brown, 4: yellowish brown, 5: dark brown, 6: deep brown, 7: reddish brown.

Shape of leaf blade (ratio of length / width)

Fifteen leaves are sampled from the central part of three vegetative shoots with an average size (five leaves from each shoot) in July (in case of Japan), and the length and width are measured. Shape (average ratio of length / width) is classified into 2: extremely oblate (≤0.75), 3: oblate (0.76 ~ 0.85), 4: broad-oblate (0.86 ~ 0.95), 5: round-oblate (0.96 ~ 1.05), 6: round (1.06 ~ 1.15), 7: round elongated (1.16 ~ 1.25), 8: elongated (1.26 ~ 1.35), 9: extremely elongated (≥1.36).

Petal color

Petal color is observed for 10 just bloomed flowers at the full bloom stage (70~80% of flowers blooming), and classified into 3: white, 5: pale pink, 7: pink, 9: deep pink.

Petal shape

Petal shape is observed for 10 flowers which have just bloomed at the full bloom stage, and classified into 3: round flat, 5: round, 7: elliptical, 9: oblong elliptical.

Calyx color

Calyx color is observed for 10 flowers which have just bloomed at the full bloom stage, and classified into 3: yellowish green, 4: green, 5: pale red, 6: red, 7: reddish purple.

Fruit shape

Fruit shape is determined based on height, thickness and width (Fig. 2) of 10 fully ripe fruits, and classified into 3: round flat, 5: round, 6: round elliptical, 7: elliptical, 9: oval (Fig. 1).

Fruit size

Twenty fully ripe fruits are weighed, and the fruit size is classified into 1: extremely small (weight <20g), 3: small (21g~35g), 5: medium (36g~50g), 6: medium-large (51g~65g), 7: large (66g~80g), 9: extremely large (>81g).

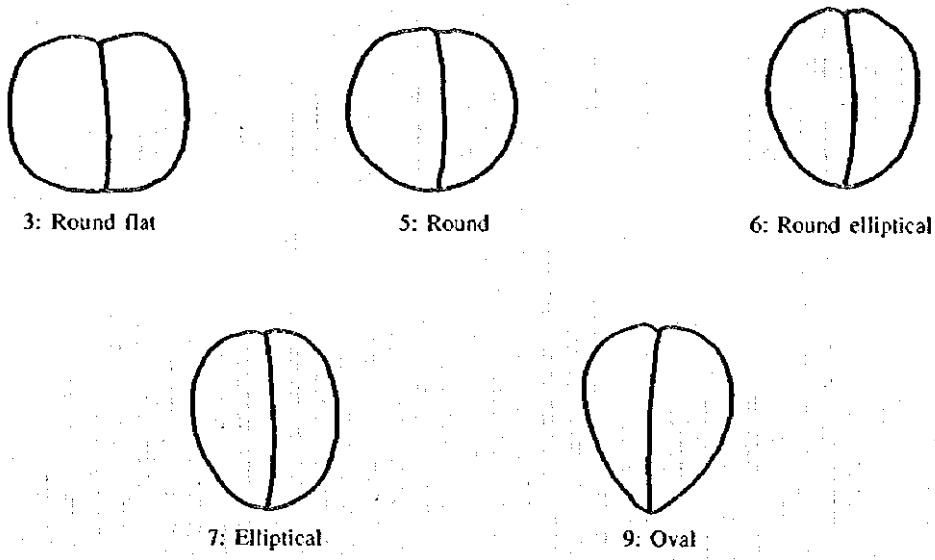

Fig. 1. Shape of apricot fruit.

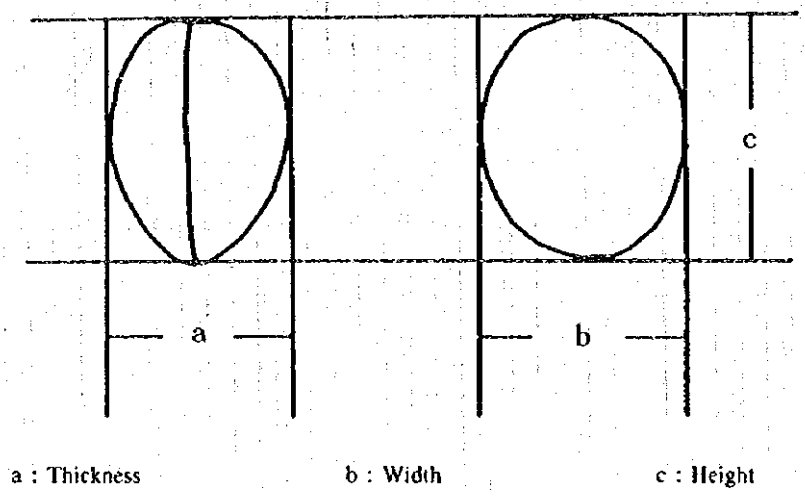

Fig. 2. Height, thickness, width of apricot fruits.

Ground color of fruit skin

Ground color of fruit skin is observed for 10 fully ripe fruits in the portion without red blushing, and classified into 2: cream, 3: light yellow, 4: yellow, 5: light yellowish-orange, 6: yellowish-orange, 7: orange, 8: red orange.

Flesh color

Flesh color is observed in a cross section of 10 fully ripe fruits just after cutting since the flesh color rapidly turns brown by cutting, and classified into 2: cream, 3: light yellow, 4: yellow, 5: light yellowish-orange, 6: yellowish-orange, 7: orange, 8: red orange.

Stone adherence to flesh

Stones of freestone type are easily separated from the flesh, while stones of clingstone type cannot be easily separated from the flesh, and stones of semi-freestone type are partially separated from the flesh. Stone adherence to the flesh is observed for 10 fully ripe fruits, and classified into 1: freestone, 3: semi-freestone, 5: semi-clinging stone, 7: clinging stone.

Shape of stone

Shape of stone is observed for 10 stones collected from fully ripe fruits, and classified into 2: round flat, 3: round, 4: round-elliptical, 5: elliptical, 6: oblong elliptical, 7: broad ovate, 8: ovate (Fig. 3).

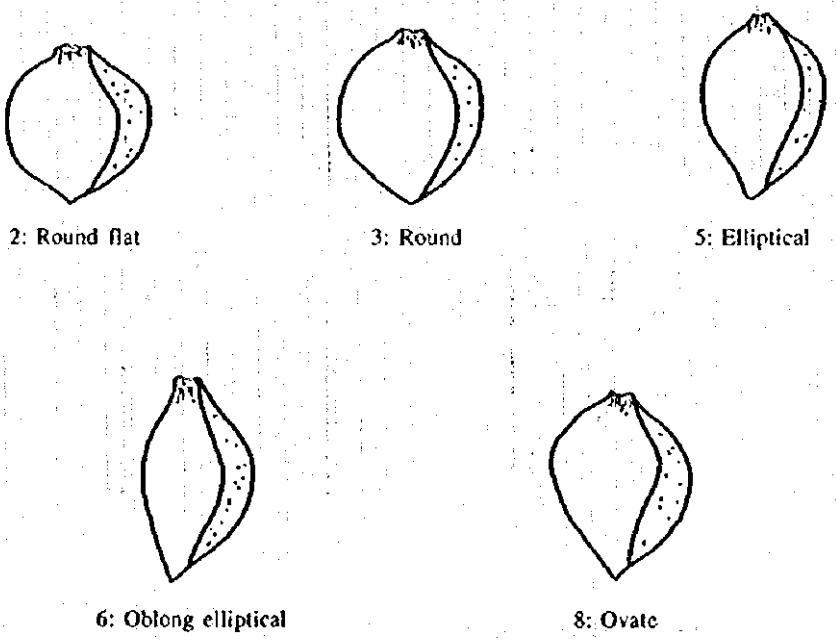

Fig. 3. Shape of apricot stone.

2. Secondary characters

< Essential items>

Habit of tree

Habit of tree is evaluated based on the angle between new shoots and scaffold on two trees, and classified into 3: upright, 5: intermediate, 7: spreading, 9: weeping.

Vigor of tree

Vigor of tree is evaluated based on the length and the thickness of shoots for 2 trees, and classified into 3: weak, 5: intermediate, 7: strong.

Number of branches

Number of one-year old branches grown from the upper 2m portion of secondary branches is counted, and classified into 3: few (≤20), 5: intermediate (21~40), 7: many (≥41).

Number of spurs

Number of one-year old shoots (more than 10cm in length) grown on two-year old branches over 1m in length is counted for ten branches, and classified into 3: few (< 10), intermediate (11~20), 7: many (> 21).

Number of flower buds

Number of flower buds within 10 cm of 10 branches is counted, and classified into 3: few (≤ 5), 5: medium (6~10), 7: many (≥ 11).

Flowering time

Flowering time corresponds to the day when two trees reached full bloom (70~80% of flowers bloom), and classified into 1: extremely early, 3: early, 5: intermediate, 7: late, 9: extremely late.

Physiological fruit drop

Physiological fruit drop is evaluated based on the difference between the number of fruits at harvest and that just after thinning, and classified into 3: few, 5: intermediate, 7: many.

Productivity

Productivity is evaluated based on the total weight of harvested fruits from two trees, and classified into 3: low, 5: intermediate, 7: high.

Harvest

Harvest is determined based on the period of fruit development for two trees: days from full blooming to the middle of harvest when half of the fruits are harvested, and classified into 1: extremely early (≤ 60 days), 3: early (61 ~ 75 days), 5: mid-season (76 ~ 85 days), 7: late (86 ~ 100 days), 9: extremely late (≥ 101 days).

Leaf fall time

Leaf fall time corresponds to the day when 80 % of the leaves of two trees in the field fall, and classified into 3: early, 5: mid-season, 7: late.

Resistance to bacterial canker

Resistance to bacterial canker is evaluated based on the degree of infection of fruits for two trees in fields, and classified into 3: low, 5: intermediate, 7: high.

<Optional items>

Fertility of pollen

Fertility of pollen is determined based on the appearance of yellow pollen grains in 10 flowers at full bloom when anthers are mashed by fingers just after dehiscence, and classified into 3: low, 5: intermediate, 7: high.

3. Tertiary characters

<Essential items>

Uniformity of fruit size

Uniformity of fruit is determined based on the size and shape of 10 fully ripe fruits, and is classified into 3: low, 5: intermediate, 7: high.

Blushing (Red coloration of fruit skin)

Degree of blushing is evaluated by the ratio of blushed area / non blushed area of the fruit skin in 10 fully ripe fruits, and classified into 1: no blushing, 3: slight, 5: intermediate, 7: large.

Fruit cracking

Degree of fruit cracking is determined based on the number of cracked fruits within 10 fully ripe fruits, and classified into 1: no cracking, 3: slight (≤2 fruits), 5: intermediate (3 ~ 4 fruits), 7: large (5 ~ 7 fruits), 9: very large (≥8 fruits).

Flesh texture

Flesh texture is determined for 10 fully ripe fruits based on sensory test, and classified into 3: coarse, 5: intermediate, 7: fine.

Firmness of flesh

Firmness of flesh is determined for 10 fully ripe fruits based on sensory test, and classified into 3: low, 5: intermediate, 7: high.

Extent of hollow between flesh and stone

Width of hollow between flesh and stone is determined for 10 fully ripe fruits, and classified into 3: small, 5: intermediate, 7: large.

Sweetness

Brix value of juice from 10 fully ripe fruits is measured with a refractometer to indicate sweetness, and is classified into 1: extremely low (Brix value ≤ 8.0%), 3: low (Brix value 8.1 ~ 10.0%), 5: intermediate (Brix value 10.1 ~ 13.0%), 7: high (Brix value 13.1 ~ 16.0%), 9: extremely high (Brix value ≥ 16.1%).

Acidity

Acidity is measured using a pH meter for 10 fruits, and classified into 3: low (pH ≥ 4.3), 5: moderate (pH 3.8 ~ 4.2), 7: high (pH 3.3 ~ 3.7), 9: extremely high (pH ≤ 3.2).

Aroma

Aroma is evaluated based on sensory test for 10 fully ripe fruits, and classified into 1: no aroma, 3: extremely weak, 5: weak.

Eating quality

Eating quality is determined based on sensory test for 10 fully ripe fruits, and classified into 3: poor, 5: fair, 7: good, 9: excellent.

Shelf life of fruit

Twenty fully ripe fruits are kept at a room temperature of around 25°C, and the change of quality is evaluated. The duration from the beginning of the test to the day when half of the fruits became too soft or damaged corresponds to the shelf life of fruit, and is classified into 3: short, 5: intermediate, 7: long.

Stone size

Size of 20 stones from fully ripe fruits is measured. The average value of length (cm) × width (cm) × thickness (cm) is used to indicate the size of stones, and classified into 1: extremely small (≤ 3.0), 3: small(3.1~7.0), 5: intermediate (7.1~10.0), 7: large (10.1~13.0), 9: extremely large (≥ 13.1).

<Optional items>

Astringency

Astringency is determined based on sensory test for 10 fully ripe fruits, and classified into 1: absent, 3: extremely low, 5: low, 7: moderate.

Juiciness of flesh

Juiciness of flesh is determined based on the amount of juice extracted from 10 fully ripe fruits, and classified into 3: little, 5: moderate, 7: juicy.

Suitability for processing

Suitability for processing is determined based on the appearance, taste, and ease of handling dry fruits or fruits in syrup, and is classified into 3: low, 5: fair, 7: high.

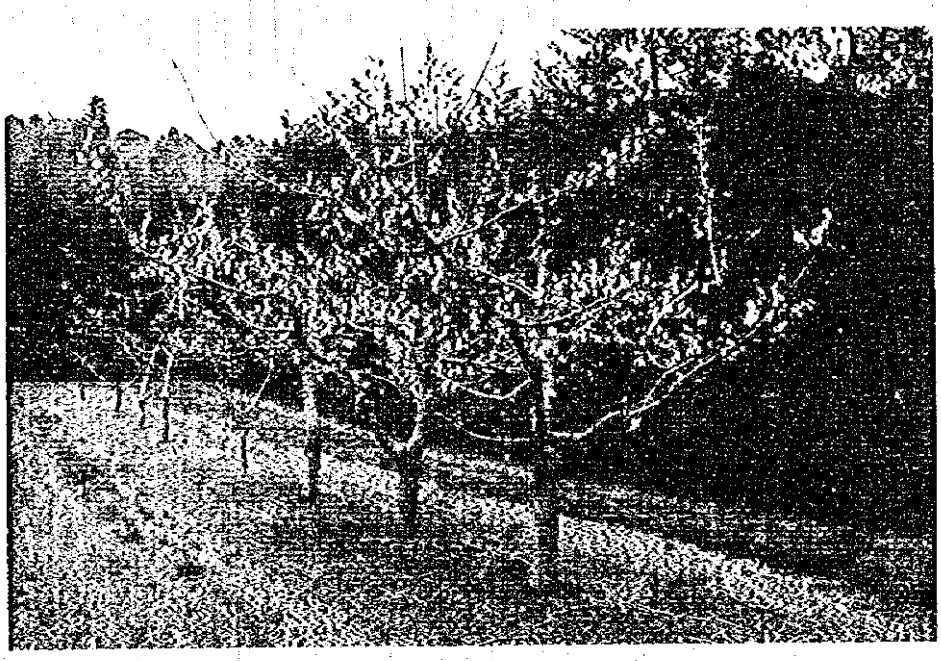

Photo. 1 Apricot genetic resources in fields.

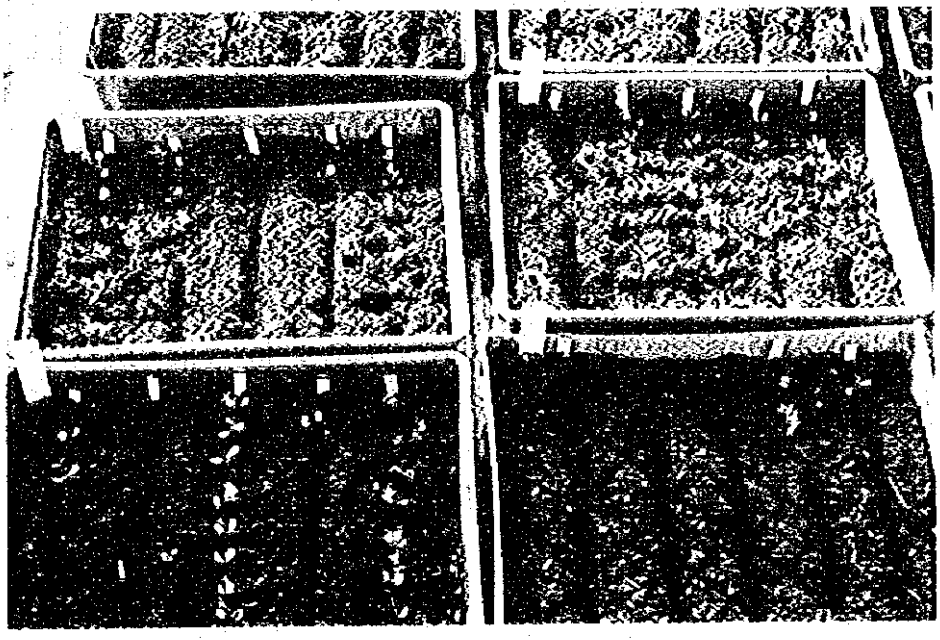

Photo. 2 Germination of apricots.

V. Persimmon

V-1. Cultivation of Persimmon Genetic Resources for Evaluation of Characteristics

V-2. Evaluation of Characteristics of Persimmon Genetic Resources

by

Akihiko Sato

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V-1. Cultivation of Persimmon Genetic Resources for Evaluation of Characteristics

1. Raising of rootstocks of Japanese persimmon

Japanese persimmon (*Diospyros kaki* Thumb.) trees are normally raised by grafting, because propagation by cutting is very difficult. As rootstocks, seedlings of *D. kaki* Thumb. and related species *D. lotus* L. are used. *D. lotus* is hardier than *D. kaki*, but susceptible to bacterial canker and incompatible with some of *D. kaki* cultivars such as Fuyu, Matsumotowasefuyu and Mushirodagosho.

To prepare seedlings for rootstocks, seeds of *D. kaki* are taken out from full- or over-mature fruits in late autumn or winter. The seeds are washed well to prevent fungus attack during storage. After being lightly dried for 2 or 3 days under shading, they are stored in polyethylene bags and kept at 5~10°C until the next spring.

Seeds are sowed in nursery fields in the next spring. After one year's growth, when tree trunks reach a diameter of about 8~12 mm, they can be used as rootstocks.

2. Grafting

Cleft grafting is usually carried out in spring. Graft unions are taped and graft unions and cuttings should be thoroughly covered with grafting wax. By top-grafting, which is usually successful, fruits can be harvested in the following year after top-grafting. Top-grafting is usually carried out in spring at the leafing time of rootstocks.

3. Pruning of trees

The top buds or two or three buds at the top of current shoots contain flower buds. Therefore, shoots should not be cut back in winter.

4. Pollinizer

Physiological fruit drop at early stages depends on the number of seeds in fruits and parthenocarpic ability. In cultivars with a low parthenocarpic ability, fruits containing a smaller number of seeds tend to fall 1~1.5 months after anthesis. For these cultivars, pollination is necessary to ensure fruit set. It is recommended that cultivars such as 'Zenjimaru', which produce female and male flowers, should be planted as pollinizers. Some cultivars such as 'Zenjimaru' produce not only female flowers but male ones. Thinning of flowers and fruits is effective in preventing biennial bearing and in promoting fruit growth.

5. Pest and disease control

Persimmon fruit moth (*Stathmopoda masinissa* Meyrick) is a major insect pest in Japan. Adults occur two times in a year, in June and August in the western part of Japan. Larvae pierce fruits and cause dropping. Pesticides are applied during the period of occurrence of adults or just before larvae pierce fruits.

The most serious disease in Japan is anthracnose (*Gloeosporium kaki* Hori). Young green shoots developing during the rainy season in Japan (June to July), and vigorous trees,

are easily infected. Fruits are also infected throughout the developmental stages when the density of fungi is high. Shoots and fruits affected by this disease should be removed from the orchard. Fungicide application just before rainy days is effective in preventing the occurrence of this disease during the growing season.

V-2. Evaluation of Characteristics of Persimmon Genetic Resources

Characteristics of persimmon genetic resources such as fruit weight and soluble solid concentration easily fluctuate from year to year, and from location to location, depending on environmental factors. For the evaluation of these characters, repeated measurements and comparison with check cultivars are recommended.

1. Primary characters

<Essential items>

Leaf size

Leaf size is measured for 20 leaves in summer and classified into 4: small (< 90cm^2), 6: intermediate (90 ~ 130cm^2) :8 large (≥ 131cm^2).

Leaf shape

Shape of leaf is classified into 3: ovate, 5: elliptical, 7: obovate.

Sex expression

Sex expression is classified into 1: having only female flowers, 2: having female and male flowers, 3: having female, male and perfect flowers.

Fruit size

Size of fruit is classified into 1: very small (weight ≤60g), 3:small (61 ~ 140g), 5: intermediate (141 ~ 220g), 7: large (221 ~ 300g), 9: very large (> 300g).

Fruit shape in longitudinal section

Shape of fruit in longitudinal section is classified into 1: wedge-shaped, 2: obovoid, 3: elliptical, 4: ovoid, 5: rounded, 6: square, 7: short conical, 9: flat (Fig.1).

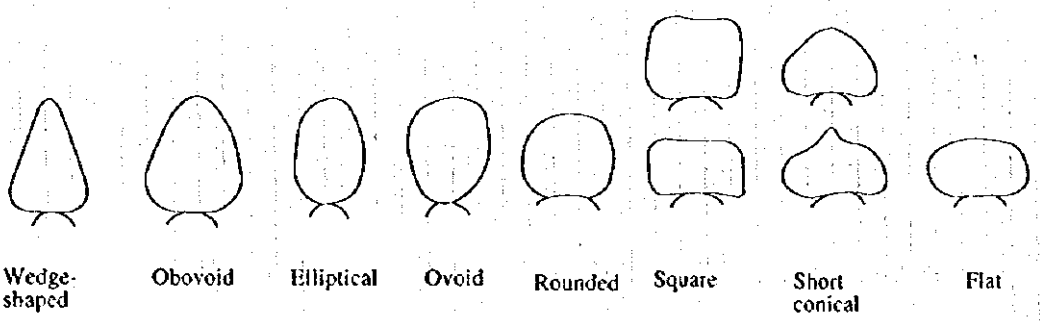

Fig. 1 Fruit shape in longitudinal section.

Fruit shape in cross section

Shape of fruit in cross section is classified into 3: elliptical, 5: rounded, 6: intermediate between rounded and square, 7: square.

Skin color of fruit at maturity

Skin color of fruit at maturity is classified into 1: greenish-yellow, 2: orange-yellow, 4: orange, 6: red-orange, 8: red, 9: black.

Classification based on astringency

Persimmon fruits are grouped into two types: non-astringent and astringent, depending on whether fruits lose astringency on trees at maturity. In addition, persimmon fruits are grouped into two types based on the change of the flesh color: darkened or unchanged under the influence of pollination. The former type is called pollination variant (PV) and the latter is called pollination constant (PC). Combining the two types of grouping, astringency of cultivars is classified into 1: PCA= pollination constant astringent type, 2: PVA= pollination variant astringent type, 3: PVNA= pollination variant non-astringent type, 4: PCNA= pollination constant non-astringent type (Photo. 1).

Grooves at fruit bottom

Grooves at fruit bottom are classified into 1: absent, 2: present (Photo. 2).

Grooves on fruit side

Grooves on fruit side are classified into 1: absent, 3: number of grooves is 1 ~ 3, 5: number of grooves is 4, 7: number of grooves is more than 5 (Photo. 2).

Shape of calyx

Shape of calyx is determined based on the ratio of width of calyx / length of calyx and classified into 1: very slender (ratio ≤1.0), 3: slender (1.01 ~ 1.20), 5: intermediate (1.21 ~ 1.50), 7: wide (1.51 ~ 2.00), 9: very wide (>2.00).

<Optional items>

Roughness of bark

Roughness of bark is classified into 3: rough, 5: intermediate, 7: smooth.

Secondary fruits

The presence of secondary fruits is classified into 1: absent, 2: present (Photo. 3).

Grooves at fruit apex

Grooves at fruit apex are classified into 1: absent, 2: present (Photo. 2).

Shape of hollow at fruit bottom from lateral view

Shape of hollow at fruit bottom from lateral view is classified into 3: swollen, 5: flat, 7: hollow like U letter.

Seed shape

Shape of seeds is classified into 1: no seeds, 2: long, 3: long triangular, 4: triangular, 5: elliptical, 6: rectangular, 7: intermediate between rectangular and rounded, 8: rounded (Fig.2).

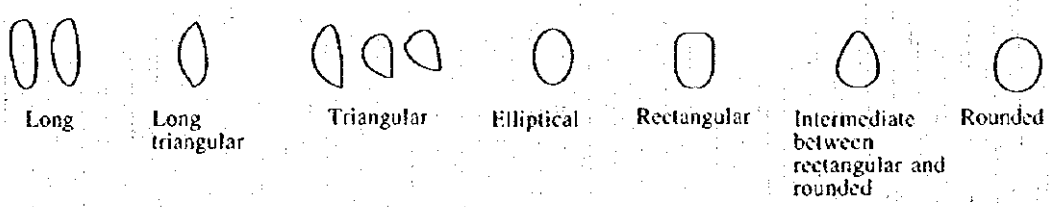

Fig. 2 Seed shape.

Seed color

Color of seeds of mature fruits is classified into 1: no seeds, 3: light, 5: intermediate, 7: dark.

2. Secondary characters

<Essential items>

Habit of tree

Habit of tree is classified into 3: spreading or drooping, 5: intermediate, 7: upright.

Vigor of tree

Vigor of tree is classified into 3: low, 5: intermediate, 7: high.

Sprouting time

Sprouting time is classified into 1: very early, 3: early (standard: Hiratanenashi), 5: intermediate (standard: Jiro), 7: late (standard: Fuyu), 9: very late (standard: Gosho).

Flowering time of female flowers

Flowering time is classified into 3: early (standard: Hiratanenashi, Nishimurawase), 5: intermediate (standard: Jiro, Saijo), 7: late (standard: Fuyu), 9: no female flowers.

Flowering time of male flowers

Flowering time is classified into 3: early (standard: Akagaki, Nishimurawase), 5: intermediate (standard: Zenjimaru, Shogatsu), 7: late, 9: no male flowers.

Number of female flowers

Number of female flowers is classified into 3: few, 5: intermediate, 7: many.

Number of male flowers

Number of male flowers is classified into 1: no male flowers, 3: few, 5: intermediate, 7: many.

Time of fruit maturity

Time of fruit maturity is classified into 2: very early (standard: Seidoshi), 3: early (standard: Izu, Nishimurawase), 4: semi-early (standard: Saijo, Hiratanenashi), 5: intermediate (standard: Koshuhyakume, Matsumotowasefuyu), 6: semi-late (standard: Yotsumizo, Mackawajiro) 7: late (standard: Jiro, Fuyu), 8: very late (standard: Hanagosho).

<Optional items>

Density of shoots

Density of shoots is classified into 3: low (standard: Gionbo), 5: intermediate (standard: Fuyu), 7: high (standard: Okitsu 20).

3. Tertiary characters

<Essential items>

Average fruit weight (g)

Curvature of calyx

Curvature of calyx is classified into 3: flat (standard: Fuyu), 5: semi-warped(standard: Jiro), 7: warped (standard: Saijo).

Brown specks in flesh

Brown specks in flesh are classified into 1: absent (standard: all PCA cultivars), 3: few (standard: Fuyu, Koshuhyakume, Aizumishirazu), 5: intermediate (standard: Shogatsu, Toyoichi), 7: many (standard: Nishimurawase, Kyara).

Fruit texture

Fruit texture is determined based on sensory test and classified into 3: coarse (rough), 5: intermediate, 7: fine, 9: very fine.

Soluble solids concentration

Soluble solids concentration is measured with a calibrated refractometer, that of astringent fruits is measured after removing astringency, for example by keeping fruits in polyethylene bags containing 35% ethanol at 18 ~ 20°C for a week.

Juiciness

Juiciness is determined based on sensory test and classified into 3: low (standard: Suruga), 5: moderate (standard: Jiro), 7: high (standard: Fuyu).

Seeds per fruit (including aborted seeds)

Number of fruits for counts should be recorded.

Cracking at fruit apex

Each fruit is scored into: no cracking=0, slight=1, small=4, intermediate=7 and large=10 according to Fig.3. Then, the index of cracking is calculated as the ratio of the sum of scores/ number of fruits. Cracking at fruit apex is classified using this index into 1: no cracking (index 0 ~ 0.09), 3: slight (0.1 ~ 0.99), 5: intermediate (1.0 ~ 2.4), 7: large (> 2.5).

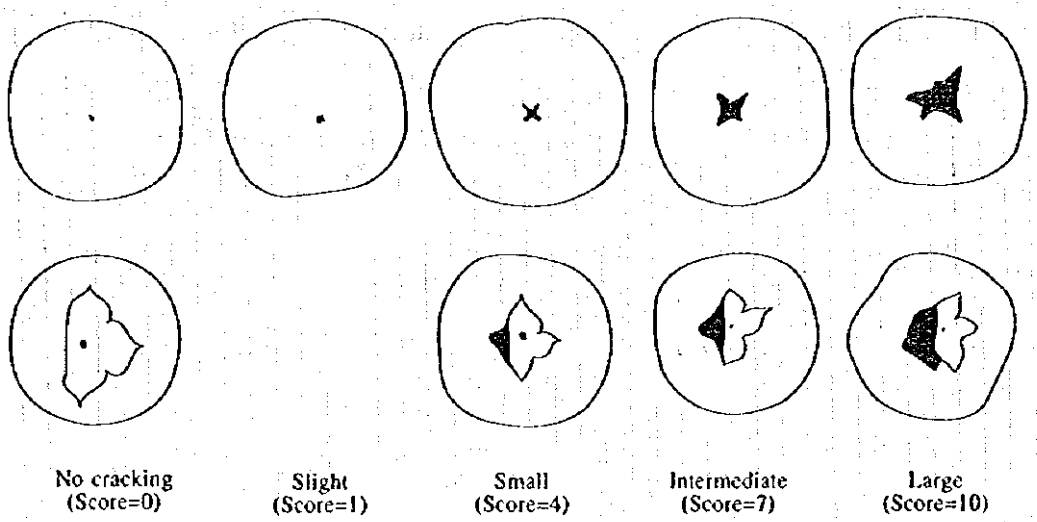

Fig. 3 Cracking at fruit apex (upper) and calyx end (lower).

Cracking at calyx end

Each fruit is scored into: no cracking=0, small=4, intermediate=7 and large=10 according to Fig.3. Then, the index of cracking is calculated as the ratio of the sum of scores/number of fruits. Cracking at calyx end is classified using this index into 1: no cracking (index ≤ 0.09), 3: slight (0.1 ~ 0.99), 5: intermediate (1.0 ~ 2.4), 7: large (> 2.5).

Stain of fruit skin

Number of fruits with stained skin is counted and stain of fruit skin is classified into 3: slight (< 25%), 5: intermediate (25 ~ 74%), 7: heavy (> 74%) (Photo. 4).

Physiological fruit drop at early stage

Degree of physiological fruit drop at early stage is observed at 1 to 1.5 months after anthesis and classified into 3: low (< 30%), 5: intermediate (30 ~ 50%), 7: high (> 50%).

Physiological fruit drop at late stage

Degree of physiological fruit drop at late stage is observed at harvest and classified into 3: low (< 30%), 5: intermediate (30 ~ 50%), 7: high (> 50%).

Yielding ability

Yielding ability is classified into 3: low, 5: intermediate, 7: high.

<Optional items>

Uniformity of fruit size

Uniformity of fruit size is classified into 3: low, 5: intermediate, 7: high.

Circular grooves at fruit apex

Circular grooves at fruit apex are classified into 1: no grooves, 3: few, 5: intermediate, 7: many (Photo. 4).

Mealiness of flesh

Mealiness of flesh is determined based on sensory test and classified into 3: no mealiness, 5: intermediate, 7: high.

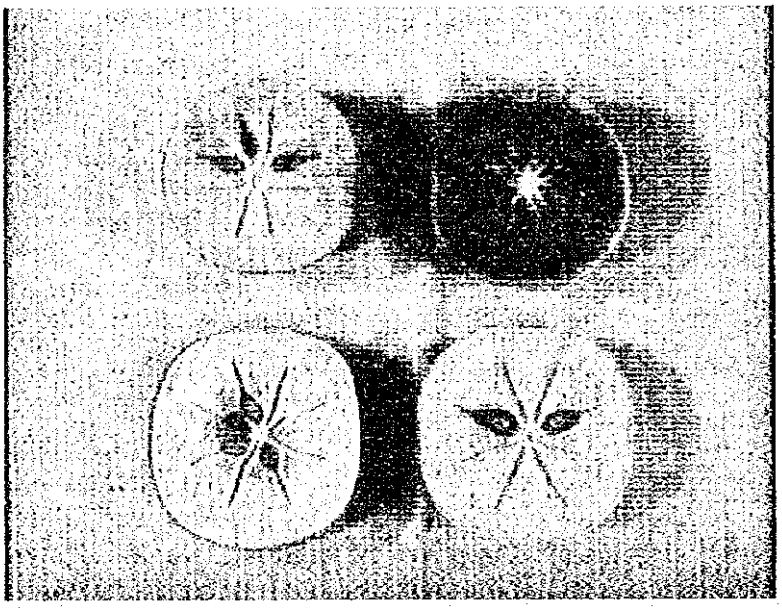

Photo. 1 Classification based on astringency.
Upper left: PCNA, upper right: PVNA, lower left: PVA, lower right: PCA.

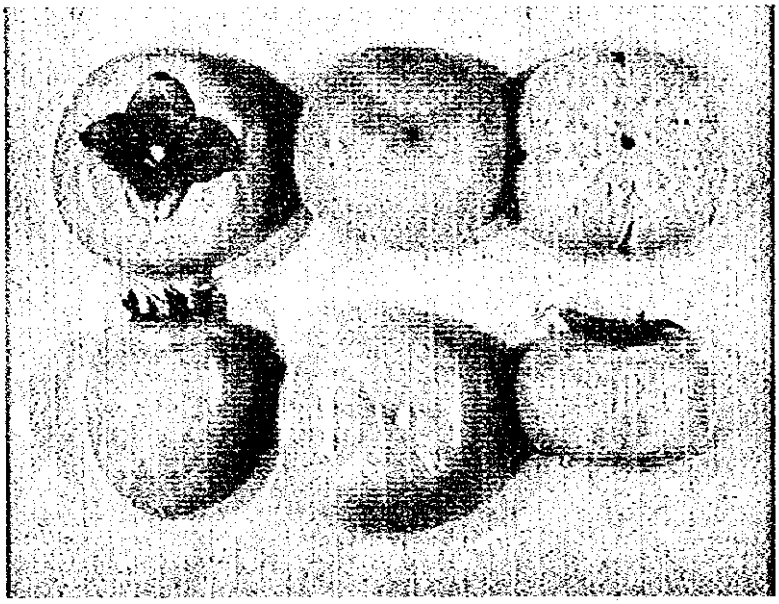

Photo 2. Left: grooves at fruit bottom, middle: grooves at fruit apex, right: grooves on fruit side.

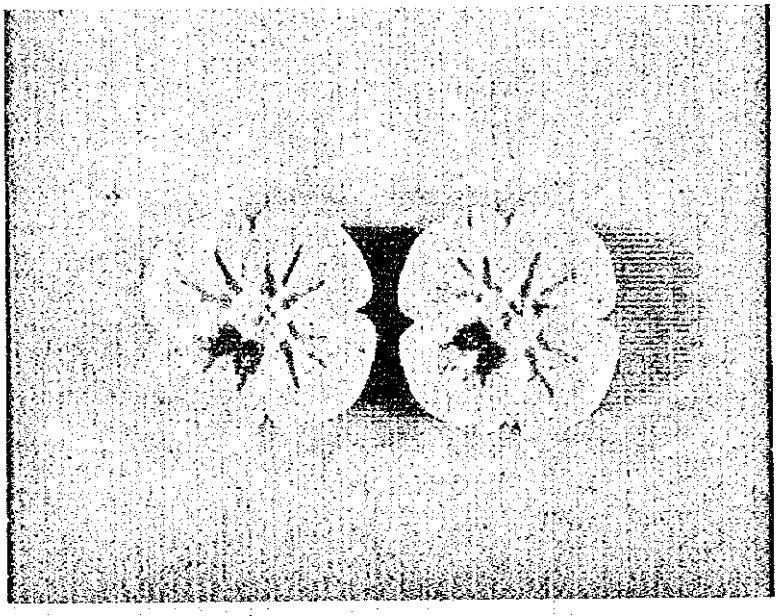

Photo. 3 Secondary fruits.

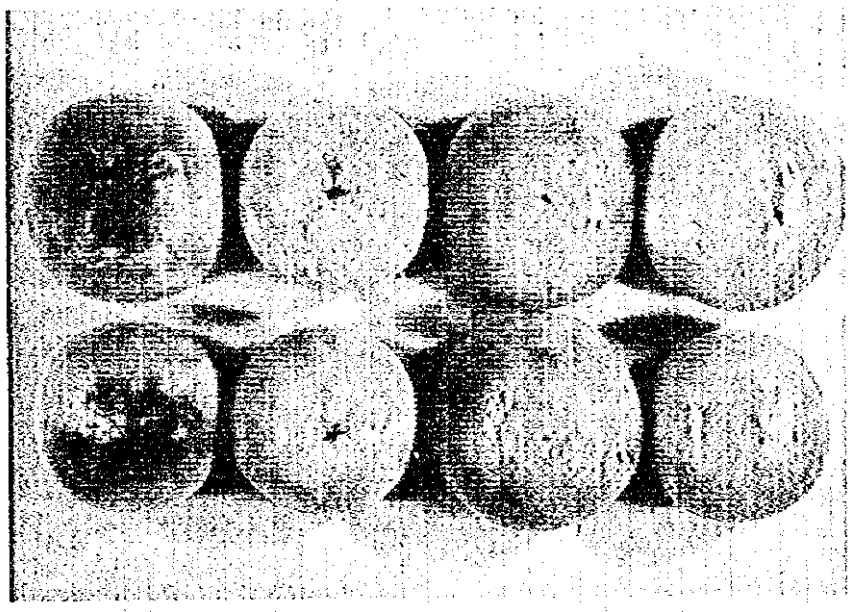

Photo. 4 Left: stain of fruit skin.
Right: circular grooves at fruit apex.

VI. Grape

VI-1. Cultivation of Grape Genetic Resources for Evaluation of Characteristics

VI-2. Evaluation of Characteristics of Grape Genetic Resources

by

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VI-1. Cultivation of Grape Genetic Resources for Evaluation of Characteristics

1. Propagation

Grapes are propagated by grafting or cutting. Grafted nursery stocks are generally used for the evaluation test. Nursery stocks raised by cutting are occasionally used for tests during a short period. Plants developed from some *Vitis* species native to North America are used as rootstocks to avoid grape Phylloxera infection. Cultivars for rootstocks are 5BB Selection Kober, SO4, 3309 Coudere, Riparia Gloire, 110 Richter, etc. Whip-grafting is carried out from early to mid-spring. Greenwood grafting is easier than whip-grafting. Details of various grafting techniques can be obtained from specialized books.

2. Preparation of cultivation field

Grapes grow normally in fields with good drainage and rather neutral soil with a pH of 6.5~7.0. Heavy soil can be improved by the addition of compost. For acid soil, it is necessary to apply lime to neutralize the soil pH. A vertical or horizontal trellis is set up to support grapevines.

3. Planting

Grafted nursery stocks should be planted in a shallow manner to prevent growth of roots of scions.

4. Pruning of vines

In cane-pruning of vines, canes are cut back leaving 5 to 15 buds. In cordon-pruning of vines, one or two buds are left on the cane.

5. Thinning of flower clusters and bunches

Vines usually bear too many flower clusters. If clusters and bunches in excess are not thinned out, vines will overbear, resulting in bunches of poor quality. Two or three bunches with a small or medium size, or one bunch with a large size are left on a bearing shoot of medium size. Thinning is practiced just before blooming or after berry setting.

6. Disease and pest control

Grapevines are affected by many diseases and pests. Among the diseases, anthracnose, gray mold, downy mildew, powdery mildew, ripe rot and viruses are serious. Among the pests, yellow tea thrips, grape borer and some kinds of mites are serious.

To control them, fungicides and pesticides should be applied periodically.

7. Harvest

Fruit bunches are harvested when they show the original skin color, original sugar and acid contents in juice. Harvest should be done in the morning at low temperatures, since fruits picked in the afternoon at high temperatures are prone to be poor in storability.

8. Shelf life

Shelf life is generally long in European grapes, while short in American grapes. However, bunches of American grapes can keep a good quality for two months when they are stored at -1~0°C with an antifungal substance.

VI-2. Evaluation of Characteristics of Grape Genetic Resources

Characteristics of mature leaves are evaluated on leaves at the seventh node of shoots at véraison time. Characteristics of bunches should be evaluated for untrimmed and unthinned bunches.

1. Primary characters

<Essential items>

Color of young shoot tips

Color of young shoot tips is observed for 10 growing shoots 10 to 20cm in length, and classified into 1: green-yellow, 2: light red, 3: red or violet-red, 4: violet. Observation should be repeated at least four times.

Color of woody shoots

Color of 10 woody shoots is observed after leaf fall, and classified into 1: yellow, 2: yellow-brown, 3: brown, 4: dark brown, 5: violet-brown.

Shape of mature leaf

Shape of mature leaf is classified into 1: wedge-shaped, 2: cordate, 3: pentagonal, 4: circular, 5: kidney-shaped (n=20), (Fig.1).

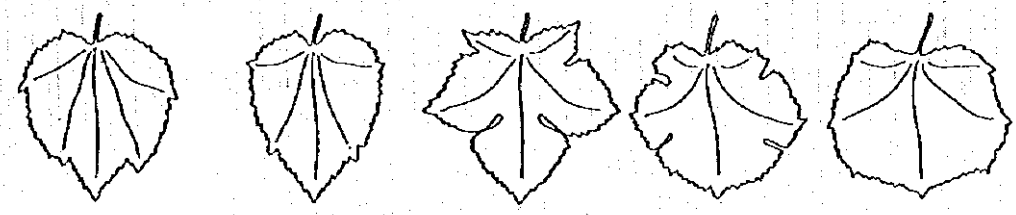

Fig. 1 Shape of mature leaf.

Number of lobes

Number of lobes is counted for 20 mature leaves, and classified into 1: 0, 2: three, 3: five, 4: seven, 5: more than seven.

General shape of upper lateral sinus

Shape of sinus near the tip of leaf is observed for 20 mature leaves, and classified into 1: absent, 2: open, 3: closed, 4: overlapping lobes.

General shape of petiole sinus

Shape of petiole sinus is observed for 20 mature leaves, and classified into 1: wide open, 2: open, 3: closed, 4: overlapping lobes.

Density of tomenta of leaf

Density of tomenta is observed between veins of the underside of 20 leaves, and classified into 1: absent or very low, 3: low, 5: intermediate, 7: high, 9: very high.

Sex of flower

Sex expression of flowers is observed for 10 flower clusters and classified into 1: male, 2: male to hermaphrodite, 3: hermaphrodite, 4: hermaphrodite to female, 5: female (Fig.2).

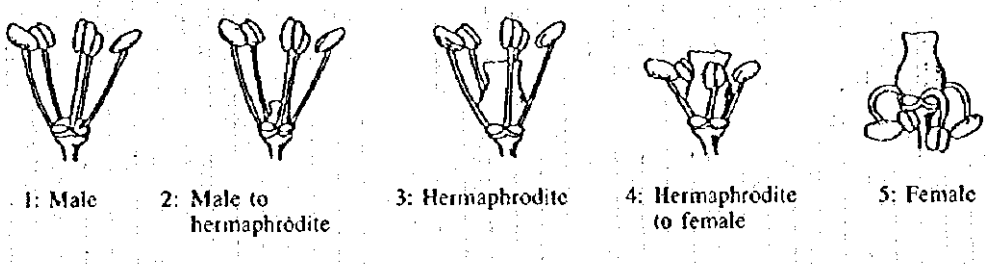

Fig. 2 Sex expression of flower.

Size of berry

Weight of berry is measured for 20 berries at harvest, and size of berry is classified into 1: very small (< 1.0g), 3: small (1.0~2.9g), 5: intermediate (3.0~5.9g), 7: large (6.0~9.9g), 9: very large (≥10.0g).

Shape of berry

Shape of berry is observed for 20 berries at harvest, and classified into 1: flat, 2: roundish, 3: short elliptical, 4: ovate, 5: obovate, 6: cylindrical, 7: long elliptical, 8: arched (Fig.3).

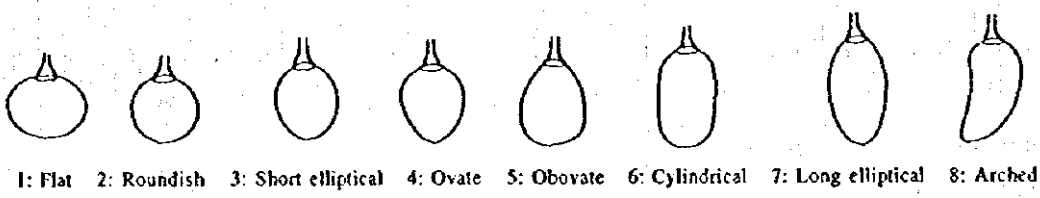

Fig. 3 Shape of berry.

Skin color of berry

Skin color of berry is observed for 20 berries at harvest, and classified into 1: green-yellow, 2: rose, 3: red, 4: red-brown, 5: violet red, 6: gray-red, 7: violet-black or blue-black.

Presence of seeds

Presence of seeds is observed for 20 berries at harvest, and classified into 1: absent, 3: present.

<Optional items>

Density of tomenta of young shoot tips

Density of tomenta of young shoot tips is observed for 10 growing shoots 10 to 20cm in length, and classified into 1: absent or very low, 3: low, 5: intermediate, 7: high, 9: very high.

Distribution of tendrils

Number of successive tendrils is counted for 10 shoots at flowering time, and classified into 1: ≤2, 3: ≥ 3.

Color of petiole

Color of sunburned side of petiole of 20 mature leaves is observed, and classified into 1: green, 2: light red, 3: red.

Color of peduncle

Color of sunburned side of peduncle is observed for 10 bunches at harvest, and classified into 1: light green, 2: green, 3: light red.

2. Secondary characters

For the evaluation of traits of plant, two plants should be observed.

<Essential items>

Vigor of vine

Vigor of vine is evaluated based on the thickness and length of shoots, and classified into 3: low, 5: intermediate, 7: high.

Sprouting time

Sprouting time corresponds to the time when the first leaf appears on 20 to 30 percent of buds of vines, and classified into 1: very early, 3: early, 5: intermediate, 7: late, 9: very late. For example, 3: Delaware and Kyoho, 5: Pione and Muscat Bailey A, 7: Kaiji and Rosaki.

Flowering time

Flowering time corresponds to the time when about 70 percent of calyptras of flowers shed or split, and classified into 3: early, 5: intermediate, 7: late. For example, 3: Campbell Early, 5: Delaware and Kyoho, 7: Kaiji and Rosaki.

Ripening time

Ripening time is determined based on the seed color and taste of fruits, and classified into 1: very early, 3: early, 5: intermediate, 7: late, 9: very late. For example, 1: Portland and Himrod, 3: Campbell Early and Kyoho, 5: Neo Muscat and Muscat Bailey A, 7: Koshu and Kaiji, 9: Emperor.

Fruit cracking

Degree of fruit cracking is observed at harvest, and classified into 1: no cracking, 3: slight, 5: intermediate, 7: large, 9: extremely large.

Shattering

Degree of shattering is determined based on the difference between the number of flower buds and number of set berries in a bunch, and classified into 3: slight, 5: intermediate, 7: large.

Resistance to anthracnose

Resistance to anthracnose is evaluated based on natural infection, and classified into 3: low, 5: intermediate, 7: high.

Resistance to downy mildew

Resistance to downy mildew is evaluated based on natural infection, and classified into 3: low, 5: intermediate, 7: high.

Resistance to ripe rot

Resistance to ripe rot is evaluated based on natural infection, and classified into 3: low, 5: intermediate, 7: high.

Resistance to powdery mildew

Resistance to powdery mildew is evaluated based on natural infection, and classified into 3: low, 5: intermediate, 7: high.

<Optional items>

Separation of berry from pedicel

Degree of separation of berries from pedicels is evaluated based on the observation of 5 bunches at harvest, and classified into 3: low, 5: intermediate, 7: high.

3. Tertiary characters

Characteristics of fruit are evaluated at harvest.

<Essential items>

Size of bunch

Average weight of five bunches is measured, and size of bunch is classified into 1: very small (<100g), 3: small (100~199g), 5: intermediate (200~349g), 7: large(350~549g), 9: very large (≥ 550g).

Compactness of bunch

Compactness of bunch is observed, and classified into 1: very low, 3: low, 5: intermediate, 7: high, 9: very high. For example, 3: Kyoho, 5: Muscat Bailey A, 7: Delaware.

Skin thickness of berry

Skin thickness of berry is determined for 10 berries, and classified into 3: thin, 5: intermediate, 7: thick. For example, 3: Rosaki, 5: Delaware, 7: Campbell Early.

Skin separation from flesh

Separability of skin from flesh is observed for 10 berries, and classified into 3: high, 5: intermediate, 7: low. For example, 3: Delaware, 5: Pione, 7: Muscat of Alexandria.

Difficulty of breaking down flesh during mastication

Difficulty of breaking down flesh during mastication is determined based on sensory test, and classified into 1: easy, 5: intermediate, 9: difficult. For example, 1: Muscat of Alexandria, 5: Kyoho, 9: Delaware.

Juiciness of flesh

Juiciness of flesh is determined for 10 berries based on the quantity of juice squeezed from a berry by pressing with fingers, and classified into 3: little juice, 5: intermediate, 7: juicy. For example, 3: Rosaki, 5: Delaware, 7: Kyoho.

Brix value of juice

Ten berries are sampled at random from each of five bunches, and they are squeezed. Brix value is measured with a refractometer for the juice, and classified into 3: low (< 15.0%), 5: intermediate (15.0~17.9%), 7: high (18.0~19.9%), 9: extremely high (≥ 20.0%).

Acidity of juice

A part of juice used for the measurement of Brix value is titrated with 0.1N NaOH to the end point of pH 8.1. Acidity is expressed in % of tartaric acid, and classified into 1: extremely low (< 0.35%), 3: low (0.35~0.54%), 5: moderate (0.55~0.74%), 7: high (0.75~0.94%), extremely high (≥ 0.95%).

Particular flavor of fruit

Particular flavor of fruit is determined based on sensory test, and classified into 1: no flavor, 2: muscat, 3: foxy, 4: others. For example, 1: Delaware, 2: Muscat of Alexandria, 3: Niagara, 4: Steuben and Himrod.

Number of seeds per berry

Number of seeds per berry is counted for 20 berries, and classified into 1: no seeds, 3: few (< 1.5), 5: intermediate (1.5 ~ 2.4), 7: many (≥ 2.5).

Number of flower clusters per shoot

Number of flower clusters per shoot is counted for 10 shoots of medium length, and classified into 1: very few (< 1), 3: few (1), 5: intermediate (2), 7: many (3), 9: very large number (> 3).

<Optional Items>

Shape of bunch

Shape of bunch is observed for five bunches, and classified into 1: globular, 2: cylindrical, 3: conical, 4: winged cylindrical, 5: winged conical, 6: poly-winged, 7: double-clustered (Fig.4).

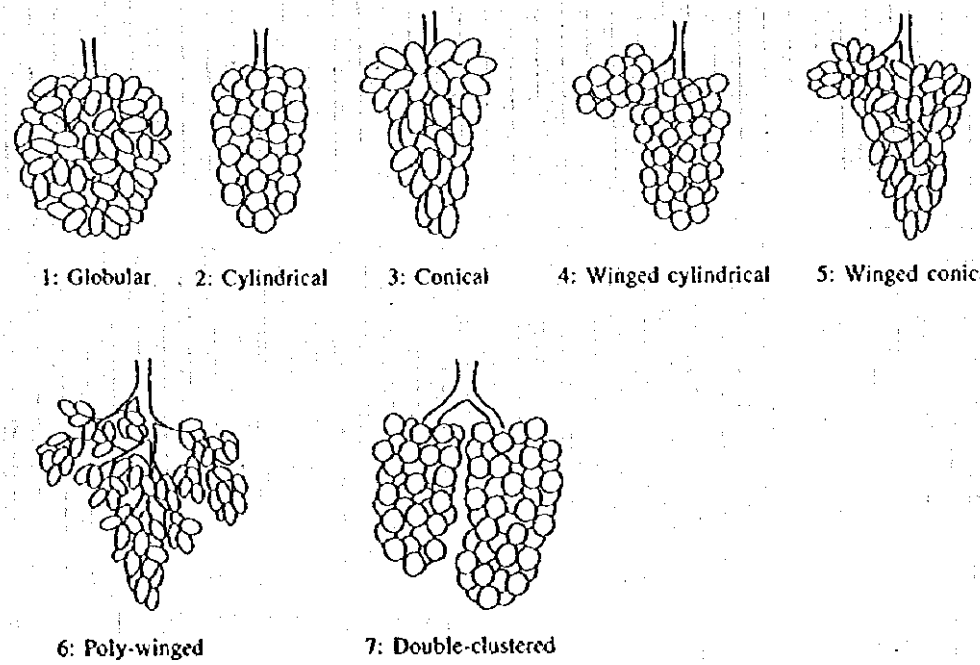

Fig. 4 Shape of bunch.

Average weight of berry

Twenty berries are sampled at random from a trimmed and thinned bunch and weighed. Sampling and weighing are repeated five times for different bunches. Average weight of berry is calculated and expressed to the first decimal in gram.

Degree of bloominess of berry

Degree of bloominess of berry is observed for 5 bunches at maturity, and classified into 3: low, 5: intermediate, 7: high. For example, 3: Kaiji, 5: Delaware, 7: Kyoho.

Firmness of flesh

Firmness of flesh is determined based on sensory test, and classified into 3: low, 5: intermediate, 7: high. For example, 3: Niagara and Portland, 5: Steuben, 7: Muscat of Alexandria.

Astringency of juice

Degree of astringency of juice is determined based on sensory test, and classified into 1: absent, 3: low, 5: moderate, 7: high.

Ease of coloring

There are two types of coloring of bunch, one by diffuse sunshine and the other by direct sunshine. Ten bunches are bagged after berries are set and their color is observed at harvest, and classified into 1: no coloring, 3: easy (coloring by diffuse sunshine), 5: intermediate, 7: difficult (coloring by direct sunshine). For example, 3: Muscat Bailey A and Campbell Early, 5: Kyoho and Pione, 7: Kaiji and Koshu.

Use

Use of fruit is classified into 1: fresh market, 2: wine, 3: fresh market and wine, 4: fresh market and juice, 5: rootstock.

Photo. 1 Color of young shoot tip.
Left: light red, right: red.

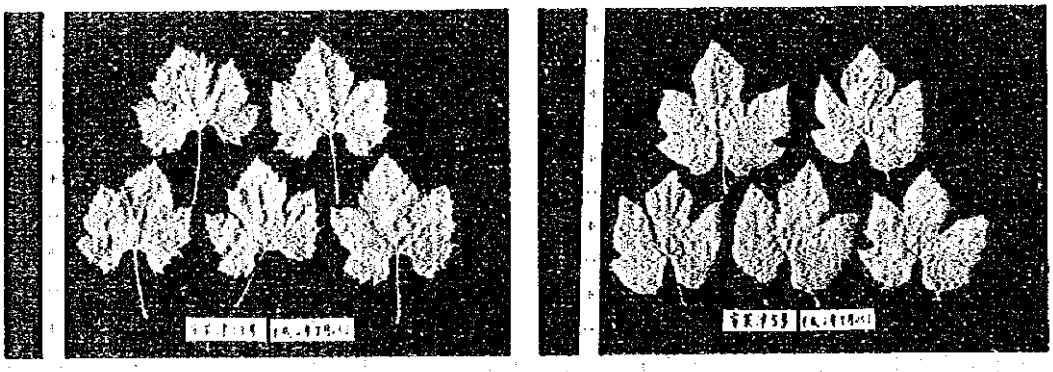

Photo. 2 Shape of mature leaf.
Left: pentagonal, right: pentagonal.
General shape of upper lateral sinus of mature leaf.
Left: lobes are overlapping, right: open.
General shape of petiole sinus of mature leaf.
Left: widely open, right: open.

VII. Chestnut

VII-1. Cultivation of Chestnut Genetic Resources for Evaluation of Characteristics

VII-2. Evaluation of Characteristics of Chestnut Genetic Resources

by

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VII-1. Cultivation of Chestnut Genetic Resources for Evaluation of Characteristics

1. General properties

The genus *Castanea,* consists of more than ten species, all of them originating and being distributed in the northern hemisphere. Among them, American (*C. dentata*), European (*C. sativa*), Chinese (*C. mollissima*) and Japanese (*C. crenata*) chestnuts are commercially cultivated, and the cultivation of American chestnut has decreased because of the occurrence of Endothia canker. Other related species which show some intermediate traits between *Castanea* and *Quercus* or *Shiia* are distributed in Southeast Asia.

2. Propagation

1) Raising of rootstocks

One-year-old seedlings are used for rootstocks. Large nuts should be used as seeds to obtain vigorous, well-developed rootstocks. The use of seedlings raised from seeds of the same species of scions is suitable for preventing graft incompatibility. Seeds for rootstocks are usually sown in early March. The seeds are planted laterally to promote vigorous and straight growth, and are covered with soil at a depth of 5 to 10cm. Before germination, straw mulching is effective to achieve uniform growth (Fig. 1).

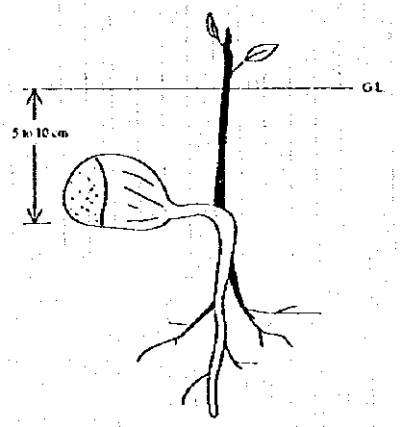


Fig. 1 Sowing and germination of chestnut seed.

2) Preparation of scions

Vigorous, well-developed current shoots, which do not bear nuts and are not water sprouts, are suitable for use as scions. Scions are collected before the end of February, when they are still at the dormant stage, and kept in polyethylene bags to prevent dehydration. It is necessary to put the name tags on the bundles, particularly in case of grafting of more than two lines. It is necessary to avoid low humidity and wet conditions. Success of grafting depends on the selection of slightly dehydrated scions. After careful packing, scions are stored in a refrigerator at 0 ~ 2°C.

3) Grafting

There are several grafting methods such as splice-grafting, whip-grafting, wedge-grafting, side-grafting, cleft-grafting, and inlay-grafting and budding, but, veneer-grafting is the most common in Japan. Grafting is usually carried out in spring, from the end of March to the middle of April in Japan. To avoid freezing injury, scions should be grafted at a height of 30 ~ 50cm above the ground level (Fig. 2).

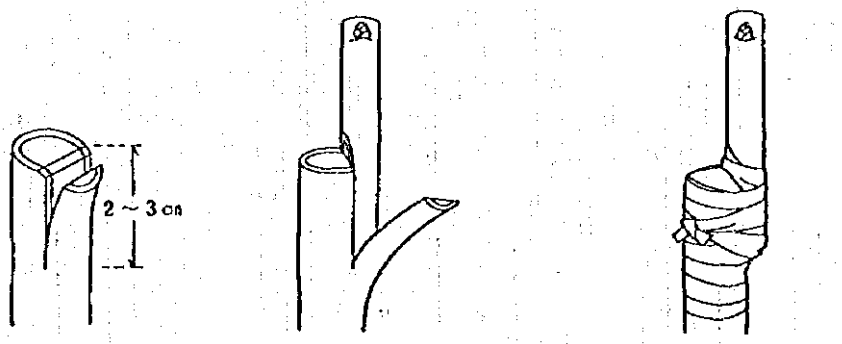


Fig. 2 Grafting of chestnut.

4) Management of nursery

Grafted nursery stocks should be tightly tied to stakes to avoid wind damage. After grafting, rootstocks tend to produce a large number of sprouts and suckers, which should be removed regularly, or they might disturb the growth of scions. Weeds should be controlled, and if necessary, fungicides or insecticides should be sprayed.

3. Planting (Transplanting)

In most cases, nursery stocks are planted in the field after growth for one year. Planting season occurs in fall or spring, but, spring planting is recommended for areas with heavy snow fall. Large planting holes with abundant drainage are suitable, but in case of heavy clay soil with limited drainage, small holes are suitable. To prevent damage such as bending down associated with strong wind or rain, plant materials should be tied tightly to stakes after planting (Fig. 3).

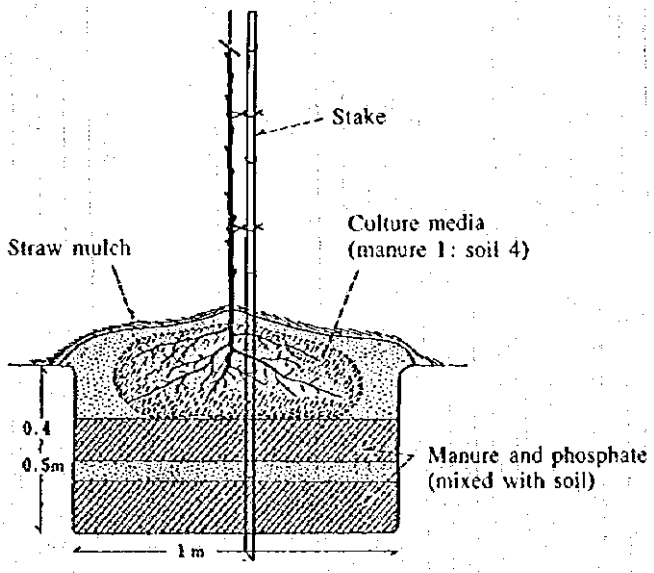


Fig. 3 Preparation of planting holes.

4. Preparation of cultivation field (Site selection and orchard design)

Land with gentle slope is suitable for planting to avoid freezing damage. Although chestnut trees show a wide adaptability to various soil types, the optimum results are obtained in the case of cultivation on sandy loam soil with adequate drainage. Chestnut trees grow well on slightly acid soils with optimum soil acidity of pH5.5 ~ pH6.0. Although planting space of 5×5m is common in commercial cultivation, space above 7×7m is recommended for the evaluation of genetic resources.

5. Training and pruning of trees

Modified central leader training has been carried out in traditional chestnut orchards, but, absence of training and pruning might be recommended for the evaluation of characters of genetic resources. Recently, low tree height cultivation method with simplified training has been gradually disseminated. Regardless of the methods adopted, excessive shoot removal should be avoided while trees are young (Fig. 4).

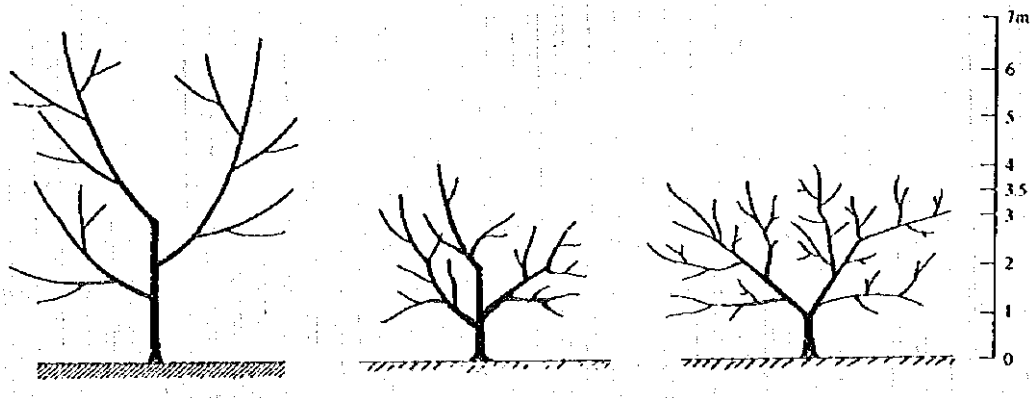


Fig. 4 Tree training system for chestnut.

6. Thinning of flowers and fruits

Thinning of flowers and fruits is not practiced commonly for chestnut trees, because training and pruning have the same effect on fruit bearing.

7. Soil management

Clean culture system is recommended to avoid competition for water and nutrients with grasses. On the other hand, sod culture system is recommended as it is free from nut contamination and soil borne-diseases such as trunk rot, caused by *Phytophthora castaneae*. In case of sod culture system, since competition for water and nutrients and damage caused by the Japanese swift moth *Endoclyta excrescens* increase, adequate control measures should be taken. Mulching is also commonly practiced, although removal of mulch at regular intervals is necessary to avoid damage by rats and other rodents.

8. Fertilization

In case of soil with low fertility, the amount of chemical fertilizer and organic materials applied should be increased. For adult trees, fertilizer is applied near the edge of tree crowns because roots become twice a wide as the spread of branches. Usually one half of the total amount is applied as basal fertilizer during the dormancy season, and the remaining is applied as side-dressing twice or three times.

9. Pest and disease control

There are many kinds of diseases and insect pests. The diseases and insect pests that frequently cause serious damage are as follows:

<DISEASES>

Chestnut blight, or canker (*Cryphonectria parasitica*)

Chestnut blight is one of the most destructive diseases of chestnut trees. American and European chestnut trees are highly susceptible to the disease, while Chinese chestnut trees are highly resistant but not immune. It has been shown that hypo virulent form of chestnut blight fungus is effective in disease control in Italy.

<INSECT PESTS>

Japanese giant silk moth (*Caligula japonica*)

Adults are 35mm long and 130mm wide. Larvae in the fifth instar are covered with white hair, and form a net-like cocoon. Larvae attack only leaves. Larvae in the fifth instar eat a large amount of leaves, and in some cases, whole leaves of well-developed trees are eaten up in a day or two. Eggs are laid in a mass mostly on the underside of main limbs. Collection and burning up of collected egg masses is the easiest and most effective method of eradication.

Chestnut gall wasp (*Dryocosmus kuriphilus*)

Adult wasps are about 3mm long. Adults attack vegetative buds and form galls, which disrupt shoot growth. Chestnut gall wasp has only one generation a year. Only female wasps have been collected. Although spraying might be useful during the adult emergence, cultural control such as removal of weak twigs at the time of pruning is more effective. Susceptibility of chestnut trees to this wasp depends upon the cultivars.

Peach moth (*Canogethes punctiferalis*)

This insect is a predator of many kinds of fruit trees, and chestnut and peach are most seriously damaged. It goes through two or three generations a year, and the damage by the second generation is very serious. The damage to early ripening cultivars is more serious than that to late maturing cultivars. Larvae feed on young burs and nuts.

Chestnut curculio (*Curculio sikkimensis*)

The adult is mottled brown in color and is remarkable for having a proboscis as long as the body. Adults lay eggs inside kernels directly through holes bored with the proboscis. Larvae, which are plump, legless and cream-colored, feed on kernels. They make circular holes in the shells and leave the kernels after feeding for 3 ~ 5 weeks. Daily collection of all nuts is an effective method of eradication of curculios.

10. Harvest

Chestnut requires regular harvest every one or two days. To estimate the ripening time and to evaluate the quality, burs and nuts are collected after they fell down naturally from trees. To avoid mixing of nuts with neighboring trees, burs, which cracked open, are harvested by striking down with poles to the ground.

11. Storage

Keeping the water content is, in general, most important for the storage of chestnuts. For the evaluation of genetic resources, nuts should be stored under humid conditions because drying exerts some adverse effect on eating quality and other characters. Particularly for maintaining the germinability of kernels, the following methods are recommended.

Stratification

Chestnuts are piled up with moistened sand, sphagnum or saw dust alternately in suitable containers, then placed in a refrigerator. Moisture content of stuffing must be checked periodically.

Refrigeration and storage in polyethylene bags

Chestnuts are put into polyethylene bags 0.03 ~ 0.05mm thick. Optimum temperature for storage is 0 ~ 2°C. If the bags are too thick or if too many nuts are put in a bag, nut decay may occur.

VII-2. Evaluation of Characteristics of Chestnut Genetic Resources

1. Primary characters

<Essential items>

Color of shoot

Average color of sunny side of ten shoots is evaluated in the resting period, based on color charts (Japan Horticultural Plant Color Standard) and classified into 1: grayish yellow (2214), 2: yellow (1916), 3: yellowish brown (1608), 4: light brown (1016), 5: brown (1309), 7: reddish brown (1009).

Shape of leaf tip

Three fully mature leaves in the middle part of shoots are collected from well-developed five current shoots. The average shape of the tip of these fifteen leaves is examined, and classified into 3: aristate, 4: attenuate acuminate, 5: acuminate, 7: acute (Fig. 5).

Fig. 5 Shape of leaf tip.

Shape of leaf base

Three fully mature leaves in the middle part of shoots are collected from well-developed five current shoots. The average shape of the base of these fifteen leaves is examined, and classified into 3: cuneate, 4: slightly cuneate, 5: acute, 7: obtuse (Fig. 6).

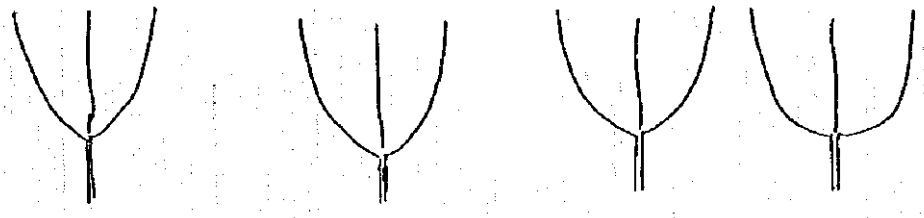


Fig. 6 Shape of leaf base.

Size of mature leaf

Three fully mature leaves in the middle part of shoots are collected from well-developed five current shoots. Average size of these fifteen fully mature leaf blades is measured in relation to area, length, length x width of leaf blade, and classified into 3: small, 5: intermediate, 7: large.

Length of male catkin

Average length of fifteen male catkins is measured at the full flowering stage, and classified into 3: short, 5: intermediate, 7: long.

Habit of male catkin

Average habit of male catkin is observed at full bloom for fifteen flowering shoots held upright, and classified into 3: upright, catkin axes remain straight, 5: intermediate, 7: spreading, tip of male catkin droops below the base of catkin (Fig. 7).

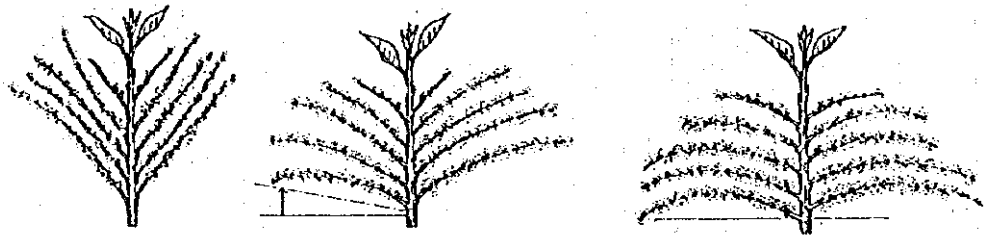


Fig. 7 Habit of male catkin.

Shape of bur

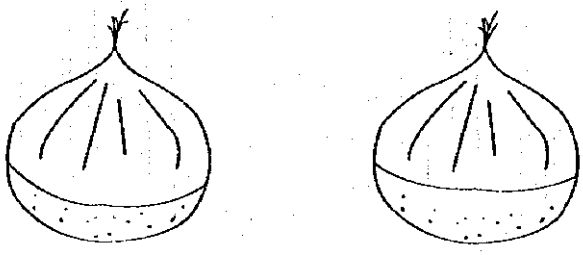
Shape of fifteen burs collected just before opening, which contain three intact fruits, is observed by measuring the width and height of the burs including spines, and classified into 3: globular, 5: flat globular, 7: squarely globular.

Length of spine

The average length of spine is measured for fifteen intact burs at full maturity, in relation to the length of the central branched spine from the base to tip, and classified into 3: short, 5: intermediate, 7: long.

Size of hilum

Fifteen outer fruits collected from fully mature intact burs containing three regular fruits are used for the measurements. The ratio of the hilum area to the surface area of the outer side is classified into 3: small (less than one-fifth of fruit surface), 5: intermediate, 7: large (more than one-third of fruit surface) (Fig. 8).



Less than 1/5 of surface

3: Small

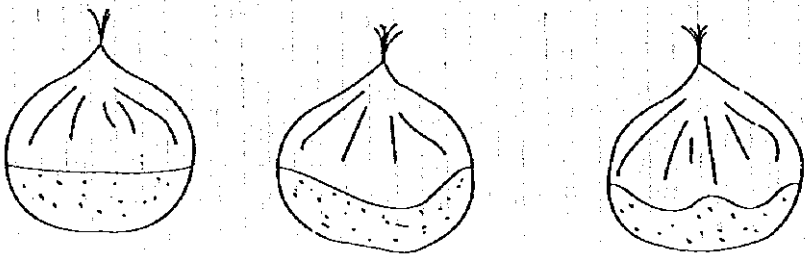
More than 1/3

7: Large

Fig. 8 Size of hilum.

Shape of separation line

Fifteen outer fruits collected from fully mature intact burs containing three regular fruits are used for the examination. The shape of the separation line on the outer side is classified into 3: straight, 5: curved, 7: undulate (Fig. 9).



3: Straight

5: Curved

7: Undulate

Fig. 9 Shape of separation line.

Color of pericarp

Fifteen outer fruits collected from fully mature intact burs containing three regular fruits are used for the examination. The average color of the pericarp is determined using color charts, and classified into 3: light brown (1007), 5: brown (1008), 6: reddish brown (710), 7: dark brown (1009), 8: dark purplish brown (719).

<Optional items>

Length of shoots

Average length of ten well-developed current season's shoots without burs is measured after leaf fall. Length is classified into 3: short, 5: intermediate, 7: long.

Thickness of shoot

Average diameter of well-developed current shoots without burs is measured in the middle part and expressed as thickness of shoot. Evaluation is repeated by the observation of whole tree after leaf fall. Classification into 3: thin (thinner than 6mm), 5: intermediate, 7: thick (thicker than 7mm).

Length of petiole

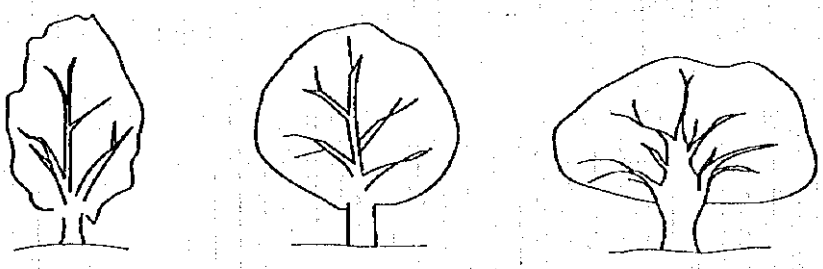
Three fully developed leaves are collected from the middle part of well-grown five current shoots and the average length of the petiole of these fifteen leaves is classified into 3: short (shorter than 20mm), 5: intermediate, 7: long (longer than 23mm).

2. Secondary characters

<Essential items>

Plant habit

By observing the shape of whole tree, ratio of tree height to width, angle of branching and direction of shoot elongation for two plants, plant habit after leaf fall, is classified into 3: erect, 5: intermediate, 7: spreading (Fig. 10).



3: Erect 5: Intermediate 7: Spreading

Fig. 10 Plant habit.

Tree size

By observing tree height, width of tree crown, and area occupied by tree crown after leaf fall, tree size is classified into 3: small, 5: intermediate, 7: large.

Density of shoots

Density of newly sprouted shoots is determined after leaf fall, and classified into 3: low, 5: intermediate, 7: high.

Time of bud burst

Loosing of the scales of buds on the tips of shoots which appeared in the previous year and development of a greenish color inside correspond to bud burst. The time of bud burst is defined as the date when 20% of the terminal buds reached the bud burst stage. Observation is carried out for two trees, and the time of bud burst is classified into 3: early, 5: intermediate, 7: late, 9: extremely late.

Time of leaf fall

The fall of about 80% of total leaves corresponds to the time of leaf fall. Observation is carried out for two trees, and the time of leaf fall is classified into 3: early, 5: intermediate, 7: late.

Resistance to chestnut gall wasp

Resistance to chestnut gall wasp is evaluated based on the ratio of gall formation, size of galls and area where gall are formed. Observation is carried out for two trees, and the resistance is classified into 3: low, 5: intermediate, 7: high, 9: very high.

Flowering time

The intermediate day between the beginning of blooming (20 to 30% of male catkins start to bloom) and end of blooming (80% of catkins fell down) corresponds to the flowering time. Two trees are observed, and the flowering time is classified into 1: extremely early, 3: early, 5: intermediate, 7: late, 9: extremely late.

Ripening time

Ripening time occurs basically when fruits drop naturally. However, for the evaluation of genetic resources, the time when burs crack open, corresponds to ripening time, which coincides with the intermediate day between the first harvest and the last harvest. Observation is carried out for two trees, and the ripening time is classified into 1: extremely early, 3: early, 5: intermediate, 7: late, 9: extremely late.

Size of bur

Size of ten intact burs which contain three fruits is evaluated just before open cracking, laterally and from side, including spines, and classified into 3: small, 5: intermediate, 7: large.

Density of spines

Average density of spines is determined for ten fully ripe burs, and classified into 0: no spines, 3: low, 5: intermediate, 7: high.

<Optional items>

Vigor of tree

Vigor of tree is evaluated based on the dimension of the tree trunk, length and thickness of current shoots, angle of shoot branching, etc. Observation is carried out for two trees, and vigor is classified into 3: low, 5: intermediate, 7: high.

Amount of female inflorescences

The amount of female inflorescences is determined based on the number of female inflorescences per shoots in the previous year and number of flowers per current shoots. At full bloom, when all the stigmas of three florets are fully elongated and spread, observation is carried out for two trees, and the amount is classified into 3: small, 5: intermediate, 7: large.

Length of peduncle

Average length of ten peduncles of the burs with three fruits is measured at the full ripening stage, and classified into 3: short, 5: intermediate, 7: long.

Thickness of peduncle

Thickness of the peduncles used for the measurement of the length of the peduncles is measured in the middle part, and classified into 3: thin, 5: intermediate, 7: thick.

3. Tertiary characters

<Essential items>

Size of fruit

Size of fruit is determined based on average weight of fruit, shape of fruit, actual length, width of fruit, etc. Thirty fruits are used, and the size is classified into 1: extremely small, 3: small, 5: intermediate, 7: large.

Density of tomenta on fruit tip

Density of tomenta is observed for outer fruits from above, in relation to the distribution area. Observation is carried out for 30 fruits, and the density is classified into 3: low, 5: intermediate, 7: high (Fig. 11).

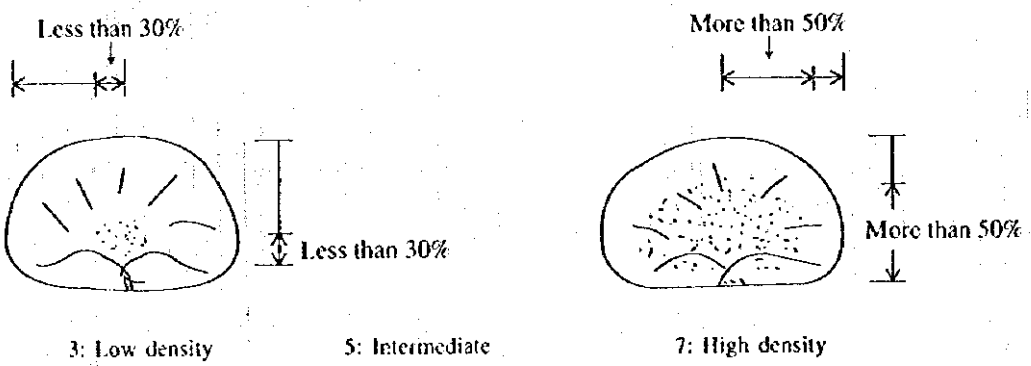


Fig. 11 Tomentum on fruit tip.

Shape of outer fruit

Shape of 30 outer fruits from 15 burs, which contain 3 fruits, is examined laterally, in relation to width, height, ratio of width to height, position of maximum width, shape of fruit apex, curved line on shoulder and hilum, etc. Shape is classified into 2: tall triangular, 3: triangular, 4: rounded triangular, 5: rounded flat triangular, 6: round, 7: concave round, 8: flat round (Fig. 12).

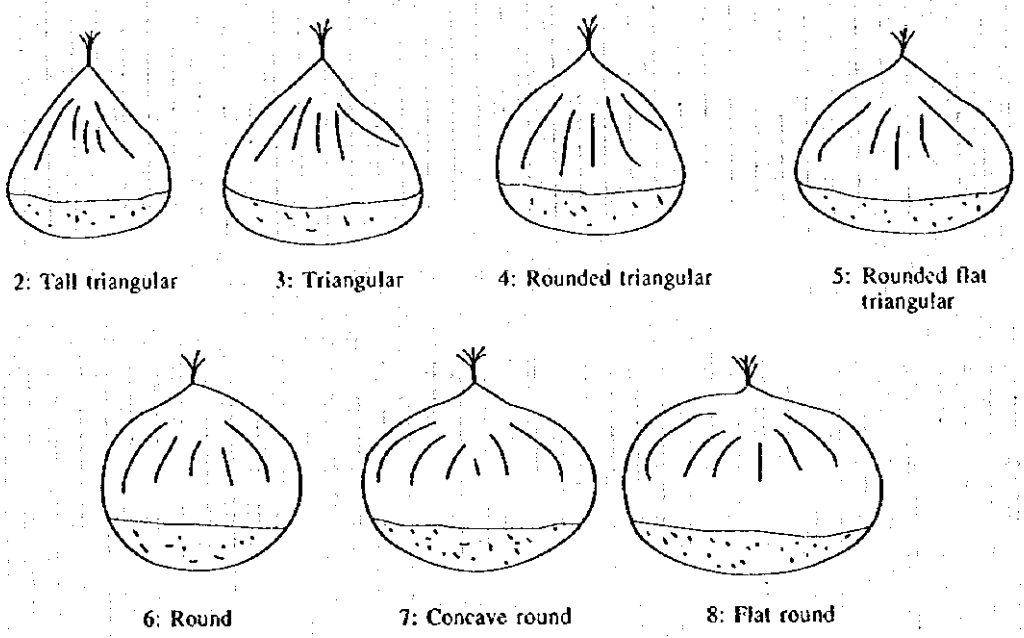


Fig. 12 Shape of outer fruit.

Split of pericarp

Split of pericarp which mostly occurs at apexes and also on the body and hilum is checked at harvest. Observation involves more than 30 fruits. Split is classified into 3: minimal (<10%), 5: intermediate, 7: Large (>15%).

Polyembryony

Fruits which bear more than 2 kernels are categorized into polyembryony at harvest. More than 30 fruits without split pericarp are cut near apex and observed. Polyembryony is classified into 3: minimal (<8%), 5: intermediate, 7: large (>20%).

Pellicle separability

Ease of peeling the pellicle after steaming and roasting is tested for 10 fruits, respectively, and classified into 3: easy, 5: intermediate, 7: difficult.

Color of steamed kernel

Ten fruits are steamed for more than 40 minutes and cut into halves. Flesh color of the cut surface is observed and classified into 3: milky-white, 5: pale yellow, 7: yellow.

Quality of pulp

Quality of pulp is evaluated organoleptically for the same fruits as those used for the examination of the color of steamed kernel, and classified into 3: clammy, 5: intermediate, 7: floury.

Sweetness

Sweetness of pulp is evaluated organoleptically for the same fruits as those used for the examination of the color of steamed kernel while they are warm, and classified into 3: low, 5: moderate, 7: high.

Flavor

Flavor of steamed fruits is evaluated organoleptically for the same fruits as those for the examination of the color of steamed kernel while they are warm, and classified into 3: weak, 5: intermediate, 7: strong.

Kernel quality

Based on the organoleptic test of steamed fruits, general quality of kernel is evaluated, in relation to flavor, taste, etc., and classified into 3: low, 5: good, 7: high.

<Optional items>

Subsidence of pellicle into kernel

Subsidence of pellicle into kernel meat is observed for more than 30 fruits cut horizontally at the maximum width. Deepest subsidence is checked and classified into 3: shallow (<1.0mm), 5: intermediate, 7: deep (>3.0mm).

Specific gravity of fruit

Specific gravity of fruit is measured just after harvest. Volume of fruit is calculated based on buoyancy, which is measured by putting the fruits into a water vessel. Specific gravity is expressed as the ratio of actual weight / volume (=buoyancy). More than 30 fruits are used, and specific gravity is classified into 3: low (≤1.02), 5: intermediate (1.03 ~ 1.05), 7: high (≥1.06) (Fig. 13).

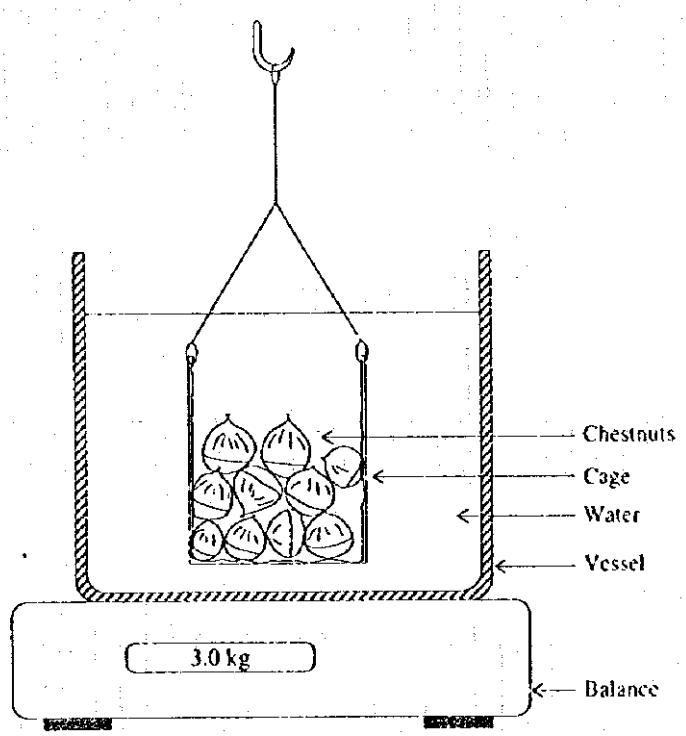


Fig. 13 Measurement of specific gravity.

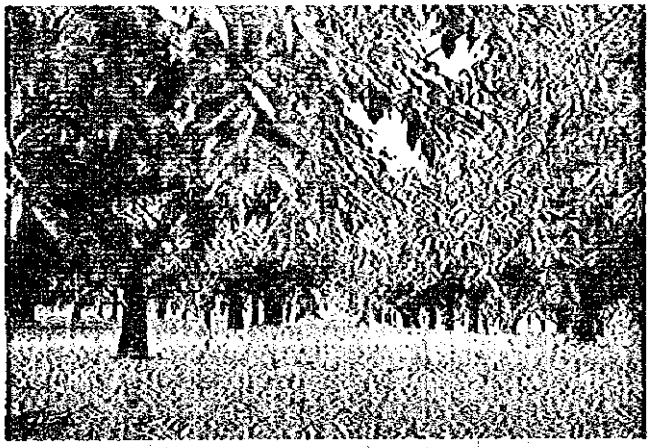


Photo. 1 Orchard for preservation of chestnut genetic resources.

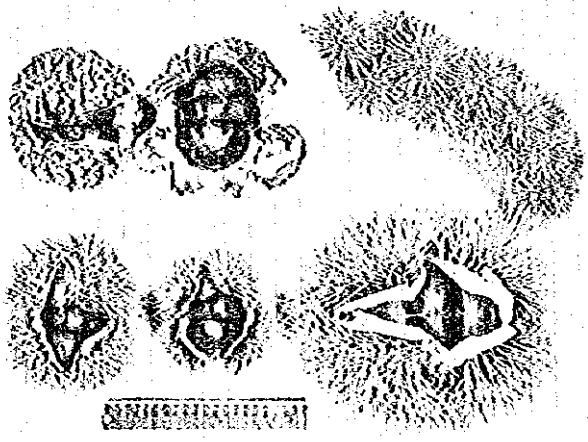


Photo. 2 Variation of shape of bur in Japanese chestnuts.

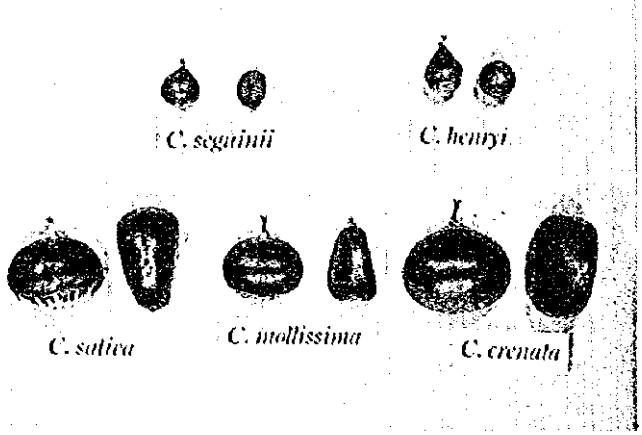


Photo. 3 Variation of fruit shape in chestnut species.

VIII. Citrus

VIII-1. Cultivation of Citrus Genetic Resources for Evaluation of Characteristics

VIII-2. Evaluation of Characteristics of Citrus Genetic Resources

by

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VIII-1. Cultivation of Citrus Genetic Resources for Evaluation of Characteristics

1. General properties

Citrus is the general term used for six genera in the orange subfamily Aurantioideae; Citrus, Fortunella, Poncirus, Clymenia, Microcitrus and Eremocitrus. Species of *Citrus* are highly diversified and many cultivars have been developed through hybridization and mutation. They are cultivated in tropical and subtropical areas, and parts of temperate areas of the world. Citrus plants show a wide variation in cold hardiness, resistance to diseases, fruit characteristics, etc.

2. Propagation

1) Raising of rootstocks

The soil for seedbed should not have been cultivated previously for citrus, otherwise, fumigation or heat-treatment of the soil is necessary. Seeds are usually sown 2 ~ 3 cm apart in a furrow at a depth of 1 ~ 2 cm, with an interval of 20 ~ 25 cm between furrows. When seedlings reach a height of about 10 cm, fertilizer high in nitrogen is applied slightly 4 ~ 5 times during the growing season. After growing for one year in seedbeds, seedlings are transplanted in the nursery. Plants much smaller or larger than the average, or showing abnormal growth are discarded. They are usually spaced 20 ~ 25 cm apart in rows which are 25 ~ 30 cm apart, with an interval of 90 ~ 100 cm between two rows. Fertilizer is applied in small amount and frequently during the growing season. Total amount of fertilizer for a year in Japan is usually N: 40, P_2O_5: 25, K_2O: 20 kg/10a.

2) Preparation of scions

It is important to use scions free from infection with viruses and viroids. Generally, the best scions are vigorous shoots of the next to last flush, or the last flush which has been hardened. The buds should be dormant and well developed. At the time of the collection of scions, all the leaves are trimmed off to prevent drying. If necessary, the scions can be stored for two or three months by sealing in a polyethylene bag and by keeping at 5°C.

3) Grafting

In areas where there is no frost, grafting may be performed at any time of the year when seedlings for rootstocks reach a suitable size (pencil-sized stem) and the cambium is active. However, considering the collection of mature scions and growth after grafting, grafting is generally carried out in spring and fall. In Japan, veneer-grafting is usually conducted in spring and budding is conducted in fall. The height of the position for grafting varies considerably in the citrus areas of the world, ranging from 5 to 80 cm above the soil. High level grafting is practiced to prevent soil-borne infection of the scion.

4) Management of nursery

Budshoots should be supported by poles to develop straight trunks and prevent breaking off at the level of the union. All sprouts on the main trunk and the stock are rubbed off before they become large. Amount of fertilizer applied varies depending on the soil fertility. Usually, the total amount of fertilizer applied in Japan is N: 20 ~ 30, P_2O_5: 10 ~ 20, K_2O: 5 ~ 10 kg/10a. Control of pests and diseases should be applied as soon as they appear.

3. Preparation of cultivation field (Site selection and orchard design)

The selected site should be relatively free from temperature and wind hazards with reasonably deep and fertile soil and adequate underdrainage. Planting distance varies depending on the cultivar, rootstock, soil, climate, etc. Usually, a distance between trees of 4 ~ 6 m in each direction is recommended. Randomized block design with 3 replications is recommended. Planting holes 60 cm in diameter, 50 ~ 60 cm in depth should be prepared one to two months before planting. Usually, compost, magnesium lime and phosphorus fertilizer are applied in the holes.

4. Planting

The optimum time for planting is late winter or early spring when the trees are dormant. One- or two-year-old trees are planted. At the time of digging, the tops of trees are cut off at a height of 30 ~ 70 cm to balance the top and root. This height will correspond to the trunk height in future. It is necessary to prevent fibrous feeder roots from drying during the digging and planting operations. Immediately after planting, the trees are supported with poles, and water is applied to settle the soil.

5. Training and pruning

Shape of citrus trees varies depending on the species and cultivars. In Japan, usually, three primary scaffold branches are well arranged on the trunk and two secondary scaffold branches are set on each primary scaffold. Pruning is practiced to prevent dense growth of branches and twigs. The optimum time for pruning is late winter when trees are dormant.

6. Fruit thinning

Number of fruits per tree is regulated to a certain extent by physiological fruit drop. However, it is desirable to thin fruits to prevent alternate bearing and accelerate fruit growth. Fruit thinning is practiced after the end of physiological fruit drop, based on the ratio of leaves to fruits. The recommended ratio in Japan is generally as follows; satsuma mandarin: 20 ~ 30, navel orange: 90 ~ 100, pummelo: 200 ~ 300.

7. Soil management

Sod culture system and clean culture system are practiced depending on the orchard conditions. The former is useful to prevent soil erosion and supply humus. However, weed control is necessary at the time of new flush development and in the dry season, when the competition for water and nutrient elements occurs between trees and weeds. If the soil pH

is lower than 5.5, it should be adjusted to values between 5.5 and 6.5 by the application of calcium fertilizer. It is also necessary to supply compost.

8. Fertilization

Amount of fertilizer varies depending on the soil fertility, cultivar, tree age, etc. In Japan, the standard amount of total fertilizer is N: 10 ~ 15, P_2O_5: 5 ~ 10, K_2O: 5 ~ 10 kg/10a for three- to five-year-old trees, and N: 20 ~ 30, P_2O_5: 15 ~ 25, K_2O: 15 ~ 25 kg/10a for ten- to twenty-year-old trees. Fertilizer is applied in spring, summer and fall.

9. Pest and disease control

Resistance to pests and diseases is evaluated for plants which are not subjected to control measures. However, if pest and disease damage becomes serious, control is necessary even for the evaluation of general traits. Chemicals are applied according to the official recommendations for the respective areas.

10. Harvest

For most citrus trees, fruits should be harvested and evaluated at maturity. However, for citrus trees which are used for a special purpose like acid flavor, fruits should be harvested not only at maturity but also at a suitable time for the evaluation of the specific traits.

11. Storage

Storage conditions vary depending on species and cultivars. Temperature of 3 ~ 10°C and relative humidity of 85 ~ 90 % are suitable for the prevention of decay and change of fruit quality.