

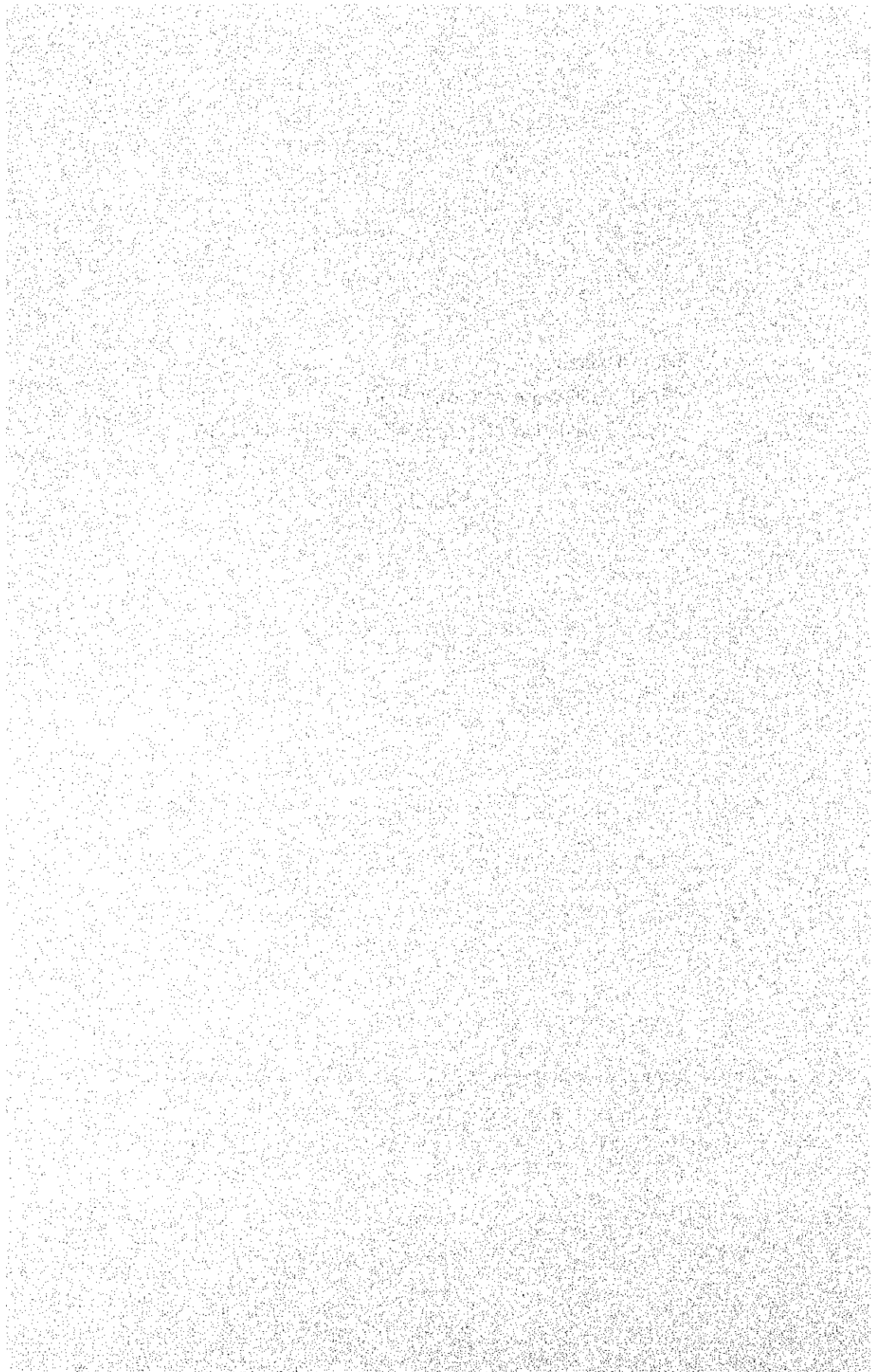
IX. Radish

IX-1. Cultivation of radish PGR

IX-2. Evaluation of characteristics of radish PGR

by

Ken'ichi Hida



IX-1. Cultivation of radish PGR

These instructions apply basically to Japanese radishes (daikon) whose root weight is approximately 1 to 2 kg. Cultural practices must be modified according to cultivar types, especially short duration cultivars of less than one month.

1. Experimental plan

Randomized complete block design with three replications is generally recommended. Two outer rows and plants at both ends of rows are set up to protect test plants and are not included in the evaluation. Add local standard varieties to the entries.

2. Preparation before sowing

Seed disinfection

Seeds are soaked in hot water at 50°C for 25 minutes and then in 1% sodium hypochlorite solution for 10 minutes (recommended by AVRDC), or well-dried seeds are heated at 70°C for 3 days. The former treatment is effective for the control of most pathogens. The latter treatment is convenient but less effective. As seed disinfection may reduce the longevity of seeds, only seeds for immediate use should be treated.

Field preparation

As some cultivars develop edible roots at a depth of more than 30 cm underground, a field with well-drained deep soil without gravel should be selected for evaluation. Soil pH should range between 5.5 ~ 7.5. When soil pH is rather low, calcium fertilizer should be applied. Organic manure needs to be also applied. Fields should be tilled at a depth of more than 20 cm. When the soil is too dry or too wet, tillage should be omitted.

Fertilizer application

Basic fertilizer is applied by broadcasting or in rows. When applied in rows, fertilizers should be put at 35 ~ 40 cm below the surface of seeding beds. The amount of fertilizer should be adjusted according to the growth conditions and projected yield. The standard total amount of fertilizer elements for autumn-sowing of Japanese radishes is N: 17 ~ 20, P: 8, K: 10 kg/10a, and the amount of basal application is N: 8, P: 8, K: 8 kg/10a.

Bed formation

Except for dry areas, seed beds are formed by plowing at a depth of 20 ~ 30 cm. The distance between the center of adjacent furrows is about 70 cm for single rows and 120 cm for double rows. In areas with heavy rainfall, furrow systems are carefully designed to drain the excess water outside of the field.

3. Sowing and management after sowing

Sowing

Holes one cm deep are dug at a distance of 30 cm between adjacent holes. Four to five seeds are sown in a hole and covered with soil, then watering is carefully applied with sprinklers. The bed soil should be moistened when the seeds are sown by controlling the soil moisture beforehand.

Thinning

When the seedlings reach the 2 ~ 3 true leaf stage, they are thinned to three healthy seedlings per seeding spot by cutting hypocotyls with nails. When seedlings reach the 5 ~ 6 leaf stage, they are thinned to the best one per seeding spot. Too vigorous and off-type seedlings must be rogued. Pesticides and fungicides are sprayed after thinning.

Irrigation

Water supply is necessary to secure normal formation of edible roots. If the soil is dry, furrows or beds are irrigated before wilting occurs. Ample supply of water with a low frequency is recommended. If there is an impermeable layer under beds, furrow-irrigation is not applicable for long-rooted varieties. Where irrigation water is scarce, drip-watering is recommended.

Top dressing

Top dressing is at first applied just after the last thinning. The second top dressing is applied 2 ~ 3 weeks later when roots are quickly thickening. Delayed application of top dressing may induce cracking and/or curving.

Insect and disease control

Chemicals are applied according to the official recommendation in the area. Enough care is necessary for the timing and order of insecticide application. Otherwise, chemicals may decimate only natural enemies of radish. When insecticides are not effective, early growth of seedlings is secured by the use of protection nets.

Harvest

When lower leaves start drooping, roots of larger plants are pulled out and should be examined to determine whether they reached maturity for evaluation. When the roots become fibrous or pithy, they are considered to be mature for the evaluation at harvest. If the stage of root development is uncertain for the evaluation of an entry, sampling is repeated until some signs of overmaturity appear. Loss of surface gloss and smoothness, curving and cracking are also often signs of overmaturity, which can be observed on roots projected over the soil surface while growing.

IX-2. Evaluation of characteristics of radish PGR

Characteristics of each entry are examined when 50% of the roots become harvestable, if not indicated otherwise. For harvest time, refer to the chapter on cultivation methods. Items relating to leaf morphology are examined for the largest leaf.

The following abbreviations are used in this text for some representative and check Japanese cultivars – Sj: Shijunichi, MW: Minowase, Ho: Horyo, MN: Miyashige Nagabuto, NO: Nerima Oonaga, Oo: Ookura, Ki: Kiba Riso, Ku: Kuroba Riso, Mi: Miura, Ni: Ninengo, Sr: Shiroagari, Sa: Sakurajima, Kr: Matsumoto Kireba, Ev: Everest.

1. Primary characters

<Essential items>

Plant attitude

Plant attitude is classified into 3: erect, 5: intermediate, 7: spreading. Ex.– 3: MN, 5: NO, 7: Ni.

Leaf dissection

Type of leaf dissection is classified into 3: entire, 5: pinnatisect, 7: bi-pinnatisect. Ex.– 3: Ev, 5: MW, 7: Kr. Refer to Fig. 1 and Photo. 1.

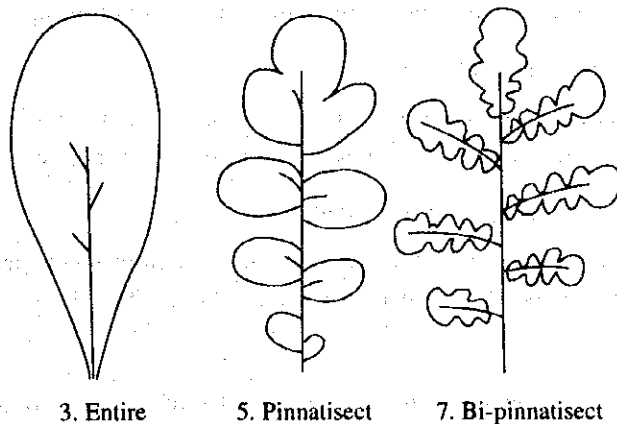


Fig. 1 Leaf Dissection.

Leaf color

Basic color of leaves is classified into 3: yellowish green, 5: green, 7: dark green. Ex.– 3: Ki, 5: Ku, MN, 7: Sa.

Root shape

Shape of roots is classified into 0: flat, 1: round, 2: elliptic, 3: reverse short conic, 4: short conic, 5: cylindrical, 6: pointed cylindrical, 7: spindly, 8: reverse long conic, 9: long conic. Refer to Fig. 2.

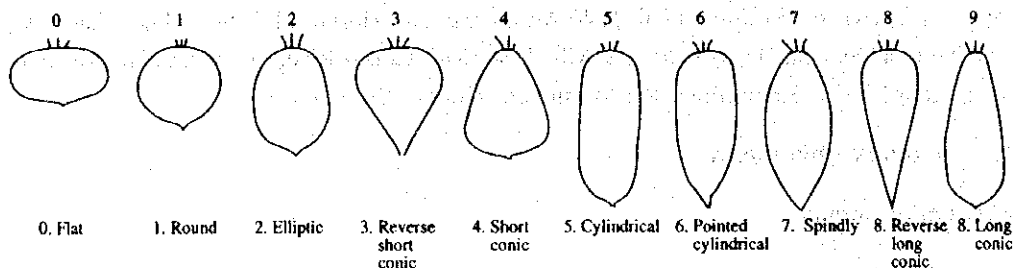


Fig. 2 Root Shape.

Root length

Measure length of succulent roots (in millimeters).

Root diameter

Measure diameter of succulent roots in the widest area (in millimeters).

Color of root surface pigmentation

Color of pigmentation on the surface of succulent roots is classified into 0: no pigmentation, 1: pale green, 2: green, 3: yellow, 4: gray, 5: pink, 6: red, 7: purple, 8: black.

Proportion of pigmented area on root surface

Entries with pigmented root are classified by the proportion of pigmented area on the entire surface of succulent roots into 1: less than 10%, 3: 30%, 5: 50%, 7: 70%, 9: more than 90%.

Maturity

Number of days from sowing to the day when 50% of the roots become harvestable is measured to indicate maturity.

<Optional items>

Number of leaves

Count the number of expanded leaves (fallen leaves are not counted).

Leaf pigmentation

Leaf anthocyanin pigmentation is classified into 0: absent (no pigmentation), 3: pink, 5: red, 7: purple.

Degree of leaf pigmentation

Entries with anthocyanin-pigmented leaves are classified by the the degree of pigmentation into 3: weak, 5: intermediate, 7: strong.

Leaf length

Measure the length of the largest leaf (in centimeters).

Leaf width

Measure the width of the largest leaf in the widest area (in centimeters).

Number of lobes

For entries with lobed leaves, count the number of lobes of the largest leaf.

Density of lobes

In the entries with lobed leaves, the density of lobes is classified into 3: low (no overlapping), 5: intermediate (slightly overlapping), 7: high (heavily overlapping). Ex.- 3: Sj, 5: Ki, 7: Ho. Refer to Photo. 2.

Root projection

Classify the proportion of overground-projected part of succulent roots into 1: less than 10%, 3: 30%, 5: 50%, 7: 70%, 9: more than 90%.

Total weight

Measure the whole plant weight (=sum of the weight of leaves and succulent roots) (in grams).

Shape of root shoulder

Shape of succulent root shoulder is classified into 1: flat, 3: round, 5: sloping, 7: thick bottle-neck, 9: thin bottle-neck. Ex.- 1: Ni, 3: MW, 5: NO, 7: Mi. Refer to Fig. 3.

Shape of root bottom

Shape of succulent root bottom is classified into 1: flat, 3: round, 5: pointed, 7: sharply pointed. Ex.- 3: Oo, 5: MW, 7: Ni. Refer to Fig. 4.

Width of stem base

Measure (in millimeters) the width of stem base where petioles are attached.

Thickest position of root

Thickest position in the succulent root is classified into 1: top, 3: upper, 5: middle, 7: lower, 9: bottom.

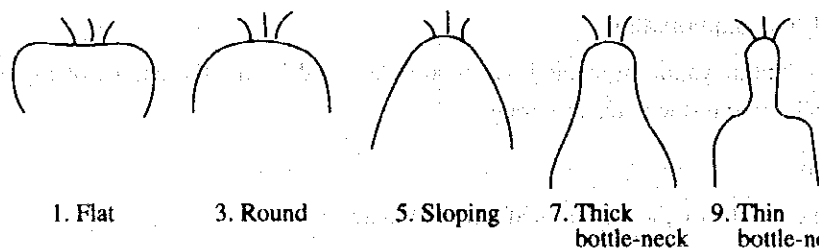


Fig. 3 Shape of root shoulder.

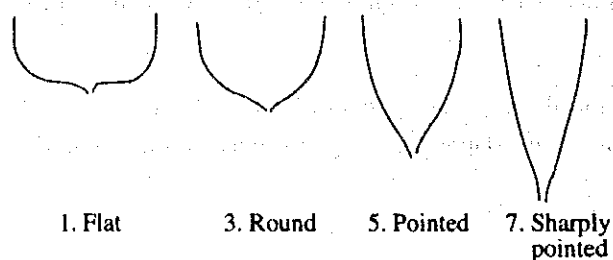


Fig. 4 Shape of root bottom.

T/R ratio

Calculate the ratio of Top(leaves)/Root (succulent root) weight in percentage.

Premature bolting

Calculate the frequency of premature bolting (in percentage).

Whiteness of root flesh

Whiteness of root flesh without pigmentation is classified into 1: transparent white, 3: pure white, 5: creamy white, 7: brownish white.

Color of root flesh pigmentation

Entries with pigmented flesh are classified into 3: green, 5: red, 7: purple. Refer to Photo. 1.

Degree of pigmentation of root flesh

Degree of pigmentation of root flesh in entries with pigmented flesh is classified into 3: weak, 5: intermediate, 7: strong. Refer to Photo. 1.

Pithiness

Earliness of pithiness formation is classified into 3: early, 5: intermediate, 7: late. Ex.– 3: Sj, 5: Ki, 7: Sa.

2. Secondary characters

<Essential items>

Resistance to *Fusarium* yellows

Degree of resistance to *Fusarium* yellows is evaluated based on natural infection or artificial inoculation and classified into 3: low, 5: intermediate, 7: high.

Resistance to soft rot

Degree of resistance to soft rot is classified based on natural infection into 3: low, 5: intermediate, 7: high.

Resistance to virus diseases

Degree of resistance to virus diseases is classified based on natural infection or artificial inoculation into 3: low, 5: intermediate, 7: high.

Cold tolerance

Cold tolerance is classified based on the degree of injury by low temperatures into 3: low, 5: intermediate, 7: high. Ex.– 3: Sj, 5: Ki, 7: Ni.

Heat tolerance

Tolerance to high temperatures is classified based on the degree of depression of succulent root development into 3: low, 5: intermediate, 7: high.

Shelf life

Shelf life is evaluated based on the period during which marketable quality of harvested roots is maintained at room temperature and classified into 3: short, 5: intermediate, 7: long.

3. Tertiary characters

<Essential items>

Root weight

Measure the weight of succulent roots (in grams).

Pungency

Degree of pungency is evaluated by sensory test and classified into 3: low, 5: intermediate, 7: high.

Sweetness

Degree of sweetness is evaluated by sensory test and classified into 3: low, 5: intermediate, 7: high.

<Optional items>

Processing suitability

Degree of suitability for a certain type of processing is classified into 3: low, 5: intermediate, 7: high. The type(s) of processing and the procedure(s) of processing must be recorded.

Taste

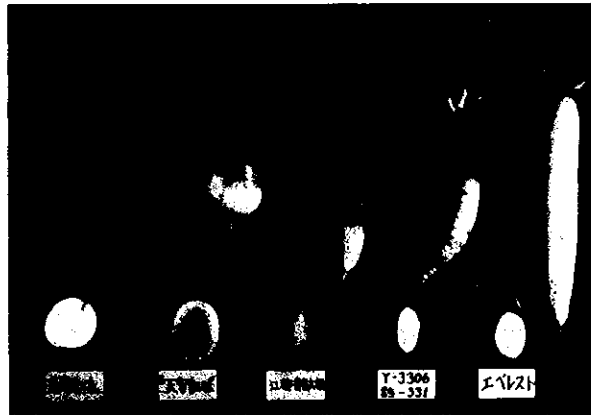
General taste quality is classified based on sensorial evaluation into 3: poor, 5: intermediate, 7: good.

Texture

Texture of succulent roots is classified based on sensorial evaluation into 3: hard, 5: intermediate, 7: soft.

Juiciness

Juiciness of succulent roots is classified based on sensorial evaluation into 3: non-juicy, 5: intermediate, 7: juicy.



No. 1 No. 2 No. 3 No. 4 No.5

Photo. 1 Leaf dissection and root color.

Leaf dissection: 1, 3-pinnatisect, 2, 4, 5-entire .

Color of root surface pigmentation and proportion of pigmented area in root surface: 1-red, more than 90%, 2-green, 60%, 4-purple, 40%, 5-no pigmentation.

Color of root flesh pigmentation and degree of pigmentation of root flesh: 2-red, intermediate, 3-green, dark.



Photo. 2 Density of lobes.

From left to right, density of lobes is sparse to thick.

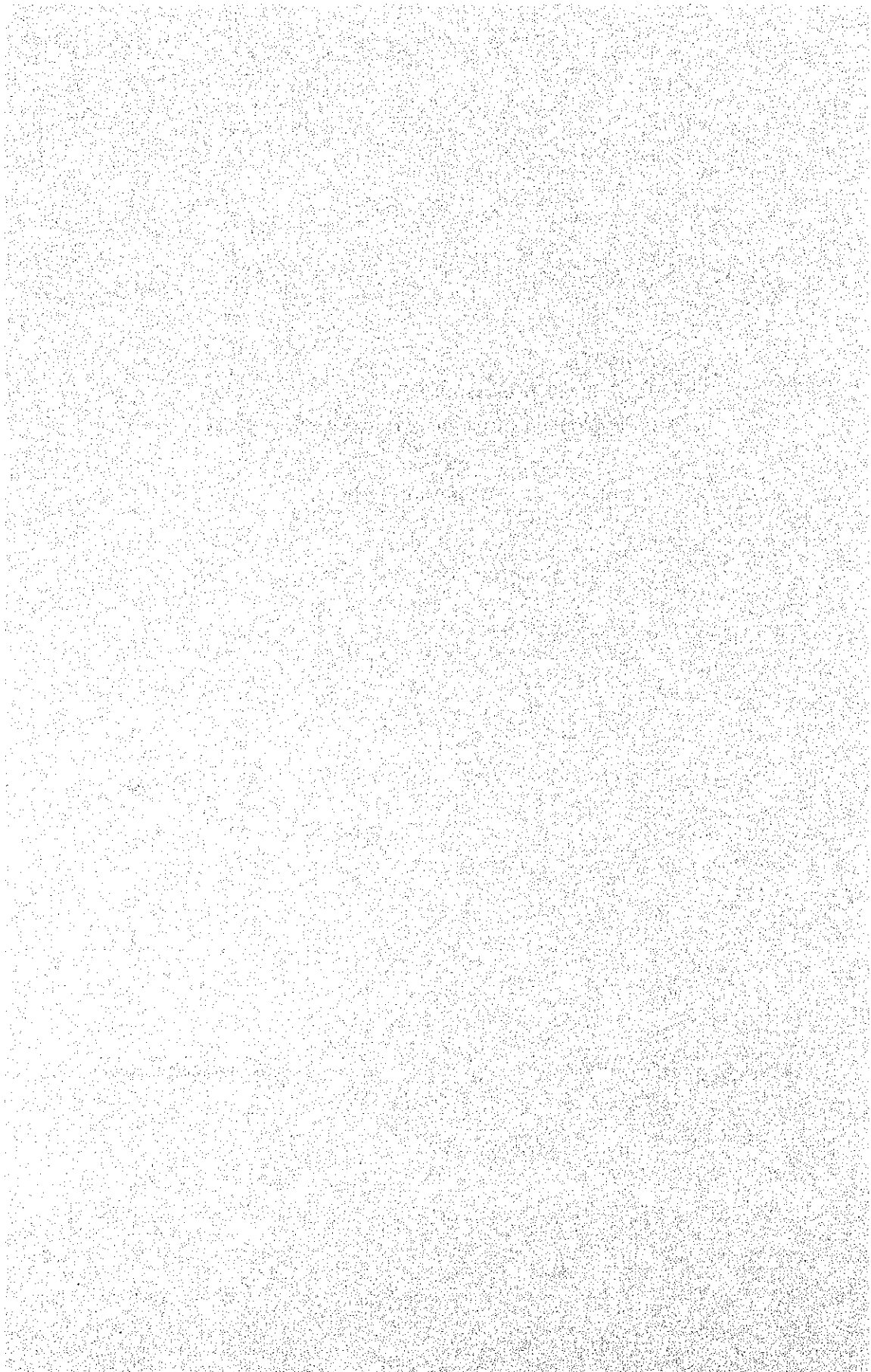
X. Carrot

X-1. Cultivation of carrot PGR

X-2. Evaluation of characteristics of carrot PGR

by

Masatake Fujino



X-1. Cultivation of carrot PGR

1. Land preparation

Soil for carrot cultivation should be deep and loose, particularly for the cultivation of cultivars with long roots. Carrots do not grow well on highly acid soils. Therefore, deep tillage of more than 20 cm is applied and the acidity of soils needs to be adjusted to pH 6.0 to 6.5 by the application of lime.

Before sowing, basal dressing of fertilizer is applied. Although the rate of fertilizer application depends on the soil fertility, the standard rate is, usually N: 2.0 ~ 2.5, P: 1.0 ~ 2.0, and K:1.5 ~ 2.0 kg/a. The application of slow-acting fertilizers is recommended.

2. Planting time

Since carrots grow better under cool-weather, seeds are sowed mainly in spring or summer. By exposure to relatively low temperature during the early stage of growth, carrots sometimes develop seedstalks before roots reach a marketable size. Therefore, in early spring sowing it is necessary to wait until the soil temperature exceeds 10°C.

3. Sowing seeds

Carrots are seeded directly in the field, usually at an interrow space of 20 to 30 cm. Hill seeding is suitable for evaluation of characteristics. The amount of seeds varies with the germinability of seeds. It is necessary to test the germinability before sowing, to control stand density as accurately as possible. Hill space of eight to 12 cm within row is recommended. To avoid the occurrence of vacant hills, 5 ~ 10 seeds are sown per hill. Seeds are covered to a depth of 1 to 1.5cm.

Carrots somewhat germinate slowly and care should be taken to keep an adequate soil moisture. The optimum temperature for germination is in the range of 20 to 25°C.

For the evaluation of PGR, one plant per hill should be used. After germination, seedlings are picked out to allow a single plant per hill to grow. Thinning should end before plants become well established (4 ~ 5 leaf stage).

4. Field management

Weeds should be controlled. The most effective method of weed control is pre-emergence application of herbicides, immediately after sowing. Diseases and insect outbreaks should be controlled by spraying of chemicals, except for the evaluation test of resistance to pests.

If necessary, additional nitrogen is applied as side-dressing. However, excessive top growth must be avoided.

5. Harvest

Removal of off-type plants is essential before harvest. It is necessary to rogue out off-plants appearing at various growth stages.

Carrots are harvested when roots reach a proper size, and washed carefully for evaluation of roots.

X-2. Evaluation of characteristics of carrot PGR

1. Primary characters

Nine essential and 30 optional items are listed as primary characters for the evaluation of carrot genetic resources.

<Essential items>

Plant attitude

Plant attitude is observed one month before harvest and is classified into 3: erect, 5: semi-erect, 7: spreading. Kokubu Senkou is classified into grade 3, Nakamura Senkou Gosun into grade 5.

Leaf sinus

Leaf sinus of the largest leaf is classified into 1: extra shallow, 3: shallow, 5: medium, 7: deep, 9: extra deep. MS Sanzun is classified into grade 3, Kuroda Gosun into grade 5, Chantenay Red Core into grade 7 (Fig. 1).

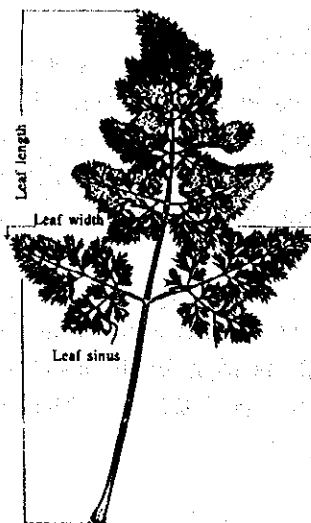


Fig. 1 Components of leaf.

Root length

After harvest, length of the main root is measured (mm) (Fig. 2).

Root shape

Classify root shape into 1: round, 2: wedge, 3: short cylindrical, 4: short tapered, 5: cylindrical, 6: tapered, 7: long cylindrical, 8: long tapered, 9: long stick. French Forcing is classified into grade 1, Oxheart into grade 2, MS Sanzun into grade 3, Kuroda Gosun into grade 5, Koyasu Sanzun into grade 6, Aichi Gosun into grade 7, Nakamura Senkou Futo into grade 8, Kokubu Senkou into grade 9 (Fig. 3).

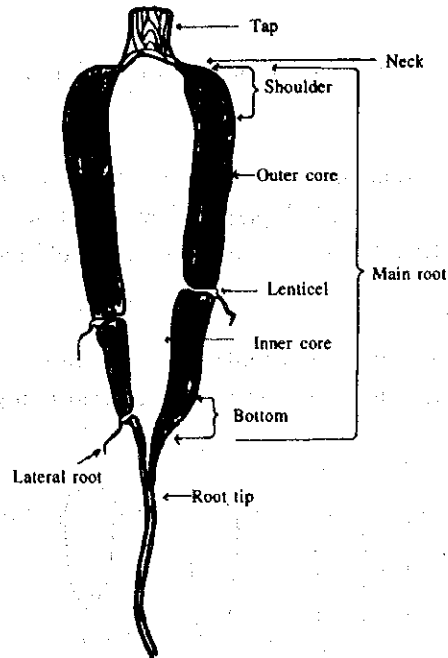


Fig. 2 Components of root.

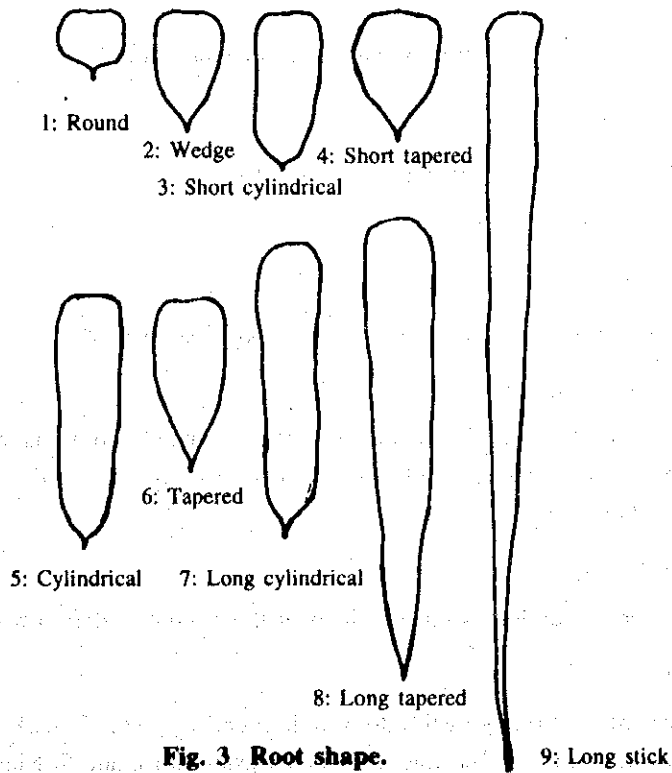


Fig. 3 Root shape.

Core diameter

Measure diameter of the central part of the main root (Fig. 2).

Root color

Classify surface color of the main root into 1: white, 2: yellow, 3: yellowish orange, 4: orange, 5: reddish orange, 6: red, 7: purplish red, 8: purple. Nakamura Senkou Gosun is classified into grade 3, Kuroda Gosun into grade 4, Kintoki into grade 6.

Exposure of root shoulder

Classify degree of exposure of root shoulder into 1: deep rooted, 3: level rooted, 5: semi-uprooted, 7: uprooted. Koizumi Ettou Gosun is classified into grade 3, Kuroda Gosun into grade 5 (Fig. 4).

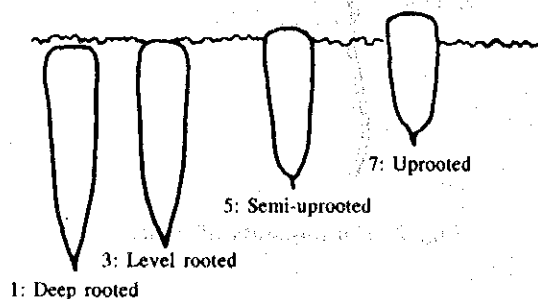


Fig. 4 Exposure of root shoulder.

Bolting percentage

Count the percentage of bolting plants at harvest.

<Optional items>

Seed size

Weigh random samples of 500 seeds with a precision balance.

Seed germination rate

Percentage of seeds which germinated at 25°C is counted two weeks after sowing. Usually, petri dishes 9 cm in diameter and Toyo filter papers No.2 are used. One ml of pure water is added to 200 seeds.

Number of leaves

Count number of true leaves on ten plants at three months after sowing.

Leaf color

Classify leaf color during growth into 3: light green, 5: green, 7: dark green. Kuroda Gosun is classified into grade 3, Nakamura Senkou Gosun into grade 5, Kintoki into grade 7.

Anthocyanin pigmentation of leaf

Classify anthocyanin pigmentation of leaves during growth into 0: absent, 3: weak, 5: intermediate, 7: strong.

Leaf length

Measure length of the largest leaf for ten plants three months after sowing (Fig. 1).

Leaf width

Measure width of the largest leaf for ten plants three months after sowing (Fig. 1).

Petiole length

Measure length of petiole of the largest leaf for ten plants three months after sowing.

Petiole width

Measure width of petiole of the largest leaf for ten plants three months after sowing.

Petiole pubescence

Classify pubescence of petiole during growth into 0: absent, 3: thin, 5: intermediate, 7: thick. Chantenay Red Core is classified into grade 3, Nakamura Senkou Gosun into grade 7.

Green pigmentation of root shoulder

Classify green pigmentation of root shoulder at harvest into 0: absent, 1: extra light, 3: light, 5: intermediate, 7: dark. Kintoki is classified into grade 1.

Purple pigmentation of root shoulder

Classify purple pigmentation of root shoulder at harvest into 0: absent, 1: extra light, 3: light, 5: intermediate, 7: deep.

Dent of root neck

Classify dent of root neck at harvest into 0: flat, 3: shallow, 5: semi-deep, 7: deep. Koyasu sanzun is classified into grade 5, MS Sanzun into grade 7 (Fig. 5).

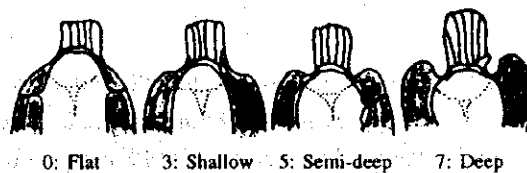


Fig. 5 Dent of root neck.

Shape of root shoulder

Classify shape of root shoulder at harvest into 3: broad, 5: round, 7: slanted. Chantenay Red Core is classified into grade 3, Nantes into grade 7 (Fig. 6).



Fig. 6 Shape of root shoulder.

Diameter of root shoulder

Measure the diameter of root shoulder of 10 main roots at harvest (Fig. 2).

Root surface

Classify the appearance of root surface at harvest into 3: rough, 5: intermediate, 7: smooth. Chantenay Red Core is classified into grade 3, Kuroda Gosun into grade 7.

Size of lenticel

Classify size of lenticels of root at harvest into 3: small, 5: intermediate, 7: large. Kintoki is classified into grade 7 (Fig. 2).

Dent of lenticel

Classify dent of lenticels of roots at harvest into 3: shallow, 5: intermediate, 7: deep. Kuroda Gosun is classified into grade 3, Chantenay Red Core into grade 7.

Outer core thickness

Thickness of outer core is measured in the cross section of the middle part of roots (Fig. 2).

Outer core color

Classify color of the outer core in the cross section of the middle part of root into 1: white, 2: yellow, 3: yellowish orange, 4: orange, 5: reddish orange, 6: red, 7: reddish purple, 8: purple. Nakamura Senkou Gosun is classified into grade 3, Kuroda Gosun into grade 5, Kintoki into grade 6.

Inner core color

Classify color of inner core in the cross section of the middle part of root into 1: white, 2: yellow, 3: yellowish orange, 4: orange, 5: reddish orange, 6: red, 7: reddish purple, 8: purple. Nakamura Senkou Gosun is classified into grade 2, MS Sanzun into grade 4, Kintoki into grade 6.

Rate of root cracking

Count the number of cracked roots for 50 plants at harvest.

Root uniformity

Genetic uniformity of main roots is classified at harvest into 3: low, 5: intermediate, 7: high. Kouyou Gosun is classified into grade 7.

Flowering time of primary umbel

Classify flowering time of the primary umbel into 1: extremely early, 3: early, 5: intermediate, 7: late, 9: extremely late.

Flowering time of secondary umbel

Classify flowering time of the secondary umbel into 1: extremely early, 3: early, 5: intermediate, 7: late, 9: extremely late.

Number of primary branches

Count the number of primary branches at flowering.

Flower stalk length

Measure length of the longest flower stalk at flowering.

Flower stalk diameter

Measure the maximum diameter of flower stalk at flowering.

Flower stalk type

Classify type of flower stalk at flowering time into 3: erect, 5: intermediate, 7: spreading.

Umbel diameter

Measure diameter of the largest umbel at flowering.

2. Secondary characters

As for the secondary characters, the following four essential and four optional items are listed.

<Essential items>

Resistance to bacterial blight

Based on observation in the field, resistance to bacterial blight is classified into 1: very low, 3: low, 5: intermediate, 7: high, 9: very high.

Resistance to scab

Based on symptoms on harvested roots, resistance to scab is classified into 1: very low, 3: low, 5: intermediate, 7: high, 9: very high.

Resistance to soft rot

Based on symptoms on harvested roots, resistance to soft rot is classified into 1: very low, 3: low, 5: intermediate, 7: high, 9: very high.

Resistance to root knot nematode

Based on symptoms on harvested roots, resistance to root knot nematode is classified into 1: very low, 3: low, 5: intermediate, 7: high, 9: very high.

<Optional items>

Field storage durability

Based on observation in the field, the degree of field storage durability is classified into 1: very low, 3: low, 5: intermediate, 7: high, 9: very high. Senkou Ettou Gosun is classified into grade 5, Kokubu Senkou into grade 7.

Heat tolerance

Based on observation in the field, the degree of heat tolerance is classified into 1: very low, 3: low, 5: intermediate, 7: high, 9: very high. Nantes is classified into grade 3, Kuroda Gosun into grade 5.

Growth under low temperature

Adaptability to low temperature is classified into 1: very low, 3: low, 5: intermediate, 7: high, 9: very high. Nakamura Senkou Gosun is classified into grade 7.

Growth under high temperature

Adaptability to high temperature is classified into 1: very low, 3: low, 5: intermediate, 7: high, 9: very high. Umagome Futo Sanzun is classified into grade 7.

3. Tertiary characters

As tertiary characters, the following two essential and five optional items are listed.

<Essential items>

Root weight

Measure root weight of ten plants at harvest.

Texture

Through the evaluation of sliced roots by a panel, the texture of root is classified into 3: rough, 5: intermediate, 7: smooth. Kintoki is classified into grade 3, Nakamura Senkou Gosun into grade 7.

<Optional items>

Carotene content of root

Carotene content of harvested roots is evaluated by a conventional method.

Lycopene content of root

Lycopene content of harvested roots is evaluated by a conventional method.

Sugar content of root

Sugar content of harvested roots is measured with a Brix meter.

Dry matter percentage of root

The ratio of dry matter to fresh weight is calculated.

Aroma of root

Degree of aroma of carrot is classified into 3: weak, 5: intermediate, 7: strong.

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