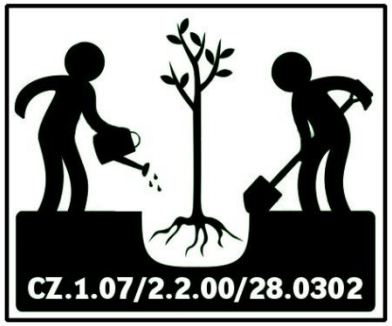
INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ



Inovace studijních programů AF a ZF MENDELU
směřující k vytvoření mezioborové integrace
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Tato prezentace je spolufinancovaná z Evropského sociálního fondu a státního rozpočtu České republiky

Root vegetables

Apiaceae family

- Carrot, parsley, parsnip, celeriac

Brassicaceae family

- Radish, small radish, Swedish turnip, turnip, (horseradish)

Goosefoot family - Chenopodiaceae

- Garden beet

Sunflower family - Asteraceae

- Black salsify

Root vegetables

- Required by customers all year round
- Excellent storability
- Rich in vitamins: provitamin A
- Risk of nitrates accumulation
- Fleshy root, petioles, leaves
- Profitable vegetables for growers

Carrot *Daucus carota* L. ssp. *sativum*

- Hierarchy in the Czech Republic: 1. Onion, 2. Cabbage, 3. Pea, 4. Carrot (700 ha)
- Carrot covers 7 % of total area of vegetables in the CR
- Yield: 22 tons worldwide, 35 tons in Europe, 37 tons in CR
- Succesful growers in CR: 80 t/ha (land preparation, lumps formation)
- Major carrot producers in Europe: Poland, France, UK
- Consumption: 8 kg per capita annually
- Recommended intake: 11.5 kg

Carrot

Nutritional value of carrot

- Dry matter 12 %
- Fibre 3 %
- Protein 1.4 %
- Lipids 0.3 %
- Carbohydrates 8-10 %

- Dietary minerals ($mg.kg^{-1}$):

Ca	490 mg	K	2,820 mg
Fe	15 mg	Zn	2 mg
Na	450 mg	Mn	1 mg
Mg	210 mg	J, Se	traces
P	310 mg	S	192 mg
Cl	320 mg	Cu	0.8 mg

- Vitamins (mg .1000 g^{-1}):

E	**26**	(recommended daily intake: 8 mg/day)
C	49	
A	**35**	(beta-carotene)
B_{12}	2.7	
PP	8.1	

- Edible part: 0.7 (for culinary processing)
- Essential oils: daukol, alkaloids: daucin, sesquiterpenes
- Rich in silicon
- Culinary use: process with double bond fats (butter, vegetable oils) as they help intake the carotene
- Carrot are included in special diet (liver, gallbladder, and intestine diseases)

Botanical characteristics of carrot

- Biennial, heterogamous plant
- Carrot forms fleshy cylindrical root the first year (pulp, skin)
- Second year of vegetation: flower stalk, up to 1.6 m high, inflorescence with umbel, petite white flowers
- Fruit: non-dehiscent diachene, breaks into achenes with spiky thorns (seed processing: thorns are eliminated)
- Fussy leaves
- Weight of 1,000 seeds: 1.2 g
- Carrot sprouts at 5°C, germinating ability of seed: 3-4 years
- Roots do not winter, and turn mushy and break at -3°C.

Requirements

Light porous soils, no gravel, sandy-loamy to loamy-sandy soils that are rich in humus
Waterlogged soils:
Bolting
High chance of fungi infestation
pH 5.8-7.0
Optimum temperature: 18°C (higher production of carotene)
Precipitation: 460mm (April-September), fluctuations in
September: roots break
Necessary irrigation, especially if carrots are grown on ridges
Excessive moisture in first third of vegetation stimulates growth of tops to the detriment of roots

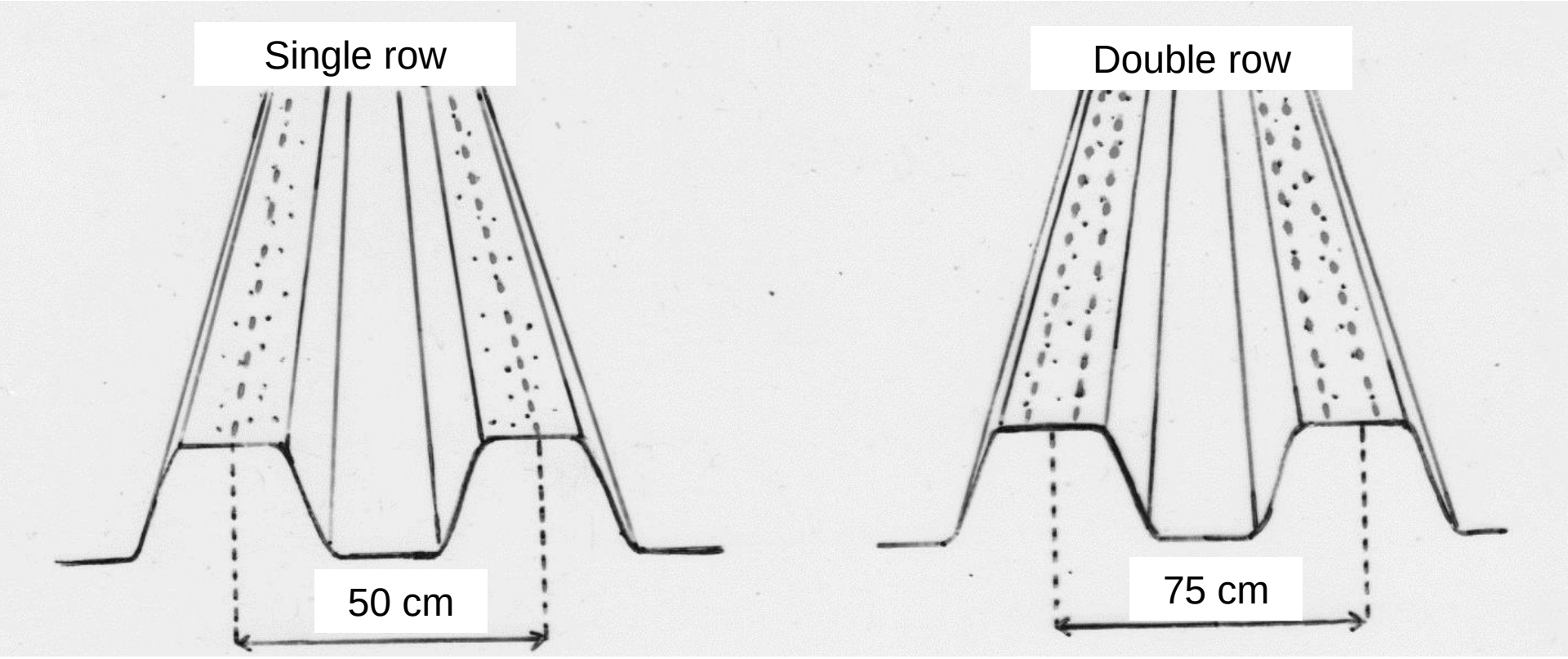
Fertilization requirements

Organic fertilization for preceding crop
Do not fertilize directly with manure
Direct application of manure enhances root breaking and worsens storability
Increase in infestation by carrot fly
Nitrogen fertilization: max. 100 kg of N per ha
Porous, light soils: apply 80% prior to sowing, apply 20% 30 days after sprouting
Excess of N: accumulation of nitrates, low colouring and storability
Requires lot of K, Ca (Mo, B)

Cropping practices

Crop rotation:
After dense crops (cereal crops, root and tuber crops, leguminous crops, and vegetables) – little weed
After species from Apiaceae family: wait for 5-6 years
Species with short vegetation period (carrot with tops) are planted as preceding crop or subsequent crop (until early July)
Fertilizers are applied at least 3 weeks before sowing: carrots are sensitive to soil salination before sprouting.
Sowing: compact seed bed

Flat surface
Row spacing: 30-42cm, 3-5cm apart in rows
Into ridges
Single rows: 50cm, double rows: 75cm
Long, straight, well-coloured roots, easier harvest



Ridges 15cm high, roots: 20-22cm Precipitation right before harvest: roots do not break, ridges dry more easily, easier harvest, ridges are made already in the autumn, metal netting in the spring, sow immediately (the earlier the seeds are sown, the better the plants sprout and the higher the yield is).

Into seedbeds
seedbeds: ca. 1.5m wide

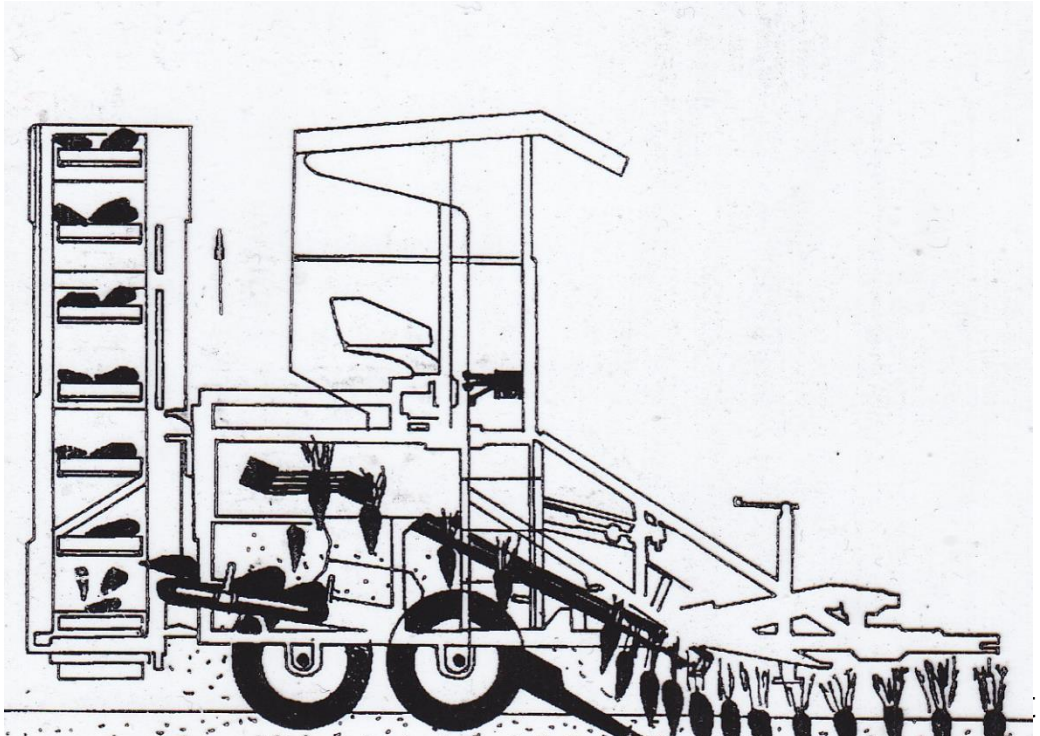
Carrot

Early varieties
Sowing in March, harvest in June (bundled carrot)
Carrots may be sown again in June and harvested in September, October
Late variety
Sowing in March and harvest in September/October (for storage)
Sowing depth: 10-15mm, exact sowing
1.2-1.6 million seeds per ha, commercial varieties: 700,000-900,000 per ha
Sprouting rate: max. 70%
Seedstock: 3-5 kg per ha

Carrot stands should be covered with unwoven fabric
Accelerates sprouting and harvest (10 days), repels carrot fly
Herbicides, protection against diseases and pests
Dry season: irrigation (gentle, may cause root breaking)
Irrigation is most needed at the beginning of vegetation during sprouting

Harvest

Early carrot for bundles
Sub-tillage, manual harvest
Late carrot: good for storage and commercial processing
Mechanized harvest on ridges (lifting of roots using ASALIFT machinery, green tops are not dry)



Postharvest treatment
Removal of soil on conveyers during harvest
High-volume containers - coolers
Sorting and packaging
Storage at 0-1°C, relative humidity: 95-98%, 120-180 days
Washing of carrots before dispatch (shelf-life of washed carrots: 14 days) Use:
direct consumption of fresh carrot
Drying
Canning
Freezing
Children’s diet (NO_3 reduced)
Juices

Parsley Petroselinum crispum (Miller)

- Parsley root: conv. radicosum
- Parsley tops: conv. vulgare
- Origins: Mediterranean, still cultivated there, introduced to Europe by ancient Romans
- Largest production in Europe: France, Netherlands
- Soup vegetable
- Average yield of the root: 14 t/ha
- The whole plant may be processed:
- tops: most valuable part of the plant
- root: soups; edible part: 0.7
- Seeds (even non-germinating seeds): pharmaceuticals - tea against phlegm, reduces flatulency in infants

Garden parsley

Nutritional value of the root

- Dry mateer 16.5 %
- Fibre 1.8 %
- Protein 2.9 %
- Lipids 0,6 %
- Carbohydrates 12.2 %

- Dietary minerals – roots ($mg.kg^{-1}$):

Ca	970	**Fe**	**30**
Na	300	Mg	516
P	1,090	K	5,080
Zn	8.4	J	0.01
Mn	0.9		

- Vitamins – root (mg.kg^{-1}):

A	5.26	PP	11.7
B1	1.0	**C**	**340**
B2	1.0	**E**	**20**
B6	1.6		

- Tops rich in vit. C 800 – 2,000 mg.kg^{-1}

Garden parsley

Essential oils: both in roots and tops
Strong renal stimulant (diuretic effect)
Root: apiin (glycoside)
Myristin and myristicin: essential oils with antibiotic effect
Apigen, a phenol, stimulates kidneys and urinary system; aphrodisiac
Dioxybenzene derivate acts on nervous system (similar to hashish)
Seeds
Diuretic effect
Analgesic effect
Seeds are part of anti-flatulency teas

Freshly ground tops
Sooths toothache (herbal remedies)
Prevents gum bleeding
Parsley tops paste helps bruises
Root infusion: 30 g per 1 L
Diuretic effect: against anasarca
Application of hot parsley tops on sores
Juice from tops mixed with honey and butter
Cough remedy

Garden parsley

Botanical characteristics

- Biennial plant with conical, fleshy root of various size
- Long petioles, dark-green, shiny
- Second year of vegetation: 0.8-1.2m long, hollow flower stalk, umbel, blooming in June and July
- Fruit: green-brown diachene, strong aroma
- Weight of 1,000 seeds: 1.3-1.5g
- Seed germination ability: 2-3 years, maximum germination ability: 80%
- Cold-resistant, winters in mild winters; risk: mice eat the insides

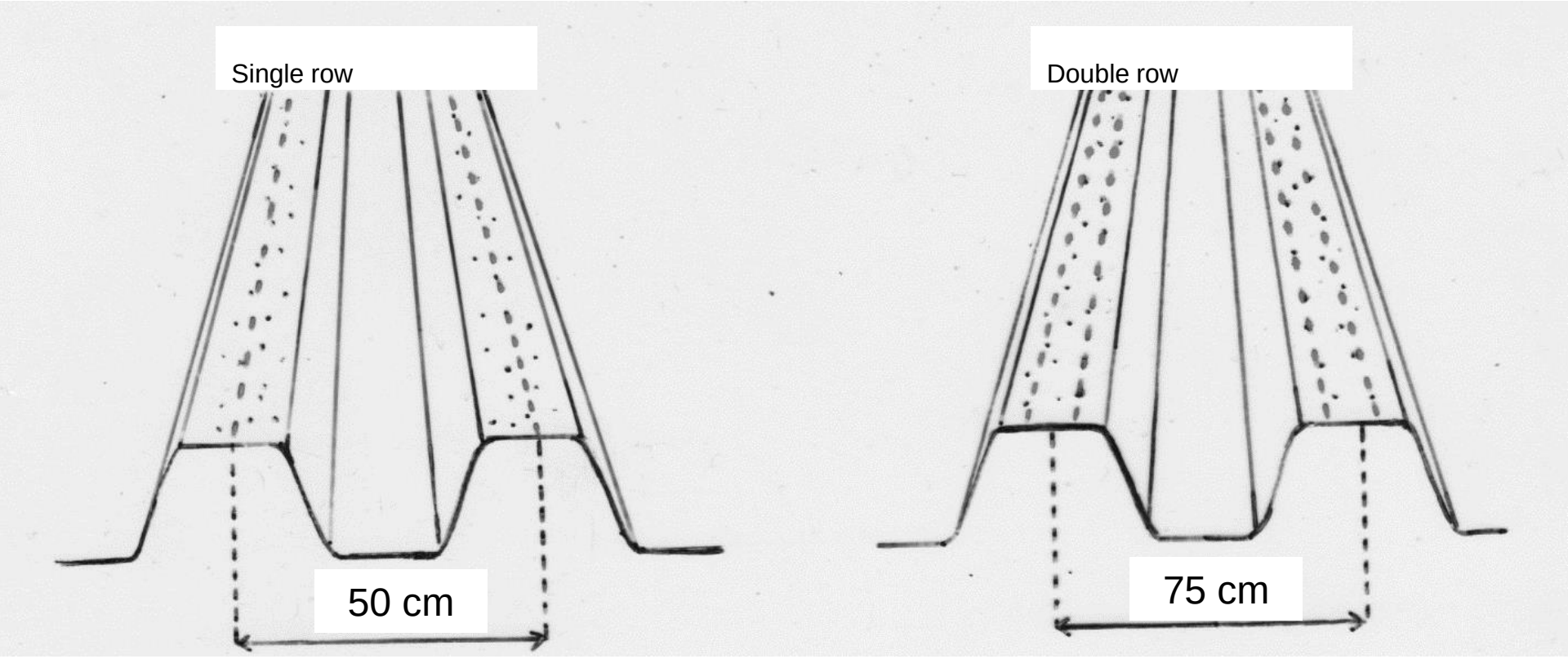
Requirements

- Similar to carrot:
- mediocre temps, airy and sunny locations
- deep soils
- Root may start to branch due to poorly processed soil (roots go 25cm deep = tillage must go 30cm deep)
- Roots are affected by rust, bacteria and fungi, and suffer from lack of air on heavy and crusty soils
- Parsley is not suitable for potato growing areas
- Gravel soil: root branching
- Moist soils: root rust

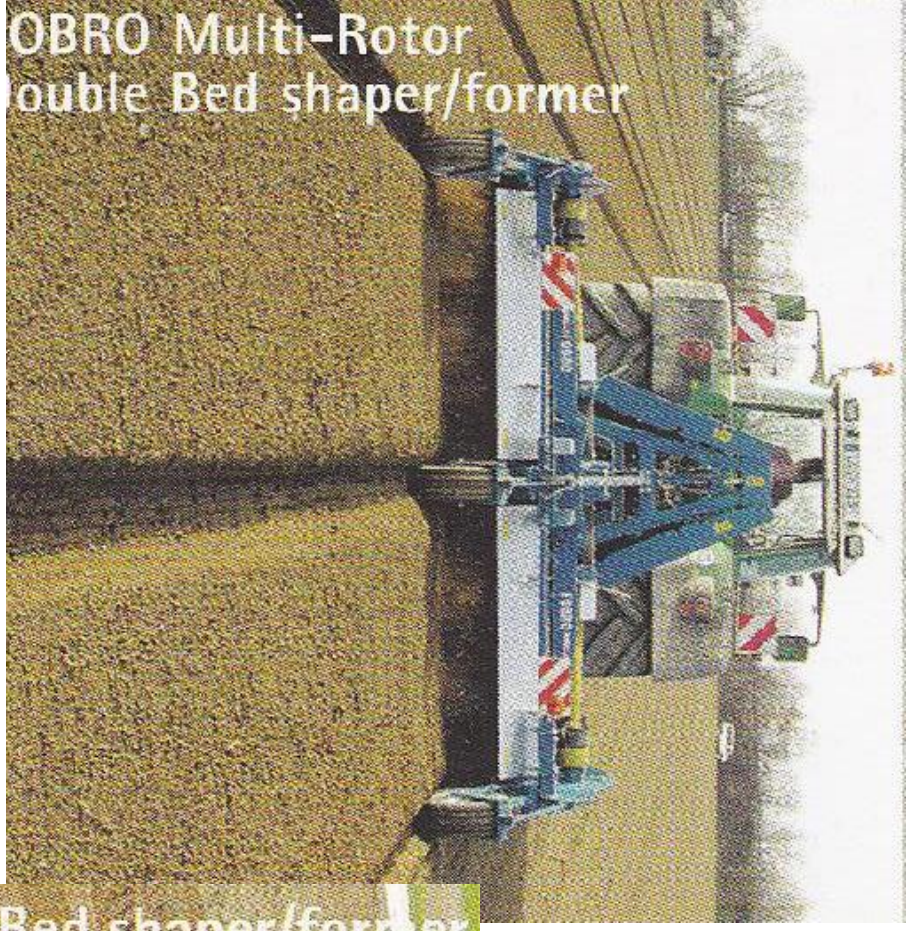
Cropping practices

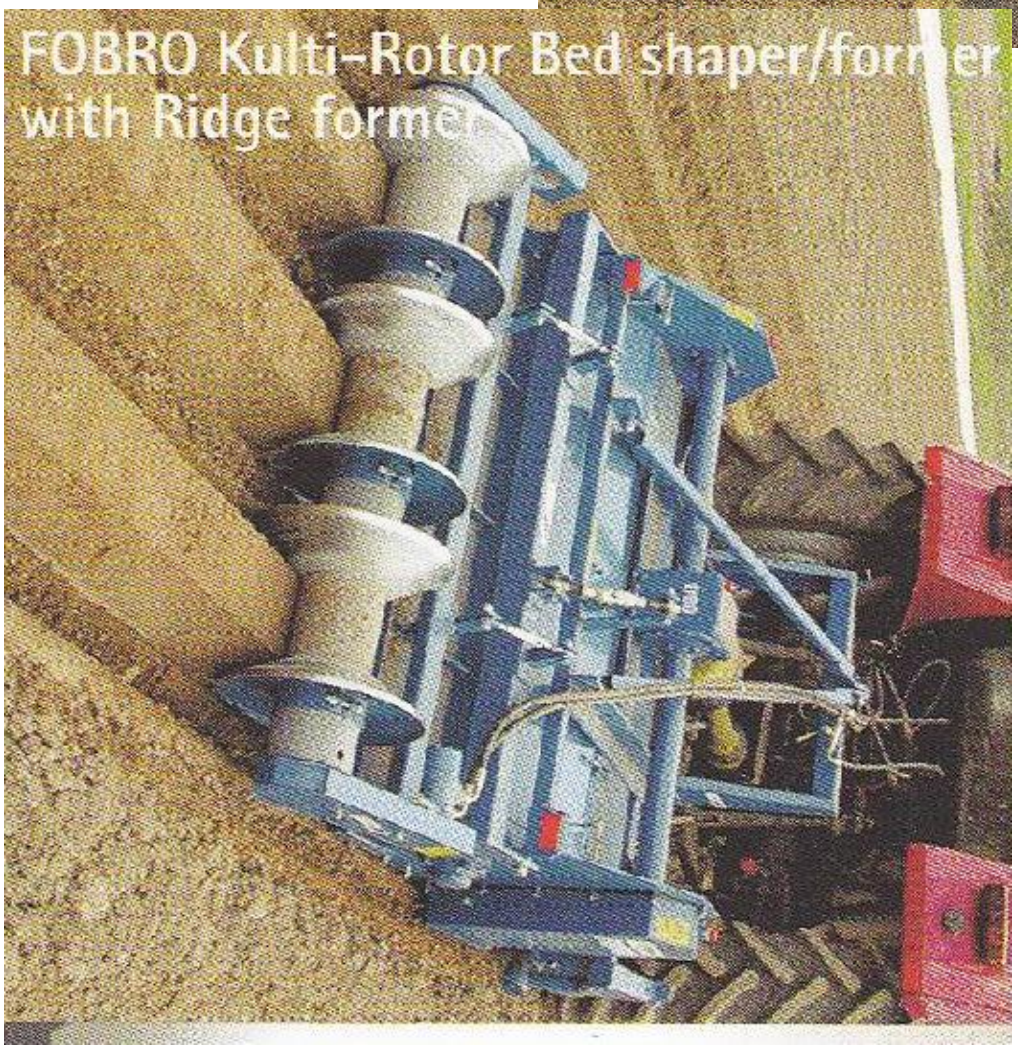
- Crop rotation similar to carrot
- Parsley is more sensitive to herbicides than carrot
- Root parsley
- Sowing: flat surface, ridges, seedbeds (1.5m wide)
- Sowing: until March, 5-7 kg/ha, latest term for sowing: by 10 April
- Sowing depth: 2cm, row spacing: 45cm
- Low field sprouting, especially in dry areas
- Flatten the soil after sowing, treat with herbicides
- Protection similar to carrot

Growing parsley on ridges



Ridges: 15cm high, roots: 20-25cm, easier harvest, ridges are made already in the autumn, metal netting in the spring, sow immediately (the earlier the seeds are sown, the better the plants sprout and the higher the yield is).


OBRO Multi-Rotor
ouble Bed shaper/former


FOBRO Kulti-Rotor Bed shaper/former
with Ridge former

Tops parsley

- Sowing: March or mid-July
- Early sowing should be covered with unwoven fabric
- Higher sowing rate and narrower rows (15-30cm)
- Fertilize with N (20-30 kg/ha) after each harvest of parsley tops
- Harvest
- Manual
- Mechanized harvester for spinach (Diadém)
- Yield: 15-20 t/ha

Parsnip Pastinaca sativa

- Cultivated plants, came from wild species of ruderal weed
- Culinary use similar to root parsley - soups
- Compared to parsley, parsnip has higher content of sugar, tops are not aromatic, entire leaves (unlike dissected leaves of parsley)
- Higher yield: 30 t (bulkier roots)
- Roots are sweeter and less aromatic Higher amounts are needed for soups cooking
- Parsnip is not affected by rust as much as carrot, suitable for potato growing areas

Botanical characteristic of parsnip

- Globular, fleshy root with wide head, spindle-like shape, yellowish, off-white colour
- Non-aromatic, odd-pinnate leaves with egg-like shape and pointy edges
- Biennial plant
- Fruit: light-brown, winged diachene
- Weight of 1,000 seeds: 2.7-4g
- Germinating ability of seeds: 2 years only
- Cold-resistant, wintering ability, mice-proof

Nutritional value of parsnip

- Water 80.2 %
- Dry matter 19,8 %
- Protein 1.6 %
- Fats 0.4 %
- Sugars **14.9** %
- Ashes 1,2 %
- Fibre 4.3 %

- Dietary minerals (mg.kg^{-1}):

Ca	586	Fe	7.2
Na	80	Mg	220
P	730	K	4,690
Zn	3	J	0.1
Mn	3.5	Se	0.02
S	300	Cu	1.2

- Vitamins:

B_1	0.8	**E**	**10**
B_2	0.9	C	180
B_6	1.1	A	1.26
B_9	0.9		

Requirements

- Sugarbeet growing regions, potato growing regions
- Loamy, loamy-sandy soils
- pH 6.8-7.4
- Second year after fertilization with organic manure (medium feeder)
- Chlorine-based fertilizers
- Slow germination: susceptible to weed infestation

Cropping practices

- Similar to parsley
- Sowing: early spring, March to 10 April
- Sowing depth: 2-3cm
- Spacing: rows 30-50cm apart, seeds in rows 6-10cm apart
- Sowing standard:
- Exact sowing: 3-4 kg/ha, otherwise: 6-8 kg/ha
- Thinning out: during the stage of 3-4 true leaves

Harvest and sorting

- End of October, early November
- First grade quality: 35-80mm root diameter
- Second grade quality: less than 20mm
- Yield: 30-40 t/ha
- Storage at 0-1°C, 95-97% humidity
- Harvested from the field, if the winter is mild

Celeriac *Apium graveolens var. rapaceum*

- Origin: Mediterranean; Czech Republic: since 17th century
- Aromatic soup and salad plant vegetable; canning and drying
- Edible part: root + hypocotyl
- Good storability (till March / April)
- Average yield: 17 t/ha, 35 t/ha is attainable
- Acreage in CR: 350 ha (2011)
- Recommended intake: 4.2 kg
- Fresh celeriac: 2.6 kg
- Processed celeriac: 1.6kg

- Contrary to other root vegetables, celeriac must be precultivated:
- Early stages of celeriac growth requires temperature range of 18-20°C; otherwise, it vernalizes, turns woody and does not form a taproot
- Sowing is technologically not plausible – tiny seeds
- Celeriac sowing standard: 30-35 g per ha only

Nutritional value of the celeriac taproot

- Dry matter 10.7 %
- Fibre 3.7 %
- Protein 1.7 %
- Vit C 80 mg/kg (10 times more in tops)
- Carbohydrates 9.9 %
- Ashes 1.5 %
- Fats 0.3 %

- Dietary minerals ($mg.kg^{-1}$):

Ca	710	**Fe**	**9,4**
Na	740 (-)	**Mg**	**330**
P	530	K	3,750
Zn	**7.3**	J	0.017
Mn	1.0	S	208
Cu	0.4	Cl	1,050 (celeriac likes KCl fertilization)

Requirements

- Originally a marshy plant, pH 6.5-7.5
- Heavier, sugarbeet growing regions
- Unsuitable for corn growing regions, celeriac absorbs water from the taproot, up to 5cm hole in the taproot
- Waterlogged and sandy desiccated soils are not good for celeriac
- First year after fertilization with manure (heavy feeder)
- Celeriac requires lot of humus, and lot of soil and air moisture

- High fertilization requirements:
- –N 160-180, P_2O_5 57-80, K_2O 200-285, MgO 50
- – 30 t of manure: add 50-70 of N, 80-100 of K_2O, 30-40 of P_2O_5 + 20 kg of B
- Half of fertilizers before planting, the other half in July
- Celeriac likes chlorine (KCl fertilizer)
- Excess of N: blackening, pulp turns blue when cooked, taproots full of “craters”
- Celeriac requires lot of Ca in soil as well as Mn and B

Cropping practices

- Deep tillage in autumn, application of manure
- Precultivation of planting stock:
- Sowing: 5 through 10 March
- 18-20°C
- 60-80 days in planting trays
- Planting: after 15 May (65,000-75,000 plants per ha) (celeriac cannot be planted before 15 May, it may get cold shock, vernalize, and turn yellow)
- Spacing
- Commercial farming: 50 x 50 or 60 x 40 (depends on tops size)
- Leisure gardeners: 40 x 40 cm

- Celeriac is the most demanding plant in terms of water supplies:
- Irrigation: regular, at least once a week during the whole vegetation period
- End of irrigation: 10-14 days prior to harvest
- Harvest: October, before strong frosts
- Fully mechanized 3-stage harvest:
- Celeriac tops are cut off
- Circular spinner removes rest of the tops
- Lifting of fresh taproots
- Storage: till March, at 0-1°C, 92% air humidity
- Yield: 26 t/ha, peak yield: 35 t/ha

Reasons for low yield:

- Late planting (June) and early planting (April)
- Wrong positioning in crop rotation (planted after winter preceding crops)
- Application of liquid manure instead of plain manure
- Late irrigation (irrigate right after planting)
- Minimum amount of plants: 65,000 plants per ha (optimum: 72,000 plants per ha)

Celeriac

Radish *Raphanus sativus* var. *major,* var. *niger*

- Old crop plant, cultivated in ancient Egypt and Greece
- Rich in antimicrobial components

Nutritional value of radish

- Dietary minerals (mg.kg^{-1}):

Ca	516 mg	K	3,220 mg	**Vit. C 800 mg/kg**
Fe	**12 mg**	**Zn**	**5 mg**	
Na	320 mg	Mn	1 mg	
Mg	260 mg	**J**	**0.04 mg**	
P	290 mg	**Se**	**0.02 mg**	
S	380 mg			

- Edible part: 81 %

- Improves intestinal microbiota, enhances secretion of digestive fluids, black radish has positive effect on kidney problems
- Juice extracted from radish is an expectorant (helps clear mucus from the airways)

L-ascorbic acid in fresh mass	
Japonská dlouhá	612.5
Sakala Okura Cross	714.6
Wiela RZ	946.8

Fibre in fresh mass	
Japonská dlouhá	17.1
Sakala Okura Cross	12.9
Wiela RZ	19.2

Daikon radish

Botanical characteristics of radish

- Biennial plant
- Fruits: a loment, weight of 1,000 seeds: 8-10g
- Germinating ability: up to 5 years

Cropping practices

- Sandy-loamy and loamy-sandy soils
- Heavier soils deform the taproot
- Lighter soils with little water supply make taproots pungent and mushy
- Second year after fertilization with manure (medium feeder); direct application of manure is unacceptable as it causes cracks and unpleasant bitter flavour
- Shallow sowing (2cm deep), 5-7 kg/ha
- Rows: 30-42cm apart (spring radishes: 20-25cm), in rows: 12-15cm apart (spring radishes: 8-10cm)
- Hoe twice

Spring varieties

- Red colour (Karmína), yellow colour (Jantar), white colour (Polodlouhá bílá)
- Taproot length: 15-20cm
- Sowing: mid-March till mid-April
- Vegetation period: 50-60 days
- Yield: 15-25 t/ha
- Manual harvest, bundles of 5 pcs for sale
- No commercial-scale growing, direct consumption, vinegar pickling (“čalamáda”)
- Storage: 2 weeks only, 0-1°C

Summer varieties

- White, purple, pink colours, multi-coloured inside
- Taproots: up to 10cm, 1kg
- Pre-sowing treatment of soil: 35-40cm deep to avoid taproot branching
- Sowing: end of June, July (earlier sowing causes bolting)
- Spacing: 40 x 20 cm
- Infested by cabbage fly protect the plants with unwoven fabric
- Vegetation period: 90-100 days
- Harvest: September, October
- Yield: up to 50 t/ha
- Storability: till March
- Financially the most profitable radish variety, unless infested by cabbage fly

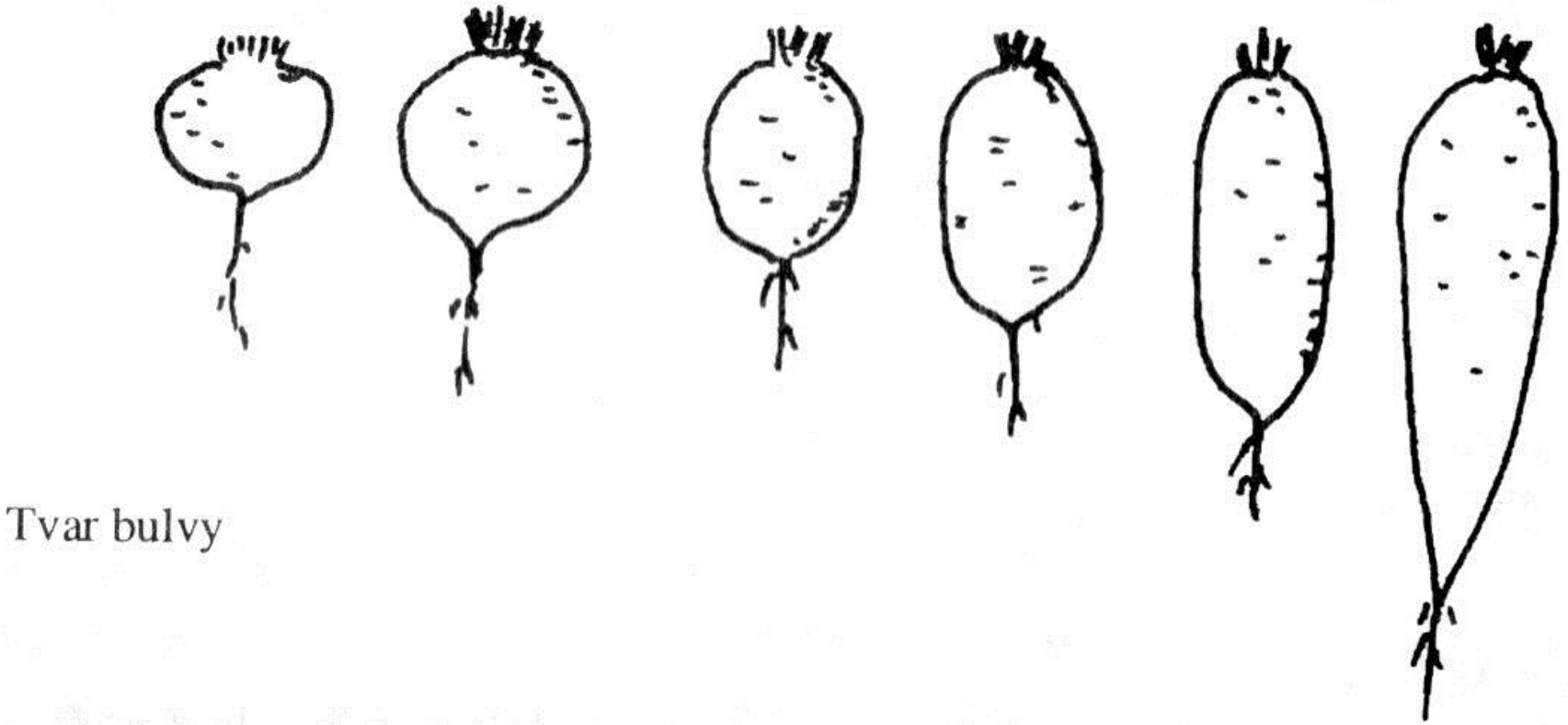
Winter varieties for storage

- Black round taproot, snow-white pulp
- Taproot: 8-10cm in diameter, peeled, white pulp is cooked (various dishes, salads, etc.)
- Juice: cleans urinary system, removes gallbladder stones, helps coughing
- Sowing: mid-April till May (by mid-July at latest)
- Rows: 30-42cm apart, seeds in rows: 8-10cm apart
- Vegetation period: 100-130 days
- Excellent storability: until next year harvest
- Yield: 30-35 t/ha
- Grown even in potato growing regions
- Not infested by cabbage fly, no diseases

Small radish *Raphanus sativus* var. *radicula*

- Annual plant, originates from radish
- Taproot consists of thickened, fleshy hypocotyl
- Vegetation period: 24-50 days
- Fruit: a silique, 2-12 seeds
- Germinating ability of seeds: 4-5 years
- Earliest vegetable
- Harvested in autumn, too

- Small radish requires specific intensity and duration of light to form taproot; vegetation period depends on length of a day:
- Shortest vegetation period: May
- Longest vegetation period: March



Nutritional value of small radish

- Dry matter 5.6 %
- Fibre 1 %
- Dietary mineals ($mg.kg^{-1}$):

Ca 470 mg	K 2,550 mg
Fe 10 mg	**Zn 2.1 mg**
Na 310 mg	**S 2,036 mg**
Mg 110 mg	P 264 mg

- Vitamins

	A	0.1	PP	2.5
	B1	0.39	C	226
	B2	0.22		
	B6	0.43		

- Mustard oil: remedy for liver and gallbladder diseases

Cropping practices

- Lighter soil with good thermal properties; pH 5.7-7.0
- Germination: 2-4°C, young plants tolerate -3°C, older plants tolerate -6°C
- Optimum temperature: 12-14°C
- Spacing: 15 cm
- 200 plants per $1m^2$
- Sowing (7-14 day intervals)
- February through May
- End of July through September
- Shallow sowing (1-2cm)

Small radish

- Unfertilized soil
- Small radish does not tolerate direct fertilization with manure, this causes pungent flavour and accumulation of nitrates
- Small radish will do with soil nutrients left after preceding crop
- Fertilization
  - N 6 g per 1 m2 60 kg / ha
  - P 2 g per 1 m2 20 kg / ha
  - K 8 g per 1 m2 80 kg / ha
- Unwoven fabric: If the seedbeds are covered too early, plants grow lot of tops and the taproot is small

Harvest

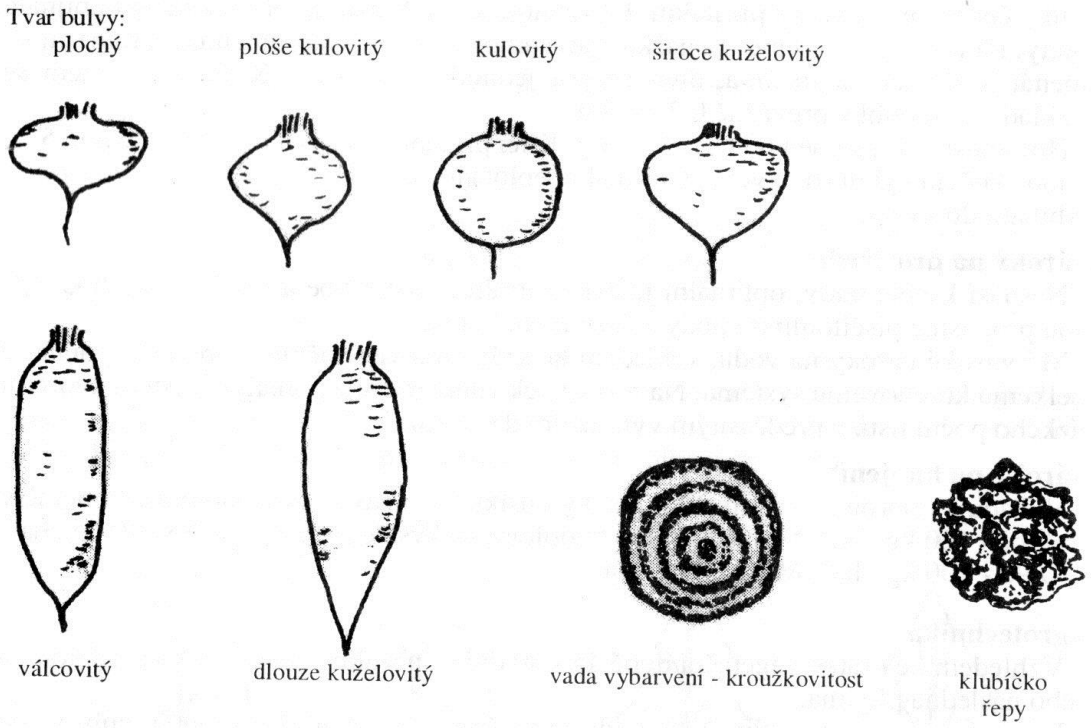
- First, small radish may be harvested manually; bundles of 10 pcs
- Second, harvesting machine picks plants without the tops (plants must be cooled then)
- Washed after delivery
- Czech consumers are conservative: only red radishes

  Small radishes may be purple, yellow, white, and multi-coloured

Garden beet *Beta vulgaris* var. *conditiva*

- Important commodity in canning industry thanks to its colour and flavour; garden beet accumulates most nitrates out of all other vegetables
- Extraction of red colorant: anthocyanin

  - Colouring of canned salads, syrups, juices, and jams
- Slows down cancer growth (beet juice)



Nutritional value

- Dry matter 9 – 12 %
- Fibre 1.5 – 2.3 %
- Protein 1.8 %
- Carbohydrates **10.6 %**
- Ashes 1.0 %
- Fats 0.1 %

- Dietary minerals (mg.kg^{-1}):

Ca	300	Fe	8.9
Na	860 --	Mg	130
P	450	K	2,410
Zn	6.6	J	0.06
Mn	7.0	S	160
Cu	0.2		

Botanical characteristics

- Grown for its richly red root
- Long petioles, smooth, shiny, slight curls on the edges
- Roots go deeply, up to 1m, but mostly 0.4 m
- Multiple fruit: a ball, wrinkly form comprising untrue brown fruits in firm seed vessel; individual balls have 3-4 seeds
- Heterogamous plant
- Weight of 1,000 seeds: 13-22 g

Requirements

- Unsuitable: gravely, waterlogged soils
- Tolerates max. altitude 500 m above sea level
- Germination: 3-4°C, sprouts within 10-14 days
- Optimum temperature: 20-25°C
- Second year after fertilization with manure (medium feeder); direct application of manure is unacceptable
- Fertilization
  - N up to 80k (maximum accumulation of nitrates!)
  - Requires lot of P and K: 60 kg P2O5 a 100-150 kg K2O /ha
  - B in borax: 20-30kg per ha

Cropping practices

- Sowing: from mid-April till the end of June
- Technically produced monogerm seed, exact sowing
- Rows: 30-42 cm apart, seeds in rows: 8-10 cm apart
- Planting depth:
  - 2 cm in heavier soils
  - 4 cm in lighter soils
- Beets are thinned out, when the plant shows 3-4 leaves (unless genetically monogerm seeds were sown)
- Hoe after sprouting
- Soil crusts are disintegrated with multi-rotors

Harvest and storage

- Premature harvest in July/August
  - Size of roots: 3-4 cm, buttery consistency; whole roots are pickled with vinegar
- Storage and canning: October harvest
  - Root: 4-15 cm, optimum: 10 cm, overripe roots are woody, crack, wrong colouring
  - Mechanized harvest: machines sub-lift the beetroot from the soil and the green tops are pulled out; tops are then cut off, roots fall into containers (ASALIFT)
  - Max. nitrates content: 3,000 mg NO_3. kg^{-1}

- Storage
  - at 0-1°C and 90-95% air humidity
  - Lasts until May or next year harvest

- Not grown much in past due to low purchase price
- Today: high demand
- Direct consumption
- Canning industry

Swedish turnip (or Swede) *Brassica napus* var. *napobrassica*

- Grown in cool, moist climates (especially in northern Europe)
- Roots have spicy flavour, pulp is white

Nutritional value

- Dry matter 8.8 %
- Fibre 2.4 %
- Protein 0.7 %
- Lipids 0.3 %
- Carbohydrates 5.0 %

- Dietary minerals ($mg.kg^{-1}$):

Ca	530	Fe	1
Na	150	Mg	90
P	400	K	1,700
Zn	3.0	Cl	310
Mn	1	S	390

- Vitamins ($mg.kg^{-1}$):

A	3.5	PP	12
B_1	1.5	C	310
B_6	2.1		
B_9	0.3		

Requirements

- Easy to grow, high yield
- all growing regions
- Vegetation period: 145-160days
- Moist regions
- Tolerates up to -10°C
- Second year after fertilization with organic manure (medium feeder)

Cropping practices

Spring sowing: March-April
Summer sowing: May-July
4-5 kg of seeds per ha
Yield: 20-60 t/ha
Storability: until April/May

Turnip *Brassica rapa* var. *rapa*

- Widely grown during WW II; whenever turnip was grown, people were poor (potatoes and grated turnip)
- “Harvest-field beetroot” – after wheat is harvested
- Harvested within 2 months:

two or three times per vegetation period

- Root: cooking and salads
- Flavour: spicier radish
- Main producers: England, France

Nutritional value

- Dry matter 8 %
- Fibre 2.7 %
- Protein 0.9 %
- Lipids 0.3 %
- Carbohydrates 4,7 %
- Ashes 0.8 %

- Dietary minerals ($mg.kg^{-1}$):

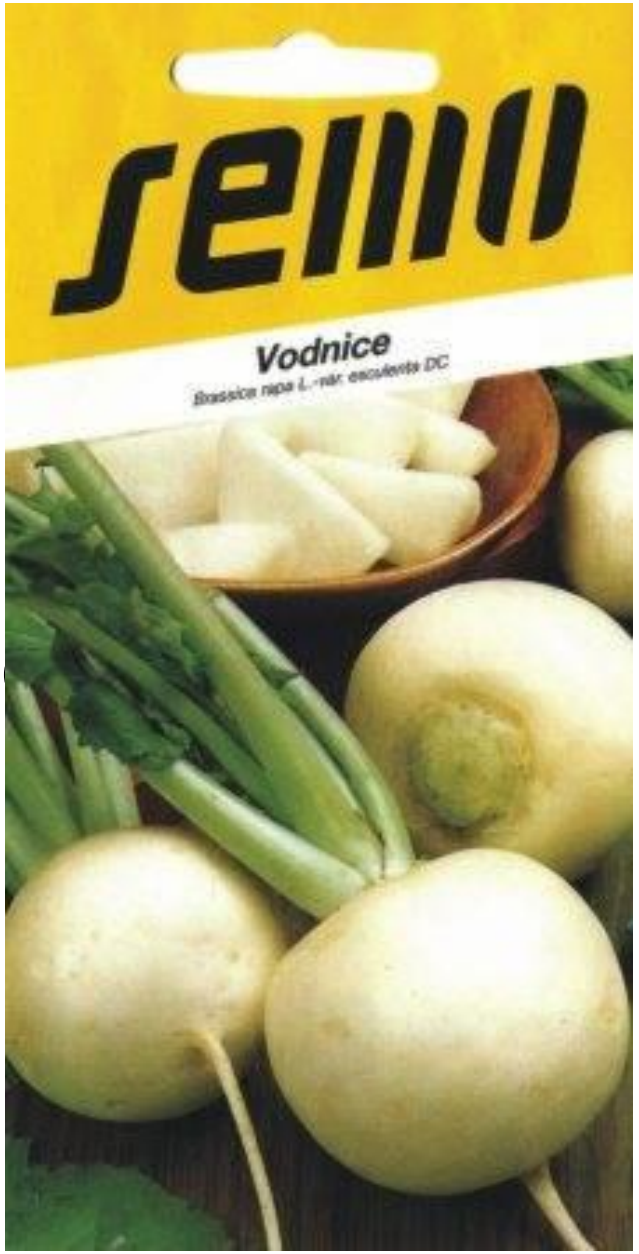
Ca	480	Fe	2
Na	150	Mg	80
P	410	K	2,800
Zn	1.0	Cl	390
Mn	1.0	S	220

- Vitamins ($mg.kg^{-1}$):

A	0.2	PP	4.0
B_1	0.5	C	170
B_2	0.1		
B_6	0.8		

Requirements

Easy to grow
Tolerates up to -7°C
Optimum temperature: 18°C
Second year after fertilization with
Sow in soils after root and tuber cr



Turnip

Sowing

Subsequent crop, sowing from April to August
Sowing also in March, harvest May through June
Spacing: rows: 30-40 cm x 10-15 cm
Taproot size: 5-8 cm

Turnip

Black salsify *Scorzonera hispanica*

- Origin: Spain; sometimes called “Spanish salsify”
- Wild plant: Spain, Siberia, Central Europe
- Cultivated from 16th century
- Not grown on commercial scale, roots are too long
- Difficult harvest, weeds pervade the whole land area
- Dark-brown to black root skin, snow-white pulp; plant drips white sauce
- Ideal vegetable for diabetic people: starch contained in the form of inulin
- Raw salsify tastes like pea; excellent spreads; good for cooking, too
- Winters: even better flavour in spring
- Poor seed germination

Black salsify

Nutritional value

- Dry matter 21.4 %
- **Fibre** 5.3 %
- Protein 1.4 %
- Lipids 4.3 %
- **Carbohydrates 13.3 %**
- Ashes 1 %

- Dietary minerals (mg.kg^{-1}):

Ca	**530**	**Fe**	**9**
Na	50	**Mg**	**230**
P	757	K	3,200
Zn	**7.3**	Cl	370
Mn	4.0	S	220

- Vitamins ($mg.kg^{-1}$):

A	0.2
B_1	1.1
B_2	0.35
B_6	0.7
B_9	0.6
PP	3.5
C	40
E	**60**

Requirements

Soil: loamy-sandy, loamy
pH 6.4-7.0; low tolerance to alkali, and acid below 5.5
Branchy roots in gravely soils
Tolerates low temperatures, winters without any damage
Second year after fertilization with manure; direct application of manure or liquid manure is unacceptable
Yield: 20 tons of root
Fertilization: 70-100 kg N, 45 kg P_2O_5, 150 kg K_2O, 16 kg MgO
P, K, Mg in the autumn

Cropping practices

Sowing: March through April
Rows: 30-45 cm apart, seeds 8-10 cm apart, 2-3 cm deep
Sowing standard: 7-8 kg/ha
Herbicides: Kerb 1.5-3 kg/ha
Storage: more than 95% humidity, 0-1°C, or leave on the field

Black salsify

Sunchoke *Helianthus tuberosus* L.

- Main producer in Europe: France
- Common from 16th century until substituted with potatoes
- Morphology similar to sunflower, smaller blooms (calathidum)
- Straight stem grows up to 1.2-3 m high and branches at the top

- Elongated tubers with wrinkly surface and thin peel are attached to tuber-bearing shoots, which is a main reason for limited cultivation of sunchoke

Sunchoke

- After the plant form tubers, it starts to grow rapidly
- Yield: 4-7 kg of tubers per $1m^2$
- Great for diabetics
  - No starch (in contrast to potatoes), just inulin
  - Rich in iron, silicon, potassium
  - Vitamins A, B1, B2, C
- Food
- Feed (game)

- Easy to grow, tolerates moist as well as dry locations
- Tuber can withstand strong frosts, good for mountainous regions
- Grows wild on river banks, in drains, balks and recent construction sites
- Sunchoke has become popular worldwide recently thanks to its inulin content.

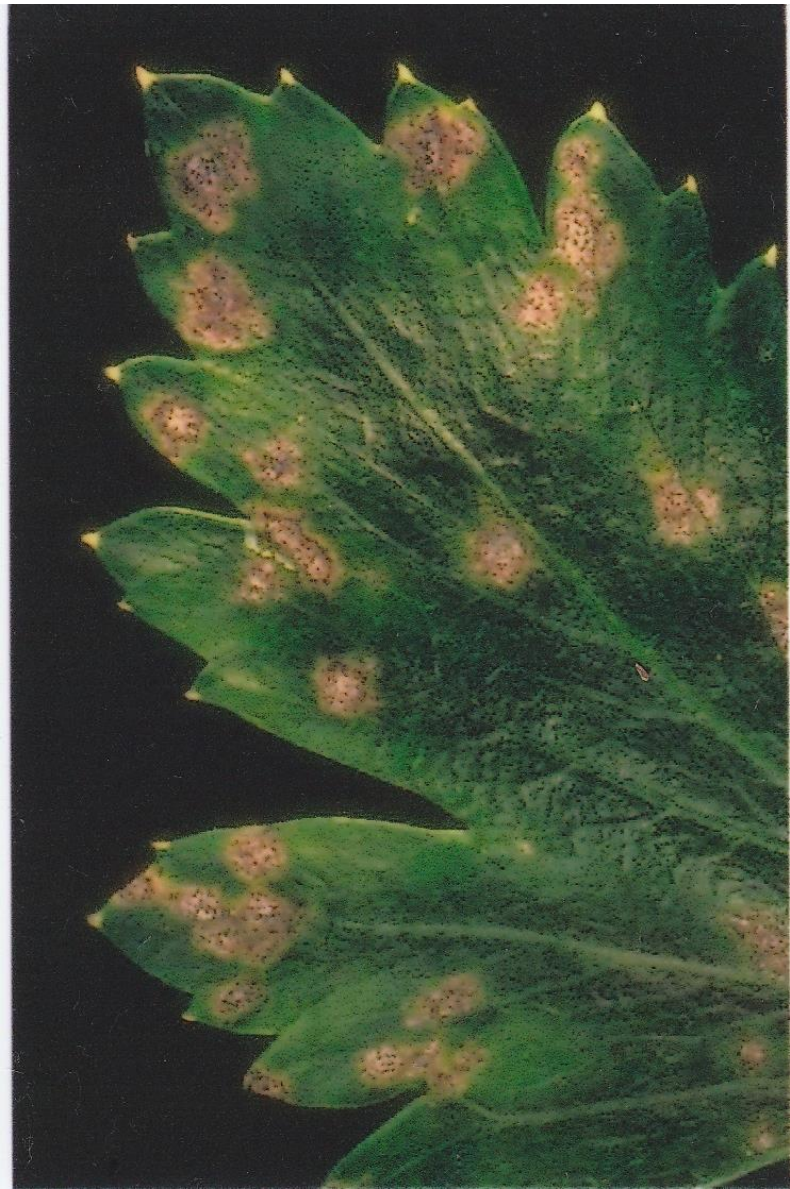
- Weeds pervade the whole land area
- Growing sunchoke on the same location several years in a row (some of the tubers are left in the soil as planting material) battles the weed problems
- But: Due to uneven distribution of tubers, use of heavy machinery, and health condition of the plants, the sprouting rate worsens
- Pre-treatment of soil before planting is similar to pre-treatment of soil for potatoes; sunchoke benefits from organic fertilizers
- Sowing: spring and autumn
- Row spacing: 60-75cm, spacing of tubers in a row: 30-45cm, planting depth: 6-10cm
- 50 thousand tubers per hectare
- Planting material: 2-2.5 tons per planting (30-60g tuber weight)

- Production of sunchoke for biomass: Perennial plantings
- Two harvest per year (first in July) with common above-ground cutters
- Tubers are left in soil over the winter
- Tubers and greens may be used for silage and for animal feed

Root vegetables: Diseases and pests

Leaf spot *Septoria apiicola*

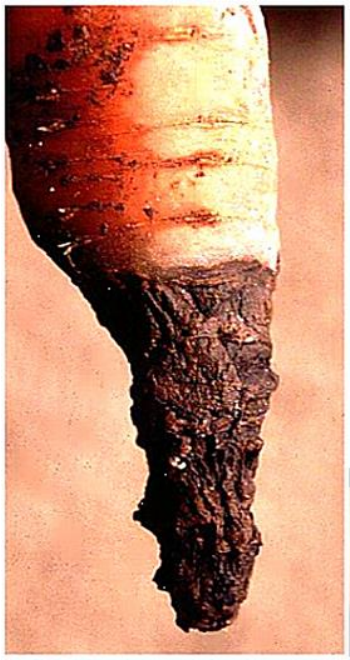
- Grey spots with pycnidia on both sides of leaves, stem and inflorescence
- Decrease in yield by 50-70%
- Survives in infested residues and seeds
- Residues must be destroyed
- Fungicides: only for seed stands
- Disinfection of seeds
- Plant more resistant varieties



Carrot black rot *Alternaria radicina*

- Fungi survives in seeds and mummified plant residues
- Decrease in yield by 50-70%

- Alternation of crops
- Proper root storage
- Seed disinfection (Benlate 5 g per 1 kg of seedstock)

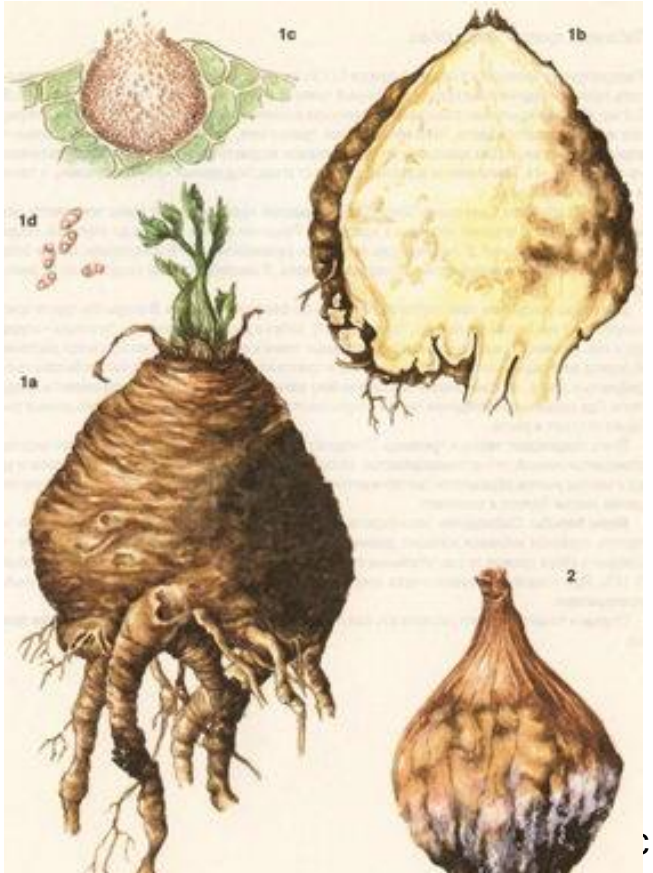


Powdery mildew *Erysiphe heraclei*

- Infestation: carrot, parsley, parsnip, dill, fennel, weeds (hogweed), etc.
- Benefits from warm and dry weather
- Transferred by seeds and weeds
- Plough in post-harvest residues, eliminate all weeds

Celery root rot *Phoma apicola*

- Infests celeriac, carrots, parsnip, and parsley
- First symptoms: tiny brown spots on leaves
- Spots colour turns from brown to rust, and pycnidia start to show; if number of picnidia exceeds a certain level, leaves turn yellow



- Pycnidia are also produced on root; tissue around pycnidia becomes soft and the plant is infested up to 3-4mm deep
- Plant produces crust around pycnidia in order to defend itself
- In the final stage of the disease, decay spreads deep inside the root tissue

- Prevention: disinfection of planting trays, hot-bed muck-soil, and tools

- Celeriac seeds do not have to be treated, if they are already disinfected for leaf spot disease

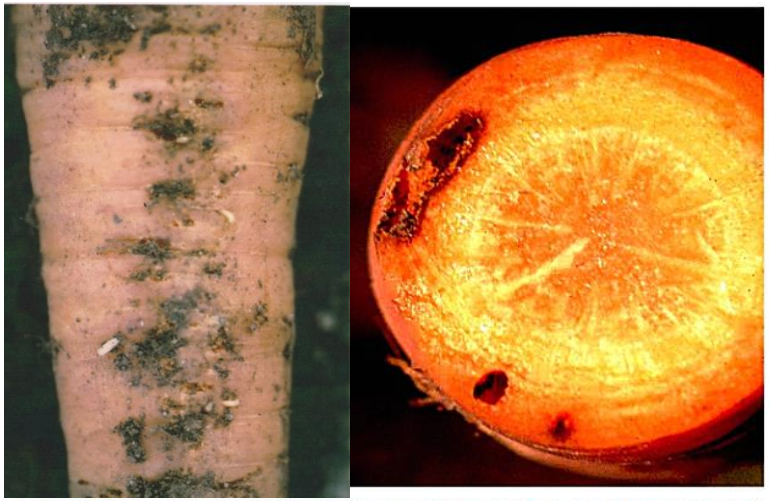
- Late sowing is better, if the grower intends to produce vegetables for winter

Beet cyst eelworm *Heterodera schachtii*

- Affects beetroot, chard, spinach, and other plants from Chenopodiaceae family
- Splitting of root cortex, cyst formation
- Maintain 5-year rotation
- Integration of suppressive plants (lucern, corn, rye, chicory)

Carrot fly *Philla rosae*

- 5-7mm long black fly
- Females lay eggs into soil in close proximity to carrots
- 7-8mm long yellow larvae ear their way through roots, roots rot and turn brown
- Two generations:
  - First adult flies are able to fly in mid-May
  - Second, more harmful generation matures in July Larvae winter in soil
- Signals: yellow, sticky boards; prevention



Carrot leaf miner *Napomyza carotae*

- 2.5mm long females pierce a carrot leaf and suck on the juice
- This causes ca. 1mm light spots on bottom side of the leaves

•0.4mm large eggs are laid individually inside the leaves and leaf petioles
•Larvae eat their way inside the root, or stay in above-ground part of the plant (celeriac, due to thick leaves)
•Larvae produce mines just below surface of the carrot root head, there are no droppings inside the mines, and the pupae are formed at the end of the mine
•Second generation within a year, May/June and August/September
•Prevention: Distance from last year’s locations

Celery fly

- 5-6 mm long fly
- Spring adult flies are yellow-red, autumn adult flies are red
- Larvae: 7-8 mm, winters as pupae in soil
- Adult flies lay eggs inside the leaves of the plants from Apiaceae family
- Larvae produce mines inside the leaves
- Leaves dry out

Green peach aphid *Myzus persicae*

- Various colours: green, olive green, yellow-green, light brown-red
- Aphids suck on leaves and roots
- Black eggs winter in peach bark cracks
- Aphids suck on bottom parts of peach tree leaves
- Winged aphids fly to their summer hosts to propagate in May or early June
- Aphids return to peach trees in the autumn, and lay eggs