



INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ



Inovace studijních programů AF a ZF MENDELU
směřující k vytvoření mezioborové integrace
CZ.1.07/2.2.00/28.0302

**Tato prezentace je spolufinancovaná z Evropského sociálního fondu
a státního rozpočtu České republiky**

Leaf vegetables

Used for salads (salad greens)



- Consumption of fresh vegetable salads in CR is one of the lowest in Europe
- CR: only 0.8 kg of salads per capita per year = 5 times lower than in developed European countries (overall low consumption of vegetables in CR: 82 kg per capita per year)
- 1st and 2nd quarter of the year in CR: Beijing cabbage and head lettuce (I. – VI. – V.)
- 3rd quarter of the year: fruit-bearing vegetables (tomatoes, cucumbers)
- 4th quarter of the year: carrot salad, beetroot (unfortunately, other root vegetables are not commonly used throughout the year, e.g. celeriac; radish or blanched cabbage)

Following Czech grown vegetables are expected to become more popular and used by Czech people:

- Iceberg lettuce
- Sweet fennel
- Celery
- Endive
- Chinese cabbage
- Red chicory (Radicchio)
- Green chicory (Zuckerhut)
- Witloof chicory

- Must be marketed: advertising, recipes, etc.
- Vegetables must be top quality, fresh, clean, and decently wrapped
- Public eating: restaurants, schools, hospitals
- Production of green tops and various specialties: smaller suburban farms (contracts)

Head lettuce (butterhead) *Lactuca sativa* L.
var. *capitata*

Originates from wild-grown prickly lettuce
(*Lactuca seriola*)

Vegetable grown in ancient Egypt, Persia,
and Greece 500 BC

Lettuce as we know it today has been
grown since 16th century





Botanical characteristics

- Annual plant, shallow roots
- Leaves are smooth as well as blistered, green, yellow-green, red as well as brown-red with distinct central vein, no petioles
- Leaves form a head, 180-500 g, wilts quickly after harvest
- If days are long, 0.8-1 m long pulpous stem with inflorescence at the top grows through the head
- Bolting is supported by long days, high temperatures, and dry weather
- Fruit: downy achene
- Frost-resistant, tolerates up to -5°C
- Optimum growing temperature: $12-18^{\circ}\text{C}$, higher temperatures: poor head packing, bolting

Nutritional value of head lettuce

Dry matter 5-8 %

Fibre 0.71 %

Vitamins (mg .1,000 g-1):

A 3 – 6 (provitamin A)

C 60 - 100

B1 3

B2 3

Low in malic acid, citric acid, oxalic acid, and asparagine

Bitter flavour: lactucin

Stimulating vegetable

Cropping practices

Germinates at 2°C

21°C germinating ability decreased

25°C germinating ability impaired

30°C germinating ability lost

Lettuce must be sown in the afternoon, if sown in summer; otherwise it will not germinate; do not sow in the morning, swollen seed has to endure the highest temperature over the noon – both in greenhouse and outdoor (!)

Grows at temperatures higher than 4°C (above 10°C: good; optimum: 16-18°C)

Young plants withstand -5°C

Regular irrigation

Growing: pH above 5.5 (optimum: pH 6.2-6.8)

Cultivation:

Pre-cultivated planting material

Direct sowing (from end of April, not so common)

Early sowing (spring) lettuce January-February (planting: 15 March-10 April)

summer lettuce April-June for autumn harvest July-August, wintering: 20-30 August

Head lettuce

Leisure gardeners: small gardens around Brno, Břeclav, Lednice, Podivín, Poštorná

Harvest: end of April, early May

8 CZK per 1 lettuce head

100,000 heads per 1 ha (1,000 heads per 100m²)

Good sales, high costs of manual labour, risk of winter killing (winter with no snow)

Most profit

Summer lettuce: not grown much, salads are made from cucumbers and tomatoes.

Beijing cabbage: mechanized harvest, much higher profit and revenue than for summer lettuce

Controlled lettuce grown outdoor

SOWING	PLANTING	HARVEST ONSET	WITH FOIL SHEETS
6.2.	5-6 weeks 29.3.	19.5.	10.5.
20.2.	↑ 10.4.	30.5.	15.5.
5.3.	↓ 25.4.	10.6.	25.5.
1.4.	6.5.	16.6.	5.6.
14.4.	4 weeks 14.5.	24.6.	14.6.
28.4.	28.5.	3.7.	<i>Early lettuce</i> <i>Summer lettuce</i> <i>Autumn lettuce</i>
5.5.	5.6.	10.7.	
12.5.	12.6.	17.7.	
3.6.	19.6.	24.7.	
10.6.	26.6.	26.7.	
17.6.	3.7.	3.8.	
24.6.	24.7.	24.8.	
1.7.	1.8.	1.9.	
8.7.	8.8.	8.9.	
15.7.	15.8.	15.9.	
22.7.	20.8.	25.9.	Lettuce requires specific light intensity and duration to form a head
25.7.	22.8.	5.10.	

Spacing: 20 x 20 cm forcing

25 x 25, 30 x 30 cm outdoor

- Sowing depth: 10 mm
- Sowing standard: 0.9 kg/ha
- Optimum: 100,000-120,000 plants per ha

Irrigation

- If available water holding capacity (AWHC) drops below 65%
- 10-15 mm dosage
- Especially before heads are formed

Harvest

Early lettuce manual sorting

Large-head lettuce one-off mechanized harvest (Asalift)

Manual labour: 400-600 hours per ha

Yield: 14-18 tons per ha, wintered lettuce: 10 tons per ha

Storage:

20°C 1 day

8°C 4 days

0°C 12 days

Iceberg lettuce *Lactuca capitata nidus jaggeri*



- Originates in the US
- “Iceberg”
 - Leaves and veins have glass-like consistency, as if they were frostbitten
 - Transported with crushed ice
- Compared to head lettuce
- Iceberg is more tolerant to transport
- Less susceptible to bolting
- Leaves are full of veins, blistered, crimped on edges, light to dark green or red
- Head: 300-1,200 g (ideal: 500 g)

Iceberg lettuce

Cropping practices

- Cropping practice is identical to head lettuce (butterhead lettuce)
- Pre-cultivated planting material, latest planting term: mid-August
- Varieties are indifferent to day length - no bolting
- Spacing: 30 x 30 or 40 x 30
- Vegetation period is 10 days longer than veget. period of head lettuce
- Manual harvest for small areas, mechanized harvest for large areas; remove outer leaves, heads are wrapped in foils
- Biggest problem: tipburn – browning of head centres
 - Physiological disorder resulting from stress caused by uneven irrigation or high temperatures; larger and heavier heads are mostly affected (harvest smaller heads)

Leaf lettuce *Lactuca sativa* L. var. **crispa**

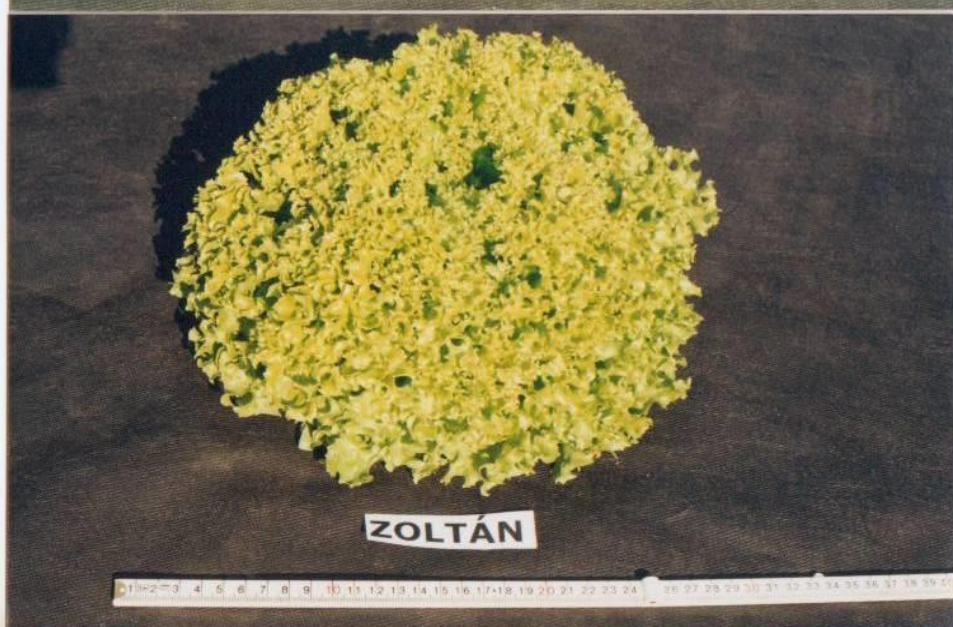
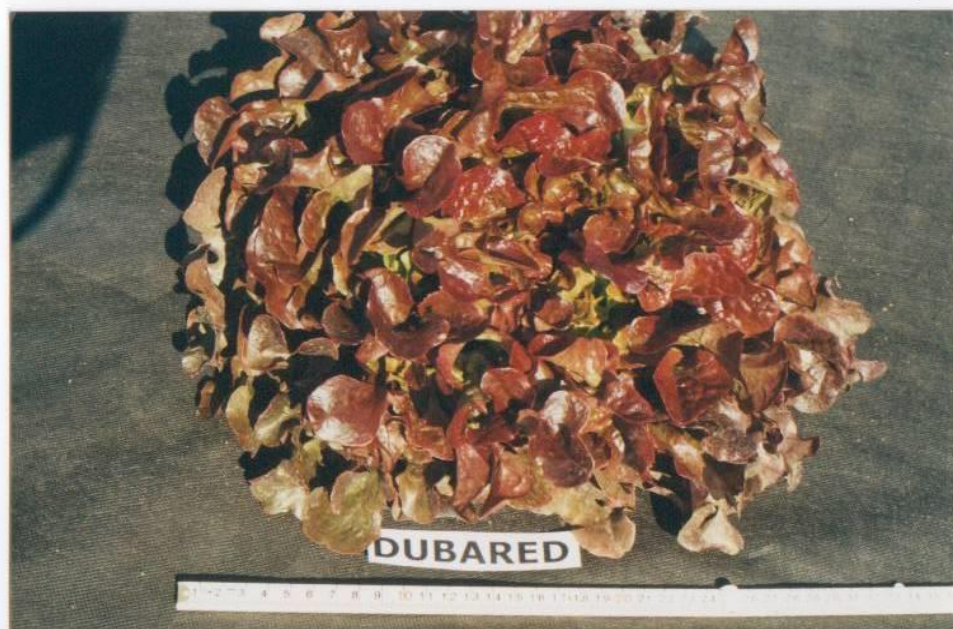
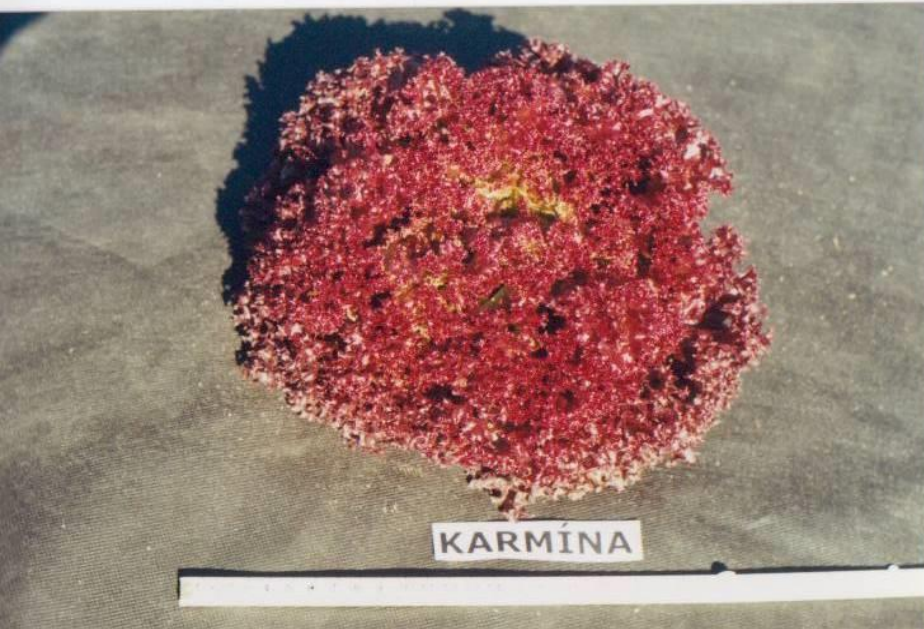
- Originates in Italy; lettuce does not form heads but rosettes of leaves of various shapes and colours (entire leaves, curly leaves; yellow, green, red, brown-red)
- Popular in Western Europe; has been replacing head lettuce
- Wilts rapidly, consume within 24 hours after harvest, ideal for McDonald, KFC, hotels – dishes are decorated with individual leaves of the lettuce



- Contains more fibre (good for health)



2 leaf types: dissected and curly



Cropping practices

- Cropping practice is identical to head lettuce (butterhead lettuce)
- Continuous plantings from spring till August
- Shorter vegetation period than in head lettuce
- Harvested within 2 months after planting
- Spacing: 0.3 x 0.25 0.25 x 0.2 m
- Harvest: manually, in the morning, cut the lettuce heads at the root neck; individual leaves may be also harvested



Leaf lettuce

Romaine lettuce *Lactuca sativa* L.var. *longifolia* Lam.

- Oldest type of lettuce, came from wild lettuce (*Lactuca scariola*)
- More robust root system, entire leaves are elongated, elliptic, with distinct veins, mildly wavy, and covered with wax coating. Lettuce forms rosettes with more or less curly leaves (200-500 g, head height: 30-40 cm)



Unpacked head rapidly wilts

Romaine lettuce

- Poorly packed heads rapidly wilt, no commercial potential
- Vegetation period is 1-2 weeks longer than veget. period of head lettuce
- Direct consumption (eaten raw in salads), may be thermally processed
- Tolerates up to -5°C without damage

Cropping practices

- Sowing: March-June
- Planting: April-July-August
- Harvest: July-October
- Spacing of plantings: 0.3 x 0.3 m
- Row spacing of seeds: 0.4 x 0.2 m
- Manual harvest, sorting (2 or 3 times)

Corn salad *Valerianella olitoria*

- Grows wild all over Europe, aromatic leaves
- No large-scale cultivation in CR; important aromatic green tops
- Lighter, moist soils
- Plants must develop sufficiently before





Nutritional value of corn salad

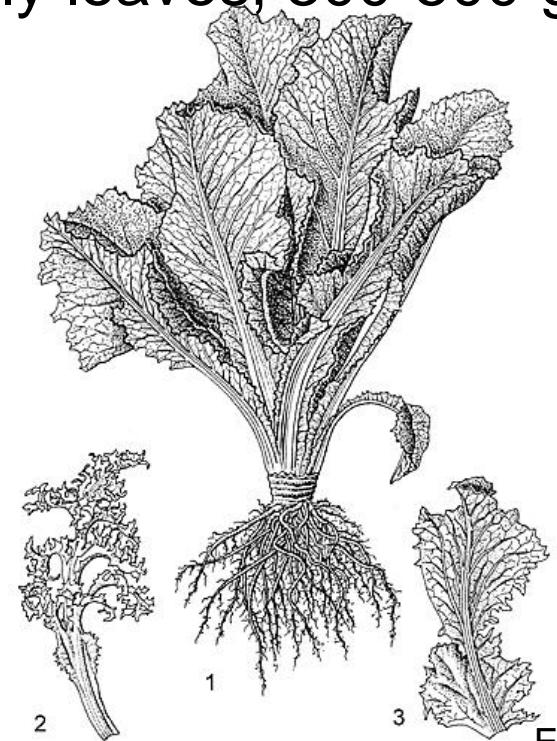
- Dry matter 6.6%
- Fibre 1.5%
- Protein 1.8%
- Lipids 0.3%
- Carbohydrates 1.0%
- Vitamins (mg .1,000 g⁻¹):
 - A 39
 - C 350
 - B1 0.65
 - B2 0.8
- Ca 350 mg
- Fe 20 mg
- P 490 mg
- Mg 130 mg
- K 4,200 mg (/kg of fresh mass)

Cropping practices

- Direct sowing: early August, September
- Harvest: October-December, March-April
- Spring sowing is not recommended, plants tend to bolt
- Sowing depth: 1 cm
- 6 kg of seeds per 1 ha
- Vegetation period: 90 days
- Spacing: 30 x 10
- Harvest of leafy rosettes
- Yield: 5-6 tons per ha, 50-70 kg per 100 m²
- Fresh seeds are not recommended, 2-4-year old seeds germinate the best
- Grows as weed: no need to pre-cultivate planting material

Endive *Cichorium endivia* L

- Type of leafy chicory: used mostly in Southwestern Europe, popular in France, Italy, Spain, and Netherlands
- Original form comes from Mediterranean
- Grown by ancient Greeks and Romans (used as fresh and pickled salads)
- Produces rosettes with more or less curly leaves, 300-500 g heads (up to 1,200 g)



Endive

- Contains twice as much fibre and dry matter than head lettuce
- Bitter flavour caused by intybin helps digestion (water-soluble, may be dissolved in water within 15-20 min)
- Tolerates up to -5°C without damage, winters under unwoven fabrics during mild winters or in unheated plastic greenhouse
- Ecological plant – no chemical protection – more robust leaves
- Annual plant



2 types of endive *Cichorium endivia* L.

var. *crispum* - curly form, leaves are fully shaped, as if cut

var. *eskariol* - entire, more robust leaves



var. crispum



var. eskariol

Nutritional value of endive

Dry matter 11%

Fibre 2.0%

Protein 1.2%

Lipids 0.2%

Carbohydrates 4%

Vitamins (mg .1,000 g-1):

C 120 mg A 11.4

B1 0.5 B2 1.2

B6 0.2

Rich in chlorophyll

Bitter flavour: intybin (water-soluble)

Less bitter than chicory and more bitter than head lettuce

•Ca 790 mg

•Fe 14 mg

•Mg 130 mg

•K 3,870 mg

•P 400 mg

•Zn 2.6

•S 320

•J, Mn, Se (/kg of fresh mass)

Cropping practices

- Identical requirements on growing as head lettuce
- Medium-heavy, moist (or irrigated) soils
- Water deficiency causes leaves to be more stiff and bitter
- Spacing: 30 x 30, 40 x 30 x cm
- Foreign producers blanch curly varieties before harvest by covering the plants with plastic foils; this a tedious work and it is much easier to harvest the plants and put them in dark for 3 days; endive becomes less bitter (chlorophyll is bitter)
- Not infested by pests due to bitterness
- Higher resistance to diseases than other lettuces
- If the smallest head is over 300 g, plants are mechanically harvested

Direct sowing:

Virtually all-year round

March - April

July-August

Mid-August-mid-September

Harvest: June

October – December

April (winters in unheated plastic greenhouse, non-woven fabric)

Pre-cultivated planting as well as cheap seeds: only non-hybrid varieties – no need to pre-cultivate

Harvest: 3-4 months after sowing

Green chicory Zuckerhut type *Cichorium intybus* L. var. *foliosum capitata*

- Originates in Italy
- Zuckerhut = sugarloaf, promising vegetable
- Produces green, conical heads (800-1,100 g), similar to Beijing cabbage: identical cropping practice, different flavour
- Used for fresh salads, contains intybin: bitter flavour
- Yield: 30 tons per ha, tolerates -7°C , harvested until Christmas
- Harvested within 2-3 months after planting or 3-4 months after sowing



Nutritional value of chicory, Zuckerhut type

Vitamins (mg .1,000 g⁻¹):

C 32 mg

B1, B2, B6

Contains inulin

•Ca 64 mg

•P 26 mg

•Mg 13 mg

•K 256 mg

•Fe 0.7 mg (/kg of fresh mass)

Cropping practices

- Low requirements (similar to lettuce)
- Necessary irrigation, optimum temperature: 20-24°C
- Direct sowing or planting containers: 1-10 July, never earlier!
- Pre-cultivation of planting material: more than 20°C, lower temperatures: plants bolt
- Planting: 1 Aug-15 Aug
- Spacing: 40 x 25, 30 x 30, 30 x 35 cm (80,000 plants per ha)
- Harvest: 15 Sep - 30 Nov
- Yield: 30 t/ha
- Tolerates up to -7°C, harvested until Christmas, if winter is mild
- Storage: up to 2 weeks

Red chicory Radicchio type Cichorium intybus L. var. foliosum capitata

- Originates in Italy
- Requires higher temperatures, tolerates temperatures above 0°C, max. -2°C
- Round, flat-round or conical heads (400-700 g)
- Strong bitter flavour: preparation of mixed salads
- Rich red colour: temperature difference between day and night must be 8-10°C
- Lot of waste: edible part makes up only 50% of the plant
- Yield: 18-20 t/ha



Radicchio



Treviso

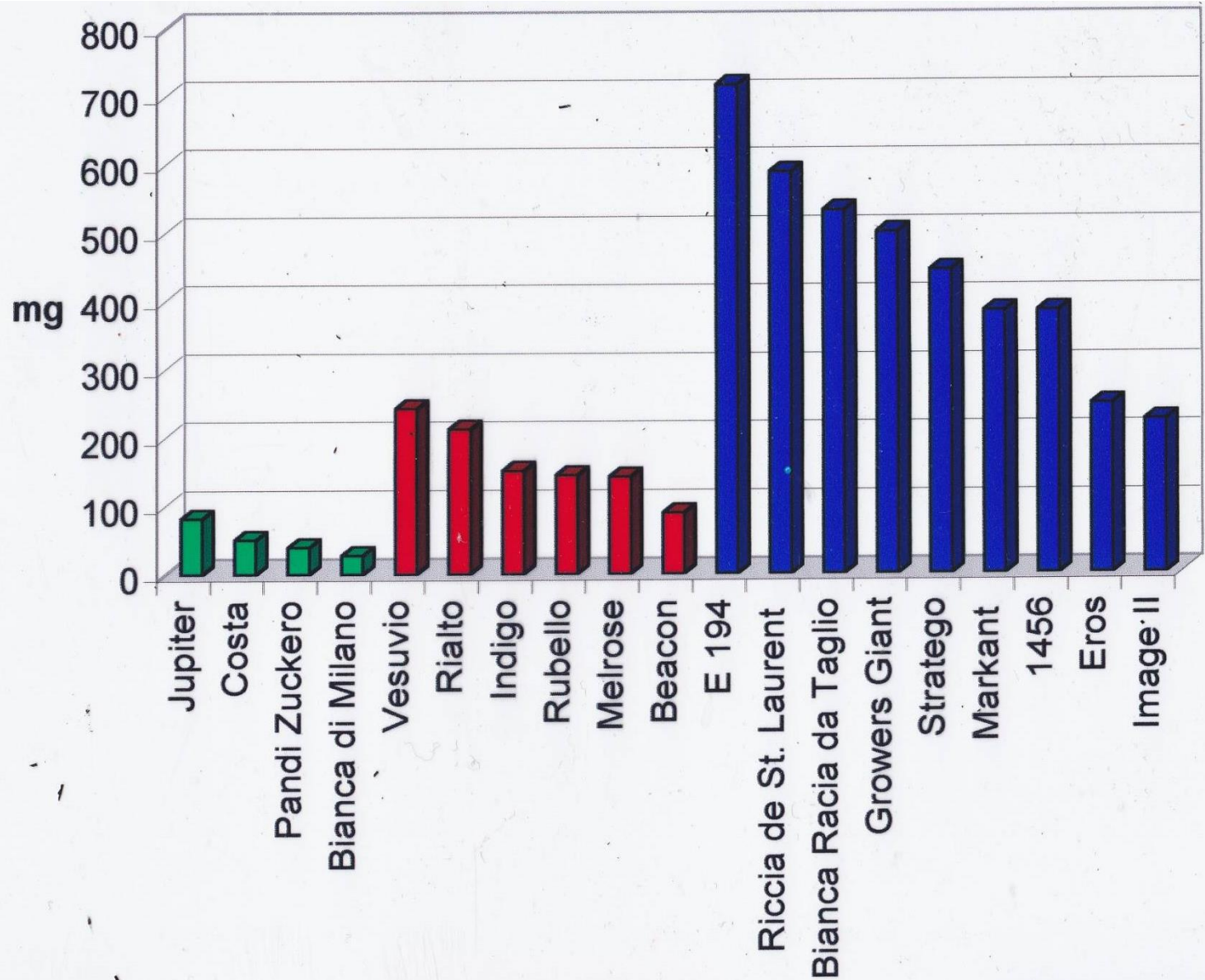
Nutritional value of red chicory

- Similar to Zuckerhut chicory
- More bitter: 2.5 times more intybin
- Used as an ingredient in mixed salads (with white blanched cabbage + 10% chicory: colourful salads)

Cropping practices

- Sowing: 15 February-10 July (direct sowing after 15 April)
- Planting: 1 April – 10 August
- Harvest: 15 June – 10 October
- Spacing: 30 x 25, 30 x 30
- 12-16 plants per m²
- Harvest by mid-October, tolerates -2°C at most
- Rich red colour: temperature difference between day and night must be 8-10°C (nowhere in Italy = chicory is grown in Ostrava region and Poland, and then imported to Italy)
- Basically not grown (Ostrava only), no sales in CR

Nitrates concentrations in chicory and endive (mg/kg of fresh mass)



zelený typ čekanky

červený typ čekanky

štěrbák

Witloof chicory *Cichorium intybus* var. *foliosum*

- Forced vegetable: production of chicons (December, January, February); low requirements on energy
- Roots are intermediary for chicons production
- Belgium: 9,000 ha
- Netherlands 2,500 ha
- France 20,000 ha



Nutritional value of chicons

- Vitamins (mg .1,000 g⁻¹):
 - C 4
 - B1, B2, B6
 - Folic acid 52 mg
 - Stimulating vegetable
- Ca 64 mg
P 21 mg
Mg 13 mg
K 180 mg (/kg of fresh mass)

Cropping practices

- Preceding crop:
 - Good: cereals
 - Bad: potatoes, beetroot, sugar-beet, cumin
- K affects roots and chicory quality: dosage of 150-200 kg per ha
- P affects germination and earliness: 40-60 kg per ha
- Mg affects chicory firmness: 20-25 kg per ha
- Few N on leaves: 40-60 kg per ha
- Optimum pH 5.8-6.4

1. Roots cultivation

- Direct sowing: 15 April – 10 June, 1.5-2.5 kg per ha
- Depth: 2-3 cm, rows: 42 cm
- Hoe at the stage of 4-6 leaves
- Roots harvest: First half of October
- Green tops must be twisted off manually (ROOT CROWN CANNOT BE DAMAGED)
- Store the same day (roots dry out quickly)
- Root head diameter: 3-6 cm, 16-18 cm long; strong roots develop open chicons
- Root yield: 11-13 t per ha; attainable: 16-18 t per ha (250,000-300,000 roots per 1 ha)
- Storage of roots: 1-5°C (optimum: 1-2°C), humidity: 95-98%

2. Chicons forcing

- Forcing time: December-February (dark spaces)

- Forcing:

8-12°C 45-60 days

12-18°C 35-40 days

18-25°C 20-30 days

- 350-500 roots per 1 m²
- Boxes filled with substrate for root crown, or hydroponics
- Yield: 25-40 kg/m²
- 1st grade quality chicons: 100 g
- Purchase price of one 1st grade chicon: CZK 6
- There are 3 producers in CR in Pardubice region who grow chicons for their own clients

Beijing cabbage *Brasica rapa* var. *pekinensis*

- Origins: Far East, 300 BC in China
- Imported to Europe in 17th cent.
- Common vegetable in China, Japan, Korea, USA, and Western Europe
- Number 1 salad vegetable in CR 1
- Excellent flavour, good nutritional value and storability
- Annual, heterogamous plant
- Wide, light-green, fine leaf blade connected to a pulpy petiole



- 500-3,000g head, firm and freely packed - conical, columnar, barrel-like shape
- Long days: head is not developed, plant bolts (low temperatures during sprouting)
- Germination: at least 18°C for 1 month
- 0-16°C: bolting
- Above 1°C: bolting after head development
- Above 22°C: no bolting
- Optimum temperature for head development: 12-16°C
- Seed germinating ability: 3-5 years
- Weight of 1,000 seeds: 3-5 g

Varieties of Beijing cabbage

- 1. Pekinensis variety: barrel-like shape, tightly packed head
- 2. Cylindrica variety: cigar-like shape, poorly packed head
- 3. Laxa variety: non-packed head, very soft



Nutritional value of Beijing cabbage

Dry matter 4.6%

Fibre 1.6%

Protein 1.1%

Lipids 0.3%

Carbohydrates 1.0%

Vitamins (mg .1,000 g-1):

C 360 (salad: 80-100)

- Ca 400 mg

- Fe 6 mg

- P 550 mg

- Mg 110 mg

- K 2,020 mg

- Zn 2.0 mg

- Mn 2.8 mg (/kg of fresh mass)

Cropping practices

- Low requirements on location, up to 700 m above sea level
- Sugarbeet production regions; soils with good water-holding capacity, rich in humus and nutrients
- pH 6.5-7
- Usually grown as a subsequent crop after early vegetables (after pea, winter mixtures of cereals and legumes, and early potatoes)
- Medium feeder (organic manure for preceding crop)
- Vegetation period in CR: 85-95 days
- No other vegetable can develop so much good organic matter within such a short period of time.

- Precultivation of planting stock:
- Smaller spacing, more developed seedlings with 5-7 true leaves
- Less adaptable to dry conditions
- Tends to bolt
- Low seed demand: 0.6 kg per ha

- Direct sowing:
- More robust root system
- Better adaptability to moisture conditions
- Higher resistance to tipburn
- Disadvantage: higher seed demand: 0.9 kg per ha (exact sowing)

Only certain varieties	Main term
Sowing: 1 March-1 April	1-15 July (early sowing: bolting)
Planting: 1 April – 20 April	20 July – 5 August
Harvest: 1 June – 30 June	15 October – 25 October
Spacing: 40 x 30	40 x 40
Yield: 50-60 tons per ha	50-70 tons per ha
Sowing standard: 0.6 kg per ha (for planting) 0.9 kg per ha (direct sowing)	

Germination: at least 18°C for 1 month

Must be covered with non-woven fabric right after planting (flea beetles, pollen eater, cabbage fly): especially at the beginning of July, after sugar-beet harvest

- Fertilization:
 - N 100 - 120 kg
 - P₂O₅ 60 kg
 - K₂O 100 - 140 kg
- Supplementary irrigation at least once a week 15-20mm doses (shallow roots)
 - Supplementary irrigation: 120-150 mm
 - Total water consumption: 250-270 mm
- Harvested before temperatures drop below -5°C (last decade in October, first decade in November)

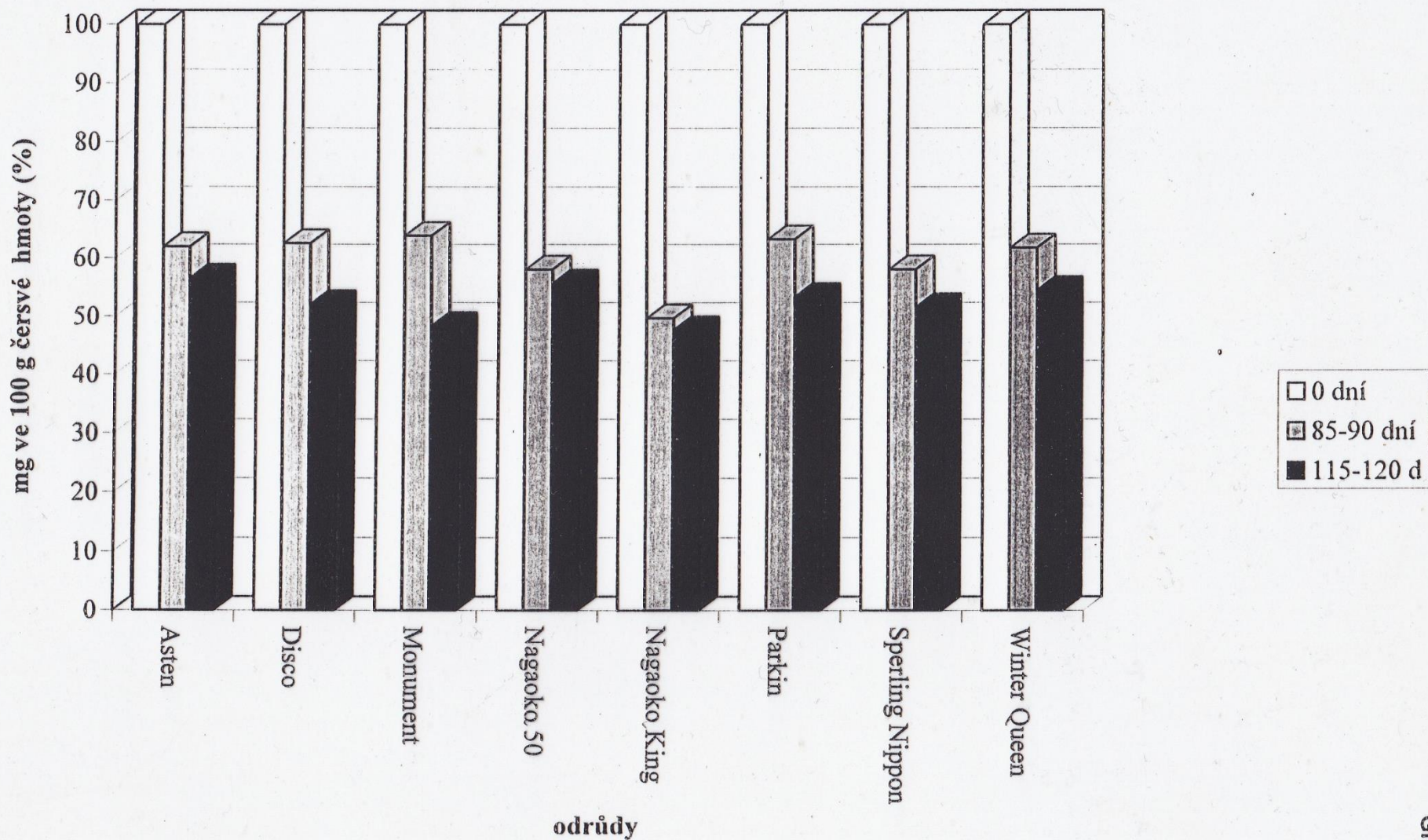
Requirements on cabbage heads for storage

1. Minimum weight of 700 g, optimum weight: 1,000-2,000 g, maximum: 2,500-2,600 g (more than 2.6 kg: overripe, crack during storage)
2. Fully developed heads, packed, firm, green
3. Great condition, not infested with any pests or diseases
4. Removal of dry, damaged leaves and roots (leave the outer leaves, prevent vapour)
5. Rotten leaves must be removed under all circumstances, random inspection for tipburn

Storage requirements

- 0.5-1°C, 90-95% relative humidity
- Premises: cellars, frost-free spaces with 8-10°C temperature
- Store in piles; store without roots in boxes
- Place in cold room before storage
- May be stored till mid-February

Obsah kys. l - askorbové během chladírenského skladování - procentické vyjádření



Benefits of Beijing cabbage

1. Short veget. period (60-110 days): may be grown as a subsequent crop, good in plastic greenhouses (after cucumbers and tomatoes), harvested for Christmas
2. Direct sowing
3. High yield: 50-60 tons per ha
4. Low requirements on heat; low temperature during head development
5. More resistant to low temperatures than head lettuce
6. 3-4-month storage
7. Higher nutritional value than head lettuce
8. Easily digested protein
9. Fewer nitrates than head lettuce
10. Good quality, brittle consistency, great potential
11. Excellent revenues (300,000-400,000 CZK per ha)

Drawbacks of Beijing cabbage

1. Infestation with diseases (*Alternaria brassicae*) and pests (cabbage fly, flea beetle, pollen eater)

Use non-woven fabric against 2nd generation cabbage flies and flea beetles

2. Higher sensitivity to chemical spray concentrations



Chinese cabbage *Brasica rapa* var. *chinensis*

- Origin: Far East
- Direct consumption, 90% edible
- No head development, only 0.3-0.5m high semi-erect or low-ground leaf rosette with leaf petioles
- Leaf blade is stiff, shiny; petiole is long
- Vitamin C: 1,000 mg/kg
- Vegetation period: 60 days (sowing-harv
- CR grows 4 domestic varieties – no inte
- Imported to UK from China



Nutritional value of Chinese cabbage

Dry matter 5.0%

Fibre 2.0%

Protein 1.2%

Lipids 0.25%

Carbohydrates 1.1%

Vitamins (mg /1,000 g-1):

C 600 – 1,000

•Ca 400 mg

•Fe 6 mg

•P 550 mg

•Mg 110 mg

•K 2,000 mg

•Zn 2.0 mg

•Mn 2.8 mg (/kg of fresh mass)

Cropping practices

- Sowing: 1 July – 15 August (bolts if sown earlier)
- Planting: 1 August – 10 September
- Must be covered with non-woven fabric immediately (flea beetles, cabbage flies)
- Sowing standard: 0.7-0.8 kg per ha
- Spacing: 40 x 30, 40 x 40 cm (62,000 – 64,000 plants per ha)
- Regular irrigation once a week, shallow roots
- Veget. period: 60 days
- Yield: 35-40 tons per ha, rosette: 500-800 g
- Storage: cooling chamber, 10 days, 0-2°C (wilts quickly)

Chard *Beta vulgaris* var. *cicla*

- Origin: Mediterranean, developed from sea beet
- Grown by ancient Greeks, Romans; China: since 9th century



- Good for higher altitudes
- First year: rosette with petiolar, thickened, brittle and juicy leaves rich in fibre
- Petiole colour is a varietal feature
- Petioles: 3-8 cm, good for salads, sweet flavour, similar to beetroot, lots of fibre
- Leaf blade: used as a spinach, spinach substitute with minimum oxalic acid
- Direct consumption only
- Only for leisure gardeners: wilts rapidly



Nutritional value of chard

Dry matter 7.8%

Fibre 2.0%

Protein 2.1%

Lipids 0.3%

Carbohydrates 2.9%

Ashes 1.7%

Vitamins (mg .1,000 g⁻¹):

A 35

C 390

B1 1.0

B2 1.6

PP 6.5

•Ca 1,030 mg

•Fe 27 mg

•Na 900 mg

•P 390 mg

•Mg 810 mg

•K 3,800 mg (/kg of fresh mass)

Cropping practices

- Low requirements on soil and climate, best cultivation in sugarbeet growing regions
- High requirements on moisture; tolerates semi-shadow locations
- Heavy to medium feeder, tolerates direct fertilization with manure
- Direct sowing: mid-April till mid-June
- Spacing: 40 x 40
- Harvest: September, October
- Young leaves may be harvested 2-3 weeks after sowing
- Yield: 30-40 tons per ha (summer varieties)
40-50 tons per ha (autumn varieties)

Sweet fennel *Foeniculum vulgare* var. dulce

- Origin: Italy, known since 9th cent.
- Grown for untrue "bulb / tuber": thickened basal parts of petioles
- Typical flavour and smell
- Use: mixed vegetable salads, cooking
- No pests infect petioles



K. B. All. Umbelliferae



Foeniculum officinale L. Gehäufiger Fenchel.



Nutritional value of fennel

Dry matter 14%

Fibre 3.3%

Protein 2.4 %

Lipids 0.3 %

Carbohydrates 6 %

Ashes 1.7 %

Vitamins (mg .1,000 g-1):

A 47 E 6

C 930

B1 2.7

B2 2.5

Fennel

•Ca 1,090 mg

•Fe 27 mg

•Na 860 mg

•Mg 80 mg

•P 510 mg

•K 4,900 mg

•Zn 5 mg

•Mn 3 mg

•S 200 mg (/kg of fresh mass)

Cropping practices

Medium feeder, deep soils (deep roots), sugarbeet growing regions

High requirements on moisture, otherwise fennel tends to bolt (14-hour day and 18°C temperature: bolting)

Optimum temperature: 18°C

7°C: growth stops, above 24°C: growth slows down

Sowing for pre-cultivation of planting material: 25 May – 10 June

Plantings must be pre-cultivated at 20°C (lower temperatures: vernalisation)

Planting: 15 June – 10 July

Spacing: 40 x 30, 40 x 25 cm

Harvest: 20 August – 15 October (petioles damaged at -4°C)

Storage: cooling chamber, 8 weeks, 0-1°C, 95% humidity

Minimum market weight: 100 g

Swallowtail: destroy blades, no harm to petioles



Spinach *Spinacia oleracea* L.

- Origin: Turkestan, Iraq, Iran, Afghanistan
- Europe: since 9th cent., popular since 13th cent.
- Consumption in CR: 0.7 kg per capita annually



Nutritional value of spinach

Dry matter 8.5 %

Fibre 2.1 %

Protein 3.4 %

Lipids 0.6 %

Carbohydrates 4.1 %

Ashes 1.8 %

Vitamins (mg .1,000 g-1):

A 28 E 26

C 512 PP 6.2

B1 1.47

B2 2.53

B6 2.6

•Ca 860 mg

•Fe 30 mg

•Na 650 mg

•P 450 mg

•Mg 460 mg

•K 4,500 mg

•Zn 3.4

•I 0.12

•Mn 6

•Se 0.01

•S 200

•Cu 1.2 (/kg of fresh mass)

Cropping practices

Germinates at 2-4°C, sprouts within 7 days

Optimum: 15°C

Tolerates up to -8°C

Vegetation period: 45-80 days

High requirements on moisture, intolerant to acidic soils with pH below 6.0

Fertilization with N:

50-70 kg (accumulates nitrates)

P₂O₅ 20 – 30 kg

K₂O 90 – 100 kg

MgO 30 kg

Sowing: spacing 12-15 cm provides 80-120 kg per ha



- Cropping practices dramatically changed after 1995:
- Before: sowing 20-25 kg per ha, spacing: 30-42 cm, 270 kg N per ha
- Today: sowing 80-120 kg per ha, spacing: 12-15 cm, 50 kg N per ha

- Before: manual harvest using 3-row weeder and sublifting
- Today: mechanized harvest (Diadém)
- Plants are cut off, and blown into large containers, and transported into freezing plants



SOWING

March – mid-April

July – mid-August

Second half of August – Second half of September
May
wintering)

HARVEST

May-early June

October-November

spring

autumn

Second half of April – First half of
spring (for plant

Other terms: bolting (Hot weather during harvest in July and August)

Yield: 12-16 tons per ha, attainable: 22-25 tons per ha

CR: freezing plants, energy-intensive (maintain -18°C)

World: vacuum drying (keeps colour), stored at any temp., grinded before dispatch, swells up in water before further processing

New Zealand spinach –Tetragonia expanse

- Annual plant, trailing stem, occupies 1.5 m²
- Robust, green and red leaves with silver at the bottom
- Low in oxalic acid
- Harvest: individual leaves are picked, repeatedly every 2-3 weeks
- 5-7 harvests per vegetation period
- 1 plant provides enough spinach for a 4-5m twice a month
- Poor germination: Pre-cultivation, plant after



Cropping practices

- Pre-cultivation of seedlings (poor germination)
- Fertilization:
 - N 150 kg
 - P₂O₅ 40 – 60 kg
 - K₂O 120 - 180 kg
- Spacing 80 x 60, 80 x 80
- Harvest July-October
- 3 kg of leaves per 1 m² = 25-30 tons per ha

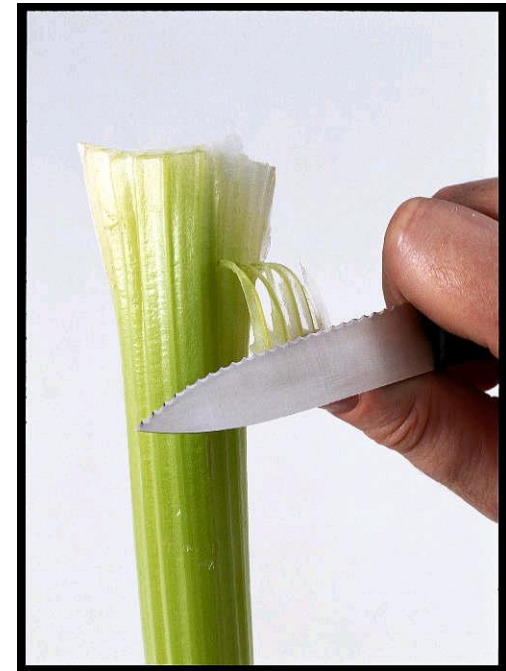
Celery *Apium agraveolens* var. dulce

Grown in Italy and France in 16th cent.

Salad vegetable, 1.2-1.5 kg of edible part per 1 plant

No taproot, only a cluster of fleshy roots

Edible parts: petioles for salads, celery sticks for frying, leaf blade is removed



Botanical characteristics

- Biennial vegetable
- First year: robust rosette with petiolar leaves and long, strong petioles
- Second year: verticillate stem, petite white blooms in umbels; small, ribbed diachene, aromatic and brown
- Shallow, spindle-like roots
- Specific flavour and smell: selanolide (in green tops), apiin, and traces of furanocoumarins

Cropping practices

- Humus, loamy, deep soils with good water-holding and heat-retention capacity
- Intolerant to dry and overly wet locations
- Deficiency of water causes development of fibrous and dry petioles, instead of fleshy and brittle ones
- Heavy to medium feeder, tolerates direct fertilization with farm-yard manure
- Intolerant to acidic soils, optimum pH 6.6-7.1
- Requires lot of boron

- Grown from plantings (petite seeds, vernalisation):
- Sowing (in greenhouse) from mid-March, late variety: mid-April
- Pre-cultivation of plantings at temperatures above 14°C
- Planting: 15 May, late variety: June
- Harvest: end of September-October, late variety: November
- Planting in spacing: 0.5 x 0.3 m (0.4 x 0.2 / 0.3 x 0.3 m)
- Fertilized with calcium nitrate once or twice
- Grow varieties resistant to leaf rust

Harvest

- Single harvest: October, November
- Tolerates ground frost up to -5°C
- Full-grown petioles should be 4-8 cm wide at the base and 25-30 cm long
- Leaf blades are cut off at the first verticill
- 30-50 tons per ha (even 80 tons per ha), after processing: 20-25 tons
- Storage: 5-6 weeks, $0-1^{\circ}\text{C}$, high air humidity

Diseases and pest of leaf vegetables

Downy mildew of lettuce *Bremia lactusa*

White spots on lower side of leaves

First, lower sides of leaves are infested, later the whole head

Protection:

Plant only varieties resistant to the disease; there are 26 types of this disease today, only 5-6 varieties are resistant to 22nd through 26th type, price is high but definitely pays



Grey mould *Botrytis cinerea*

Lower side of the leaves is coated with a grey layer; stem is infested in later stages, it starts to rot and the whole head is damaged

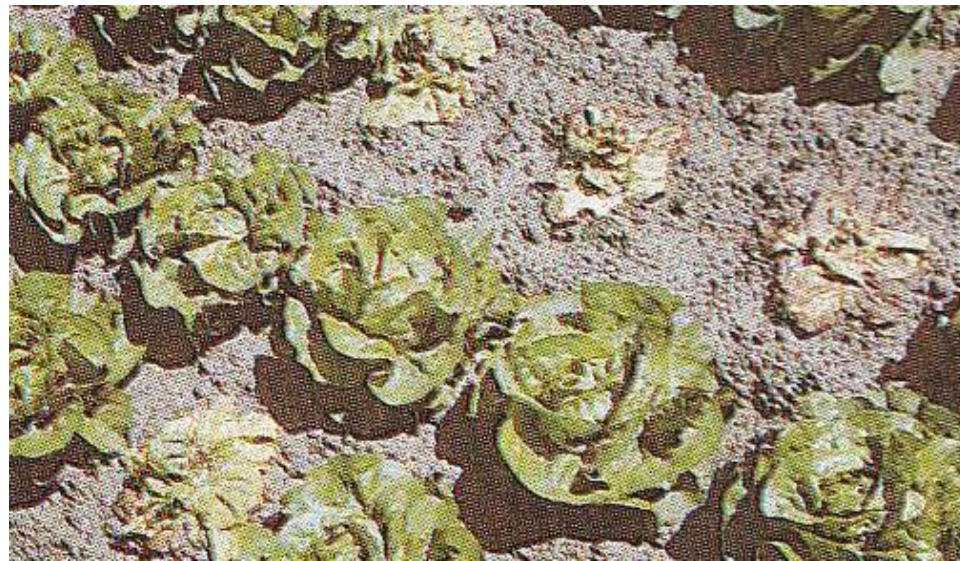
Rare infestation: only during wet weather and in heavy soils (downy mildew of lettuce is more common)

Protection:

No excessive nitrogen fertilization

Water in the morning, not in the evening so that leaves are not moist

No chemical protection



Alternaria leaf blight of cabbage crops *Alternaria brassicae*

- Oval, grey-brown to black spots, yellow rim at the leaf edge
- Infested tissue dries out and leaves crack
- Fungus is transmitted by seeds and soil
- Protection: stable fertilization, application of fungicides before rain
- Dangerous for Beijing cabbage: first, only outer leaves are infested, the whole head is damaged within a week; must be preventively sprayed in early September, repeat after rains



Beijing cabbage

Wireworms *Agriotes* spp.

Larvae eat through a stem, head turns yellow and stops growing

Common pests

Use potatoes: cut them in half, place under the ground, beetles will crawl inside



Head lettuce

Snails and slugs

Chew on leaves, defecate on cabbage heads

Mezurool, Limacid

Glass of beer: attracts the snails and slugs



Head lettuce

Cabbage fly *Delia radicum*

- First adult generation infests the plants from last-year location of brassicas at the end of April until mid-May
- Flies start to lay 1mm long white eggs within a week
- Larvae come out of the eggs after 5-10 days



- Larvae become pupae in the infested plants or in soil within 3-4 weeks
- Second generation lives during summer
- Third generation lives in the autumn
- Flies may fully destroy growing tip



Physiological disorders of Beijing cabbage and Iceberg lettuce

TIPBURN

Nicely green head on the surface, leaves turn brown inside the head, tastes the same, only a different colour

STRES: during dry weather

Deficiency of Ca in acidic soils

Over-fertilization with N

Growth shock due to replanting

Prevention: stable nutrition (N, Ca, K) and irrigation

Physiological disorders of Beijing cabbage and Chinese cabbage

Bolting

Failure to develop heads; inflorescence is developed instead

Temperatures below 18°C during germination and sprouting, and during early phases of growth