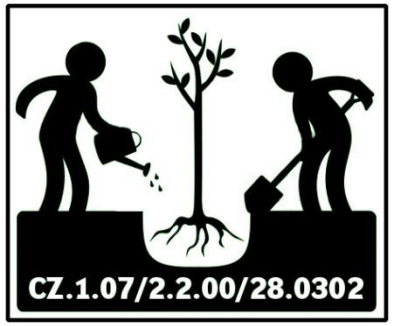
INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ



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


Cole Crops

Cryophilic Vegetables Forming a Stalk (outer + inner)

Head cabbage

Savoy cabbage

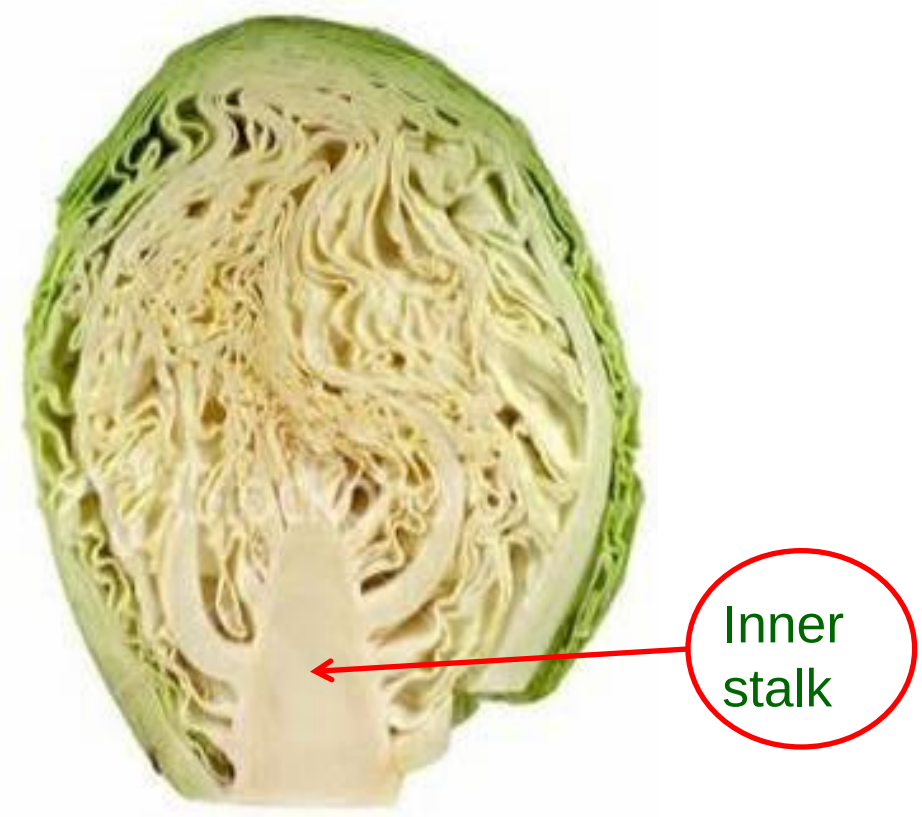
Brussels sprouts

Savoy

Cauliflower

Broccoli

Kohlrabi



- Family: Brassicas Brassicaceae
- All cole crops come from the Mediterranean:
- Optimum oceanic climate:
- Lower temperatures of around 16-20oC
- Higher humidity and soil moisture (70-80%)
- Cole crops tolerate frost (as severe as –15oC in the case of Brussels sprouts)

- This is why – as the temperature of the climate is rising – it is not possible to successfully grow summer cole crop cultivars in the Czech Republic
- Warm summers – it is not feasible to grow quality crops for summer harvest
- Growers have abandoned growing these crops (Non-standard, Class II quality)

➢ Harvesting is scheduled for spring and then only for autumn seasons

- High demands for soil air exchange
  - Inter-row hoeing or hoeing to be conducted at least once

- Heavier soils are suitable – brown soils, chernozems (beet production areas)

- Most roots set in a depth of 20-30 cm
- Irrigation – at longer intervals and in larger amounts (30 mm)

(A wax layer on leaves)

- High levels of
- Vitamin C (350-1,800 mg/kg)
- Broccoli
- Savoy cabbage, Brussels sprouts, and savoy
- Fe and Ca

Requirements on the Stalk Length

- The inner stalk – as short as possible, losses at processing, the stalk is drilled off

- The outer stalk – affects the stability of a plant
- Tall outer stalks cause plants to uproot
- For mechanical harvesting, medium outer stalks are preferable, not short ones – heads are broken when harvested

Inner stalk

Outer stalk

Outlooks for Cole Crops

•An increased proportion of storage cabbage (storage until May) at the expense of processing cabbage (butter fermentation, sterilisation)

•Increased consumption of broccoli and Brussels sprouts
•Fresh Brussels sprouts used to be harvested manually still being on the stalk – the stalk supplied the sprouts with water for a long time and the sprouts stayed fresh for 3 weeks
•Nowadays, sprouts are rubbed off by a combine harvester and turn yellow instantly, the consequence being that, nowadays, they are only intended for freezing plants

Cultivation Techniques of Cole Crops

- Planting of mini-plugs
  - The most appropriate method
  - Precondition – regular irrigation

    (Overdrying must be prevented)

- Direct sowing (summer and late cultivars)
  - Where there is no additional irrigation

  ➢ Given the seed price of foreign cultivars, it is more profitable to pre-cultivate seedling stock for summer and autumn crops, too

Dates in the Cole Crops Cultivation

	Sowing	Planting seedlings	Harvesting
Early cultivars:	1 to 20 February	By 10 April	End of May and June
	Sowing to pre-cultivate seedlings as well as direct		
	Sowing	**Planting**	**Harvesting**
Summer cultivars:	1 to 20 April	Mid-May	July–September
Late cultivars:	15 to 25 April	15 to 30 June	October (–November)
An exception			
Late broccoli	1 to 10 June	15 to 30 July	October–December

Spacing Recommended for Cole Crops

	Harvesting	Small growers	Mass production
Early cultivars:	May, June	Spacing of 40 x 40	60 x 40 cm
Summer cultivars:	July–September	Spacing of 50 x 50	60 x 50 cm
Late cultivars:	October–November	Spacing of 60 x 60	70 x 60 cm
	(May–November)		
Brussels sprouts, savoy		80 x 60 cm	

HEAD CABBAGE
(Brassica oleracea L. convar. capitata (L) var. capitata L.)

- Developed from Brassica oleracea, occurrence in **the Mediterranean, Eastern Europe, and Asia Minor**
- In the past when there were no other vegetables, cabbage was an important source of vitamin C during winter – nowadays, consumption of tomatoes and green vegetables prevails in summer

- Head cabbage is consumed

- Fresh
  (This form is starting to prevail)

- Pickled and in the form of sauerkraut
  (Germany)

- Cooked


15 October

Head cabbage – A Biennial Vegetable from the Point of View of Seed Production

➢During the first year

•A shortened, pulpy stem – a stalk

•Smooth leaves placed in the genetic spiral:

•Green (var. alba)

•Red (var. rubra)

•Internodes get shorter toward the top

−The leaves located lower grow over the leaves that are located higher – formation of a head

➢During the second year

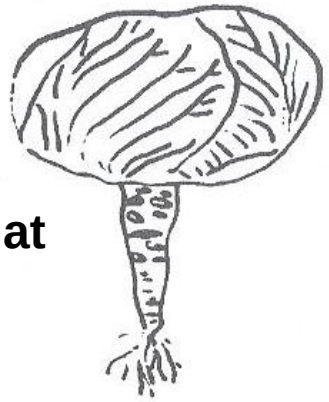
•Cabbage develops branch stems of 1-1.7 m with leaves

•Yellow flowers, the fruit is a silique – it contains globose, dark brown to black seeds

solique

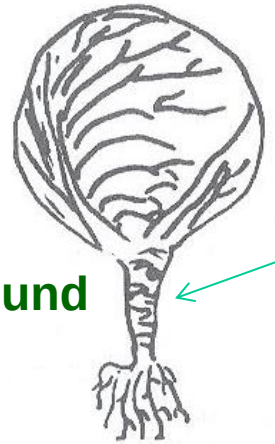
Seeds:
Thousand kernel weight (TKW) 3-5 g

Head Shape



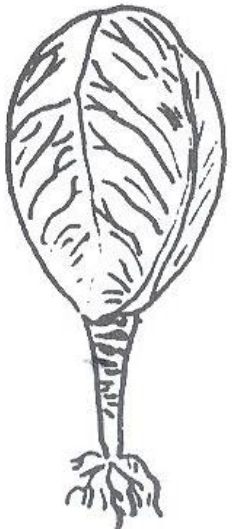
Flat

Flat-round



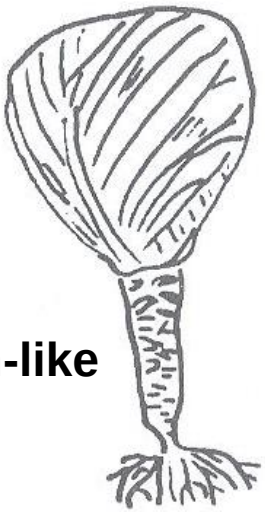
Round

OUTER STALK



Ovoid

Pointed



Balloon-like

- Cabbage cultivars are distinguished by:
- Its colour – white, red
- Its use:
- Early cabbage
- Processing cabbage
- Storage cabbage
- Time of growing – early, medium late, late
- Firmness of the head
- Compactness of the head
- The length of the inner and outer stalks

Annual production in the Czech Republic

- White cabbage: 100,000 t (15% of the total vegetable production)
- Red cabbage: 3,000 t

Yields in the Czech Republic (t/ha)

- White cabbage: An average of 40 t/ha (An area of 1,500 ha):
- Early cabbage 25 t/ha (Sold per heads)
- Storage cabbage 40-60 t/ha
- Processing cabbage 80-130 t/ha

- Red cabbage: 30 t/ha (An area of 100 ha)
- An excellent yield of 50-60 t/ha Consumption + storage
- This cabbage is not processed – it oxidises (turns brown)

Internationally: an average yield of 23 t (an area of 1,665,000 ha)

Cabbage consumption in the Czech Republic:

2004 14 kg per capita per year
2009 7.5

•In the Czech Republic, there is minimum interest in consumption of red cabbage

•Red cabbage is preferred in Germany

Nutritional Value of Cabbage

	WHITE	RED
Dry matter:	7.85%	7.51%
Dietary fibre:	1.18%	0.96%
Proteins:	1.50%	1.60%
Lipids:	0.17%	0.15%
Saccharides:	4.16%	4.06%
Minerals:	0.86%	0.76%

Vitamin and Mineral Content in Fresh Matter (mg/kg)

	WHITE CABBAGE	RED CABBAGE
C	**350-600**	**450-1000**
E	4	4
B1, B6	2-3	2-3
B12	1,5	1,5
K	2630	3020
Na	220	320
Ca	**460**	**340**
Mg	195	165
Fe	**12**	**5**
P	300	200

Early lettuce only contains 80-100 mg/kg of vitamin C

Glucosides, esters of sinapinic acid and malonic acid, glucobrassicin (especially red cabbage), antirheumatic effects of S compounds, antioxidant effects (fresh and frozen cabbage and sauerkraut)

Red cabbage is of greater biological value – an anthocyanin content of 800 mg/kg

Site Requirements

- Heavier, humus-rich soils with good moisture-holding capacity and a pH of 6.3-7.8
- Highest and stable yields in cooler beet production areas

- Placement **in a crop rotation**:
  - Preferably after perennial fodder (a high demand for soil aerating), grain, and leguminous crops
  - Do not grow after oilseed rape or brassicas (club root, pests)
  - At 4 to 6-year intervals

- Heavy feeders (medium feeder – early cabbage)

- 30 (preferably 50) t of manure per hectare, perform timely deep ploughing

- For a yield of 50 t/ha, cabbage absorbs:

- 178 kg of N, 28 kg of P, 180 kg of K, 143 kg of Ca, 28 kg of Mg, 55 kg of S **= 819 kg of pure nutrients**

- N Fertilisation
- 80% within basic fertilisation
- 20% 30 days after planting

Moisture Requirements:
-Early cabbage – 300 mm
-Late cabbage – 600 mm

-Suffering a water deficiency, cabbage lignifies and stops growing

•On sites with feasible irrigation – growing from transplants provides a higher certainty of yield

•On drier sites – cabbage from direct sowing sets roots in a greater depth and resists summer dry seasons more easily

Unsuitable Growing Conditions

- High temperatures and low humidity (maize production areas)

⇒ Decelerated photosynthesis, increased respiration, increased energy consumption, and tissue ageing

Cabbage Cultivars

1. Early cabbage:

- **Small heads of 500-700 g or up to 1 kg** (the minimum norm being 350 g)
- ↓ The content of dry matter and coarse fibre, ↑ the saccharide content
- A high water content – succulent
- The cabbage is not storable and wilts fast
- Tastier, easy to digest
- Small areas
  – The sales are low
- If heads not packed properly, it is not of big importance as they are not used for storage

2. Processing cabbage:

- Large heads of 3-10 kg
- A low dry matter content
- A high saccharide content
- A large vacuole in the cell, thin cell walls

– Bruising, the cabbage goes bad quickly and should by processed by Christmas time, then there are losses

3. Storage cabbage:

•Small, heavy heads of 2-3 kg

(Having a weight of more than 3 kg, the head may split in the storeroom)

•A high dry matter and coarse fibre content

•A low saccharide content (this cabbage does not ferment)

•Thick cell walls, small vacuoles (a small amount of the liquid)

Head Cabbage

- Seeds germinate at temperatures as low as 2-3°C
- At 11°C, seeds will sprout within 12 days
- At 20°C within 4 days

- An optimum temperature for seedlings to grow is 12-15°C
- An optimum temperature for vegetative growth is 16-20°C
- Minimum temperatures at which plants show some growth are 5-8 °C

- Cold-resistant plants
- At the stage of seed leaves, plants can tolerate a short-term drop in temperature to -6 °C
- For young plants after spring planting and plants at the harvest maturity stage, a long-term exposure to a temperature of -5°C is critical

- A 1,000-kernel weight (TKW) of 3-5 g

- Seedling pre-cultivation with 400 pcs/m2

- Precision drilling
- Grading of seeds by 1.75-2 mm / 2.0-2.25 mm
- 85,000 germinable seeds/ha

Growing Early Cultivars

1. Seedling pre-cultivation – propagation trays (8-6 weeks)

- Sowing from the end of January to the middle of February
  T160 / T260

- Chitting chambers with 18-20oC (5-6 days)

- Greenhouses
  - 1st week 6-10oC
  - Sunny days 14-18oC
  - Cloudy days 12-16oC
  - Nights 6-10oC
  - Harden off seedlings 10-14 days before planting
  - A standby of 15% (damage by frost)

2. Planting

- Between the second half of March and the beginning of April
  (By 10 April at the latest – a low price after 20 June)
- Apply a herbicide before planting or after rooting

- A spacing of 50 x 30, 50 x 40, 60 x 45 cm (60,000-80,000 pcs/ha)
- Irrigate once or twice after planting
-Conduct inter-row hoeing twice and manual hoeing once

3. Harvesting: by thinning between May and June

On 20 June, prices get changed:

- Until 20 June – One head costs 10 CZK = a head of 0.5 kg
- After 20 June – 1 kg is 8 CZK = 0.5 kg by 8 = 4 CZK A loss of 6 CZK per head!

Growing Medium Late and Late Cultivars

1. From seedlings (mini-plugs):

- Sowing in mid-April
- Planting in the second half of June
- Spacing
- For storage 50 x 50, 60 x 50 cm
- For processing 60 x 60, 70 x 60 cm
- 25,000-40,000 plants/ha

- Ideally conduct inter-row hoeing twice and hand-hoeing twice

➢ Nowadays only 2 operations:

- Inter-row hoeing once and hand-hoeing once
- Inter-row hoeing twice
- Or only inter-row hoeing once

2. Direct sowing with a precision seed drill:

- In mid-April
- Sowing standard of 0.6-1 kg/ha for graded seeds
  1.2-1.5 for ungraded seeds
- A seed depth of 2-3 cm
- **The precision seed drill plants seeds spacing them at the required distance**
- **A regular seed drill** – 2-3 times higher seeding rates, it is necessary to single the plants by hoeing as soon as possible, i.e. when they have 2-3 true leaves
- Finish singling by hand-hoeing after the plants have come up
- Conduct inter-row hoeing twice and hand-hoeing once
- More adaptable, a better developed root system
- The Opava region: usually from direct sowing – sufficient moisture, heavy soils, more rainfall
- Southern Moravia – a very dry region – it is not recommended to sow directly because the seeds will not sprout, small heads form, and rainfall is irregular

Growing Summer Cultivars (No Demand)

- Pre-cultivated seedling stock or direct sowing

	Sowing to pre-cultivate seedlings as well as direct sowing	Planting	Harvesting
Summer cultivars:	1 to 20 April	Mid-May	July–September

Dates in the Cabbage Cultivation

Cultivars	Sowing	Planting	Spacing	Harvesting
EARLY	1 to 20 February	March to beginning of April.	50 x 30	May to June
SUMMER	1 to 15 April	10 to 20 May.	50 x 50	July to August.
MEDIUM LATE, LATE	15 to 20 April	15 to 30 June	60 x 50 60 x 60	September to October.

Harvest Estimation

20 to 25 August 15 September

- Heads are smaller than .....6 cm ..... 8 cm They will not grow to meet the size standards of Class I

- To form expectations of the amount of production, preferably evaluate the state of affairs in August

- It is better to plough the crop in, if it is all of Class II or Non-standard, which is bad

- **The standard of minimum weight is 500 g**, however, it is a matter of agreement, the trader may set a minimum head weight of 2 kg

Harvesting

Early Cabbage

- **Hand thinning**
- May–June
- Put in transport coverings, transport boxes, and pallets with collars

- Small stretches of land of 1 to 5 ha – the use of machinery does not pay off
- Soft heads – damage at mechanical harvesting

- A minimum head weight of 350 g

Processing Cabbage and Storage Cabbage

- Mechanical harvesting
- Preconditions for mechanical harvesting:
- Good firmness of heads, uniformity, stand without weeds, straight rows, and soil conditions
- Harvest when the weather is dry
- The heads must not be frostbitten, mechanically damaged, cracked, or infested by disease or pests
- Balanced nutrition is essential (do not overfertilise with N)
- Optimum harvest maturity

(Heads harvested too early fade faster, those harvested too late split)

- Harvesters (e.g. ASA-LIFT) can harvest 2.5 ha per shift
- Harvesting time: 1 October–15 November
- On a one-off basis, this cabbage withstands a temperature of –5°C

- Remove the wrapper leaves from the heads
- Place the heads in pallets with collars
- Transfer the heads to storehouses

Storage

Storage cabbage

- Circulating air removes excess moisture
- Cool down to 0-1oC, humidity of 85-90%
- Storerooms
- Ventilated – Until February
- Cooled – Until May
- Controlled atmosphere – Until June

Processing cabbage

- By the end of year, losses are increasing afterwards

SAVOY CABBAGE
(Brassica oleracea L. convar. oleracea var. sabauda L.)

- Evolved from wild forms of Brassica oleracea of the Mediterranean
- Of a higher nutritional value than head cabbage, but less popular
  (The cultivar Vertus used to be grown in the Czech Republic)
- Easy to store
- Processing – freezing, cooking, or stewing
- A biennial vegetable from the point of view of seed production

- During the first year, a consumption head forms – made of curly, crinkly leaves of a pale green, yellow-green, deep green to blue-green colour
- During the second year, the savoy cabbage develops a scape; the fruit is a silique

Dry matter: 11,5 %
Dietary fibre: 1,5 %
Proteins: 4,0 %
Lipids: 0,9 %
Saccharides: 5,1 %

Mineral Content in Fresh Matter

Mineral element	mg.1000 g^{-1}
Ca	**480**
P	560
K	2800
Mg	**120**
Na	420

Vitamin Content in Fresh Matter

Vitamin	mg.1000 g^{-1}
C	**800-1050**
A	7
B1	1
B2	2,5
B6	2,5
B3 Niacin	**21**

Cabbage contains a half to one fourth less vitamin C

Site Requirements

- Unlike cabbage, savoy cabbage tolerates worse soil and climate conditions of higher locations (It does not form as large heads as cabbage)

- Medium heavy, water-retentive, rich-in-humus soils
- Beet production areas, potato production areas, and maize production areas (early cultivars)

Fertilisation

- Heavy feeders or medium feeders – (early cultivars)
- For the production of 25 t/ha, savoy cabbage absorbs:

75 kg of N, 12 kg of P, 75 kg of K, 12 kg of Mg, and 20 kg of S

Cultivation Techniques

Early savoy cabbage

- Plant pre-cultivated seedlings from the end of March to the beginning of April (until 10 April at the latest), sow directly between the end of January and the middle of February
- A spacing of 40 x 40 cm = 62,500 pcs/ha
- 50-75 days from planting to harvesting

Summer cultivars (no demand)

- Plant pre-cultivated seedlings in mid-May (sown in the first half of April) or sow directly
- A spacing of 50 x 40-50 cm = 40,000-50,000 pcs/ha
- 100-120 days from planting to harvesting

Late cultivars (autumn cultivars)

- Plant pre-cultivated seedlings in the second half of June (sown in the second half of April) or sow directly
- A spacing of 60 x 60 cm = 28,000 pcs/ha
- 120-160 days from planting to harvesting

Early savoy cabbage for wintering

- The cultivar Arkta, sowing on 20 August, planting until the end of September, harvesting at the end of May, a weight of 300-400 g
- A spacing of 40 x 30 cm = 80,000 pcs/ha
- 240-270 days from planting to harvesting

Harvesting

Overwintering cultivars

- Manual harvesting in the last ten days of May (350 g)

Early cultivars

- Manual harvesting by thinning between the end of May and the beginning of June when the heads have reached 350 g

Late cultivars

- **One-off mechanical harvesting** from October to November, heads tolerate temperatures of –8ºC
- The cultivar Wirosa can be harvested during the whole winter, it tolerates –12 to –15 º C

Head quality

- Non-cracked
- Non-bolting
- Without bruises
- Not damaged by frost

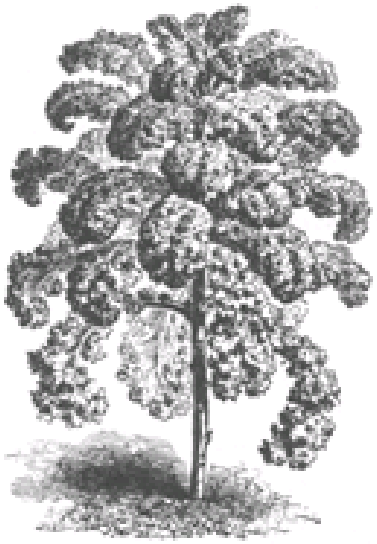
- With **early cultivars**, leaves are removed from heads except for a few wrapper leaves
- with **late savoy cabbage**, heads are left without any wrapper leaves

- Minimum weight required:
  - 350 g for early savoy cabbage
  - At least 500 g for summer and late savoy cabbage

- Nowadays, <u>agreement between the producer and the customer is decisive</u>

BORECOLE GREENS – (SAVOY)
(Brassica oleracea L. convar. oleracea var. acephala DC.)

- Originated on the Western coast of Europe
- Grown mainly in Great Britain, France, the Netherlands, Germany, and Denmark
- A vegetable similar to savoy cabbage, on a medium tall stalk which is usually of 0.6-0.7 m
- Savoy forms a rosette of 15-20 curly leaves, each of which is 150-250 g



- ➢ Vegetable
- ➢ Fodder crop
- ➢ Ornamental plant

- Savoy tolerates a frost of –15°C and is harvested as last
- It overwinters covered with snow if the temperature does not drop to –25oC

- Recommended as a heavy feeder
- Rather deep soils are appropriate (savoy sets roots in a greater deep), a pH of 6.2-7.5

- Savoy nicely tolerates penumbra and high locations over 400 m above sea level

- Ideal for potato production areas:
  - Lower temperatures
  - Higher humidity and soil moisture

- Tough leaves – an ecological vegetable – savoy does not attract pests
- Of the same taste as savoy cabbage

Nutritional Value of Savoy

Dry matter:	13,7 %
Dietary fibre:	**3,3 %**
Proteins:	**4,3 %**
Lipids:	0,9 %
Saccharides:	2,1 %
Ash:	1,1 %

Vitamin Content in Savoy
(mg.1,000 g-1 of Fresh Matter)

Vitamin	mg.1000 g^{-1}
C	**1050**
A	**41**
B1	1
B2	2,5
B6	26
PP	21
E	**17**

Mineral Content in Savoy (mg.1,000 g-1 of Fresh Matter)

Mineral element	mg.1000 g^{-1}
Ca	**2120**
P	870
Fe	**19**
Na	420
K	4900
Mg	**340**
Zn	**4**
Mn	5,5
Cl	680

- The Netherlands – colourful rosettes at ground level – as ornamental savoy in parks, of a green and purple colour – savoy plants fulfil the decorative function all winter long

- Ornamental savoy for bouquets
  – thanks to its wax layer, savoy does not wilt,
  a favourable price of 20 CZK/piece


45.

Cultivation Techniques

- Sowing – precision seed drills
  - Given the late harvest date from the end of April to the beginning of June
  - A row spacing of 50-70 cm, an in-row distance of 40-70 cm

- Mini-plugs:
  - Sowing from mid-April
  - Seed consumption per hectare being 0.3 kg (pre-cultivated planting stock)
  - Planting in June
  - Spacing: 80 x 60 cm, 80 x 80 cm

- Conduct inter-row hoeing once or twice
- When overwintering savoy, protect it against deer

- Harvesting: from October to December and during winter

1. Leaf rosettes on a shortened stalk
2. Separate leaves (3-5 leaves tied together)

- A yield of 20-22 t/ha

- Savoy can be harvested with the rootball and kept in a room where there is no frost (hobby gardeners)

3. For freezing plants (like spinach)

- Sowing from April to July
- Rows at a distance of 45 cm, a distance in a row of 15-20 cm

- **Mechanical harvesting**
  - Young plants with a non-woody stalk
  - ➢ Unlike spinach, savoy does not contain oxalic acid

BRUSSELS SPROUTS
(Brassica oleracea L. convar. oleracea var. gemmifera DC.)

- The youngest cole crop having been grown in Belgium in the 17th and 18th centuries
- A choice vegetable which is high in vitamins; fine fibre, easy to digest
- Sprouts clustered on a stem (stalk) in petiolate leaf axils
  - Lateral buds (small sprouts) of 1-5 cm in diameter, made of metamorphic, etiolated, sessile leaves without petioles
  - One plant has 25-60 sprouts

- A bitter taste is caused by glucosinolates and mustard oils, low temperatures decrease their levels
- A stalk of 0.3-1.2 m
- A robust root system
- Brussels sprouts tolerate frost of –12°C to –15°C

- Brussels sprouts demand sufficient rainfall and rather high humidity during the whole growing period
- Preferably in potato production areas but Brussels sprouts are convenient for all of the other production areas, too
- As heavy feeders, a pH of 6.4-7.4
- All produce of the Czech Republic is processed at freezing plants, not offered on the market

Glucosinolates – **a bitter taste**
– Attenuate by exposure to low temperatures

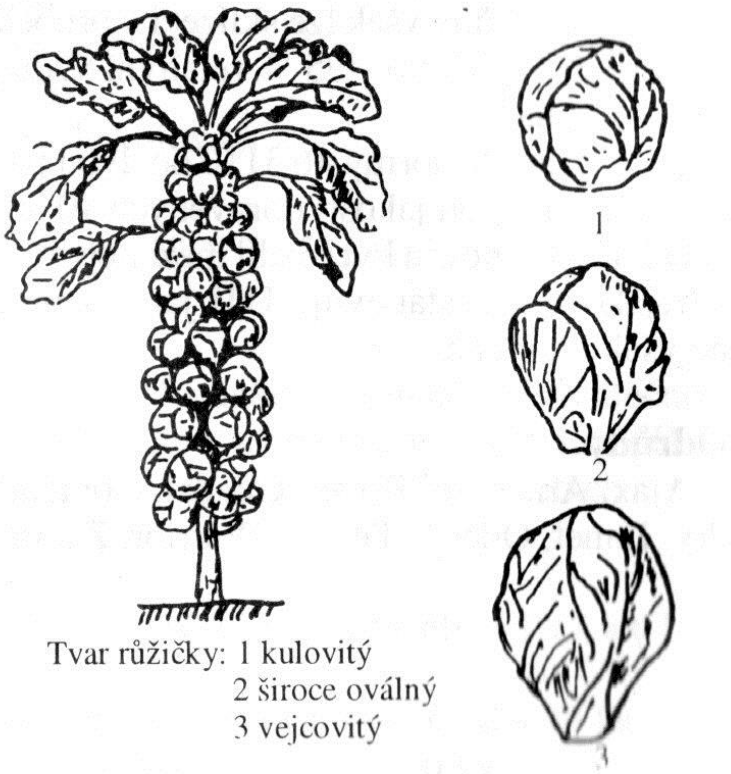
Dry matter:	11,7 %
Dietary fibre:	1,6 %
Proteins:	5,2 %
Lipids:	0,6 %
Saccharides:	7,6 %

Vitamin	mg.1000 g^{-1}
C	**1150**
E	**20**
B6	2,8
B12	**12**
B3	6,7

Mineral element	mg.1000 g^{-1}
Ca	**320**
P	864
Fe	**16**
S	1310
K	3100
Mg	**200**
Zn	**5,4**
Mn	2,7
Cl	280
Cu	1

The Stalk of Brussels Sprouts

- 0.3-1.2 m, it is no use growing cultivars with a short stalk of under 0.5 m
  (The largest sprouts get damaged when harvested)
- Preferably stalks half the height of the plant, which is 0.8-1 m
- A tall stalk – a risk of uprooting!



Cultivation Techniques

1. Pre-cultivated planting stock – sowing in (March) April
   – Planting until the end of May

- Used by bigger growers – uniformity for mechanical harvesting
- Spacing: 70 x 70, 60 x 60, 70 x 50 cm
- 20,000-30,000 plants/ha

2. Direct precision drilling in April – poorer uniformity
   (Seeds are planted in greater and smaller depths)

- Conduct inter-row hoeing twice

- Hobby gardeners crack growing points one month before harvest (from 15 September) – sprouts get firmer