Harvesting

• From the end of October to December; during mild winters with temperatures not falling below \(-12^\circ C\), sprouts overwinter (harvesting through the winter until the spring)

• Sprouts are stripped from the stalk by a rotary device directly in the field – they do not last and wilt in shops

• Sprouts used to be harvested with machetes including the stalk and did not fade

The minimum diameter of sprouts required is 10-15 mm
Yields
• 10-15 t of stripped marketable sprouts per hectare
• Price: 1 kg = 30 CZK

Storage
• –2°C
• 7 weeks – stripped sprouts
• 90-95% humidity
CAULIFLOWER (Brassica oleracea L. var. botrytis L.)

- Place of origin: The Mediterranean, Asia Minor
- One of the oldest cultivated plants
- Spread to Europe from Crete and Cyprus, having been cultivated in Central Europe since the 18th century
- Cauliflower is among the most widespread and most demanding vegetables

- A wide range of uses:
  - Storing for a short period of time
  - Processing at freezing plants and canning factories
• The edible portion is
  • A pulpy, fasciated (altered, reduced) inflorescence – white, yellow, purple
  ➢ Cauliflower forms semiglobose, firm curds consisting of short, branched, pulpy shoots ending with curled buds, the curds being covered with large leaves
  • Good covering with leaves is of advantage – the curd is shielded from the sun and there is no need to crack and bend leaves over
  • The larger the leaf rosette, the larger and higher-quality the edible portion

• The root system is weaker than that of cabbage or kale

• Seed germinative capacity of 4-5 years, TKW of 2.7-3.5 g
• Consumption in the Czech Republic:
  • 2.6 kg per capita per year, 80% of which is eaten fresh
  • Consumption of cauliflower is decreasing in favour of broccoli

• A yield of 30-35 t/ha

• An amount of manual labour of 600 h/ha (harvest)
Production Areas in the Czech Republic

Early cauliflower under 200 m above sea level
- The towns of Mělník, Litoměřice, Nymburk, Brno, Olomouc, Přerov, Hodonín, and Znojmo

Late cauliflower under 500 m above sea level
- Regions where early cauliflower is grown
  + The towns of Písek, Plzeň, Náchod, Liberec, Opava, and České Budějovice
- Cauliflower of the highest quality from autumn harvests comes from higher locations in 400-500 m above sea level
  (The Žamberk region – the foothills of the Jeseníky mountain range)
**Nutritional Value of Cauliflower**

Dry matter 8.4%
Dietary fibre 1.8%
Proteins 2.4%
Lipids 0.3%
Saccharides 4.4%

<table>
<thead>
<tr>
<th>Element</th>
<th>Value (mg/kg of fresh matter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca</td>
<td>530</td>
</tr>
<tr>
<td>Zn</td>
<td>2.2</td>
</tr>
<tr>
<td>Fe</td>
<td>7.2</td>
</tr>
<tr>
<td>S</td>
<td>336</td>
</tr>
<tr>
<td>Na</td>
<td>200</td>
</tr>
<tr>
<td>B1</td>
<td>1.17</td>
</tr>
<tr>
<td>B2</td>
<td>0.89</td>
</tr>
<tr>
<td>I</td>
<td>0.009</td>
</tr>
<tr>
<td>Mg</td>
<td>150</td>
</tr>
<tr>
<td>C</td>
<td>390</td>
</tr>
<tr>
<td>E</td>
<td>1.2</td>
</tr>
<tr>
<td>P</td>
<td>540</td>
</tr>
<tr>
<td>K</td>
<td>2,500</td>
</tr>
</tbody>
</table>

*(mg/kg of fresh matter)*
Soil and Fertilisation

- Fertile, humus-rich, loam soils with good moisture-holding capacity
- Early cultivars – lighter, heat-retaining, sandy loam soils
- Summer and autumn cultivars – heavier, beet-growing soils
- **A humus content of over 3%, a pH of 6.8-7.5** (Greater utilisation of rain and irrigation water and mineral fertilisers)
- Preceding crops: leguminous plants, leguminous fodder plants, annual fodder plants
- **As a heavy feeder** – 40 t of stable manure, the commercial compost Bioganic or a double amount of green manure
- **Also as a medium feeder** – early cauliflower on humus-rich soils
- P and K fertilisers:
  - Together with manuring on heavier soils
  - Only at the seed-bed preparation on lighter soils
• Cauliflower requires **high humidity and a sufficient amount of water in the soil**

• **Delayed formation of curds** – shading

• **Leaves growing in curds** – high temperatures above 20°C after the curd has formed

• **Riceyness** – high temperatures before the curd formation and cold weather during the curd formation

• **Biological stress** – an insufficient supply of nutrients and water and inadequate temperatures

Individual florets are irregularly ragged ("like grains of rice").
• **Molybdenum deficiency** – whiptail
  • Spray the seedlings with 0.1% sodium molybdate before planting

• **Boron deficiency** – browning of curds (brown or rust-coloured patches that break down at a later stage, curds have a bitter taste)
  • Prevention – pre-sowing fertilisation with 25 kg of Borax per ha or spraying of seedlings

• **Need to crack leaves** – early cauliflowers – poor foliage
Cultivation Techniques

1. Planting stock pre-cultivation

Early cultivars
• Sowing from the end of January to the middle of February
• Planting from the end of March to 10 April
• A spacing of 0.5 x 0.4

Late cultivars
• Sowing in mid-April • Planting in the second half of June
• A spacing of 0.6 x 0.6

Mini-plugs
• A temperature of at least 16°C (otherwise the cauliflower vernalises)
• 3-4 true leaves at the time of planting
• Need to harden off seedlings before planting (ventilation for a week)
• Foreign cultivars – expensive seed
2. Direct sowing with summer and autumn late cauliflowers

- High requirements on seed-bed preparation
  - Firm subsoil, topsoil loose up to 3 cm
- The second half of April – precision seed 0.7 kg per hectare
- Roll the soil mildly after sowing
- Protect against flea beetles and Meligethes (with rape – non-woven fabric)
- Better adaptation to extreme conditions (lack of water)
- Highest demand for moisture at the stage of formation of flower heads
Harvesting
• By thinning, harvesting platforms, 3-4 times
Cauliflower is distributed
• With wrapper leaves
• So that they cover the curd entirely, the stalk is cut off just below the wrapper leaves
• When sold in shops, leaves can be cut short, but not removed (Lacking foliage causes blackening and bruising of curds; leaves are needed to separate curds)
The yield from 1 ha is 30,000-35,000 curds; cauliflower is sold per pieces. A minimum diameter of the head is 110 mm but it is a matter of agreement nowadays.
Refrigeration and Storage
• A temperature of 0-2°C
• Until December (cauliflower is not locally stored nowadays, it is imported from abroad)
Outlooks

• An increased proportion of cauliflower processed at freezing plants at the expense of pickled cauliflower
• An increased percentage of cauliflower stored on a short-term basis for November and December
• Import only for January–April
BROCCOLI (Brassica oleracea L. convar. botrytis var. italica)

- Originated in the Mediterranean as early as at the time of Ancient Rome
- Within Europe, broccoli occurred in Italy in the 17th century and spread further after World War II
- In the Czech Republic, broccoli has only been mass-produced since 1994
- From the point of view of nutritional value, broccoli is one of the most valuable vegetables
• Similar to cauliflower – a more robust root system
• The edible portion – a head = undeveloped flower buds of a green to purple colour and a diameter of 100 to 200 mm
• Heads are harvested including the stalk which is also eaten
• In the case of delayed harvest, broccoli develops small, yellow flowers – an acrid flavour, inedible
1. Sprouting broccoli
(Brassica oleracea L. convar. botrytis var. italica)
• Less compact heads than those of cauliflower
• More or less remontant forms (a cultivar characteristic)
• Central (top) head of 10-15 cm • After this head is harvested, 4 to 10 side heads 3-5 cm in size form within 2-5 weeks (in the leaf axils of the new side axis)
• Big growers only harvest the top heads
2. Heading broccoli  
(\textit{Brassica oleracea} L. convar. botrytis var. botrytis) 
- Grown mainly in seaside regions – humid areas (the Mediterranean, England, and France) 
- Tall, thick stalks, longish leaves, only top heads of a white, yellow, or purple colour 
- The broccoli is planted in the summer, overwinters at the stage of a leaf rosette, and forms heavy and firm flower heads in the spring 
- The broccoli cannot be grown in the Czech Republic (high temperatures and dry weather)
Nutritional Value of Broccoli

One of the most valuable vegetables – vitamins and minerals

- Dry matter: 8.6-10.8%
- Dietary fibre: 0.9-1.3%
- Proteins: 2.2-3.3%
- Saccharides: 3.5-4.2%
- Ash: 0.9-1.1% (Mainly Ca, K, P, S)

A higher content of vitamin C in autumn harvests

The absorption of Ca is up to 50%, in the case of synthetic Ca, it is only 20%

An anti-sclerosis effect

Broccoli positively affects duodenal and stomach ulcers

Treatment for irradiation sicknesses

The glucosinolate sulforaphane – hinders cancer cell growth
<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Broccoli (mg)</th>
<th>Cauliflower (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>800-1,800</td>
<td>400-600</td>
</tr>
<tr>
<td>E</td>
<td>8-20</td>
<td>0</td>
</tr>
<tr>
<td>A</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>B1</td>
<td>0.8</td>
<td>1.1</td>
</tr>
<tr>
<td>B2</td>
<td>2.3</td>
<td>1.7</td>
</tr>
<tr>
<td>Ca</td>
<td>1,100</td>
<td>250</td>
</tr>
<tr>
<td>P</td>
<td>780</td>
<td>540</td>
</tr>
<tr>
<td>Fe</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>Na</td>
<td>150</td>
<td>130</td>
</tr>
<tr>
<td>K</td>
<td>3,800</td>
<td>3,000</td>
</tr>
<tr>
<td>Mg</td>
<td>240</td>
<td>240</td>
</tr>
<tr>
<td>S</td>
<td>1,350</td>
<td>1,200</td>
</tr>
<tr>
<td>Frost resistance</td>
<td>–8°C</td>
<td>–2°C</td>
</tr>
<tr>
<td>Head weight</td>
<td>300-1,000 g</td>
<td>400-2,000 g</td>
</tr>
</tbody>
</table>
Vitamin E and C Content in Broccoli Depending on the Harvesting Time

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Harvesting</th>
<th>Vitamin E</th>
<th>Vitamin C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>August</td>
<td>November</td>
<td>July</td>
</tr>
<tr>
<td>Buccaneer</td>
<td>11</td>
<td>17</td>
<td>1,023</td>
</tr>
<tr>
<td>Colonel</td>
<td>7</td>
<td>8</td>
<td>945</td>
</tr>
<tr>
<td>Emperor</td>
<td>9</td>
<td>9</td>
<td>895</td>
</tr>
<tr>
<td>Fiesta</td>
<td>7</td>
<td>9</td>
<td>937</td>
</tr>
<tr>
<td>Geba</td>
<td>10</td>
<td>12.5</td>
<td>632</td>
</tr>
<tr>
<td>Kermit</td>
<td>7</td>
<td>12</td>
<td>979</td>
</tr>
<tr>
<td>Viking</td>
<td>9</td>
<td>10.5</td>
<td>1,370</td>
</tr>
<tr>
<td>Skiff</td>
<td>9</td>
<td>9</td>
<td>940</td>
</tr>
<tr>
<td>Shadow</td>
<td>12.5</td>
<td>15</td>
<td>1,539</td>
</tr>
<tr>
<td>Switch</td>
<td>7</td>
<td>9.5</td>
<td>1,032</td>
</tr>
<tr>
<td>Corvet</td>
<td>6</td>
<td>9.0</td>
<td>871</td>
</tr>
</tbody>
</table>

Optimum conditions for broccoli – Autumn:
- Falling temperature
- Rising humidity
Broccoli Cultivation Techniques

<table>
<thead>
<tr>
<th>Crop</th>
<th>Early Summer</th>
<th>Autumn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sowing</td>
<td>20 January–10 February</td>
<td>1 March–25 May</td>
</tr>
<tr>
<td>Harvesting</td>
<td>15 May–1 June</td>
<td>15 June–1 September</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spacing</th>
<th>45 x 45</th>
<th>60 x 35</th>
<th>60 x 35</th>
<th>60 x 40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of plants</td>
<td>48,000-50,000</td>
<td>48,000</td>
<td>42,000</td>
<td></td>
</tr>
<tr>
<td>Yield (t.ha⁻¹)</td>
<td>8-10</td>
<td>10-20</td>
<td>20-30</td>
<td></td>
</tr>
</tbody>
</table>

There is no bolting in the autumn.

TKW of 2.5-3.5 g

The head tolerates a frost of -8°C without being damaged.
Cultivation Techniques
Early crop
– Planting of mini-plugs
– Irrigate thoroughly
– The crop must not dry out excessively! (stress)
Summer and autumn crops
– It is more profitable to pre-cultivate planting stock (high seed prices)
– direct precision drilling of 0.5 kg/ha
Quality Standards
• The minimum diameter of inflorescence is 80 mm, the length of the edible portion including the stalk is 200 mm
• Packed and compact heads

Storage
• 0-10°C 5-6 weeks
• 5°C 5-10 days

All broccoli residues can be fed to domestic animals (rabbits) = a non-waste crop.
Deer graze broccoli preferentially.
KOHLRABI
Brassica oleracea L. convar. acephala var. gongylodes (L.) Markgr.
• Kohlrabi comes from the Mediterranean and was already known in Ancient Rome
• Most frequently grown in Western and Central Europe
• A short growing period, a wide range of culinary uses
• From the original wild Brassica oleracea
• Axial tuber – forms by a reduction in the stem length and considerable secondary thickening at the growing point (Incorrectly called a bulb)
• The weakest root system of all cole crops – short and fibrous
• Cultivars are distinguished by colour, shape, and tuber size

• White (var. alboviridis)
• Purple (var. purpurescens)

Thinner skin – more susceptible to splitting of tubers
Thicker skin – more juicy, tastier
Nutritional Value of Kohlrabi

<table>
<thead>
<tr>
<th>Component</th>
<th>Value (mg/kg of fresh matter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter</td>
<td>8.7%</td>
</tr>
<tr>
<td>Dietary fibre</td>
<td>2.2%</td>
</tr>
<tr>
<td>Proteins</td>
<td>2.1%</td>
</tr>
<tr>
<td>Lipids</td>
<td>0.2%</td>
</tr>
<tr>
<td>Saccharides</td>
<td>5.8%</td>
</tr>
<tr>
<td>Ca</td>
<td>630</td>
</tr>
<tr>
<td>Zn</td>
<td>1.7</td>
</tr>
<tr>
<td>B6</td>
<td>1.2</td>
</tr>
<tr>
<td>Fe</td>
<td>42 (!)</td>
</tr>
<tr>
<td>S</td>
<td>400</td>
</tr>
<tr>
<td>C</td>
<td>450</td>
</tr>
<tr>
<td>Na</td>
<td>520</td>
</tr>
<tr>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Mg</td>
<td>240</td>
</tr>
<tr>
<td>P</td>
<td>513</td>
</tr>
<tr>
<td>K</td>
<td>2,300</td>
</tr>
</tbody>
</table>

*(mg/kg of fresh matter)*
Cultivation Techniques

• Loam and loam sandy soils with a sufficient content of humus and a sufficient nutrient reserve, a pH of 6.0-7.3
• Unsuitable – clay, impermeable soil
• As a heavy feeder 35 t of manure, compost
• Essential is additional irrigation during the whole growing period (At least once a week, preferably twice a week, not more than 15 mm)
• At the time of seedling precultivation, kohlrabi needs a temperature above 14°C (Otherwise it vernalises and bolts)
EARLY CULTIVARS

1. Planting stock pre-cultivation (60-65 days)
   • Sowing between the end of January and the beginning of February
   • Planting – during the last ten days of March, at the beginning of April
   • A spacing of 25 x 25, 25 x 30, 30 x 30
   • 120,000 pcs/ha (200 g each)

2. Direct sowing in the field (early cultivars)
   • Between the end of March and the beginning of April
   • Harvesting:
     • By thinning at 2-day intervals, a yield of 20-30 t/ha
     • Harvest duration of 2-3 weeks, the kohlrabi is not storable
LATE CULTIVARS
• Planting stock pre-cultivation or direct precision drilling
• Sowing between mid-April and the beginning of July (Depending on the earliness of the cultivar)
• Planting from the end of May to the end of July
• A spacing of 30 x 40, 40 x 40 cm
• Harvesting – between July and October on a one-off basis, without leaves
• A weight of 400-500 g (Gigant 2,000 g)
• A yield of 45-50 t/ha, convenient to store until March
• A growing period of 130 days from planting
<table>
<thead>
<tr>
<th>Sowing</th>
<th>EARLY CROP</th>
<th>SUMMER CROP</th>
<th>LATE CROP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Beginning of February</td>
<td>March–April</td>
<td>May/June, end of May–middle of July</td>
</tr>
<tr>
<td></td>
<td>End of March May–June</td>
<td>April–May</td>
<td>August–October</td>
</tr>
<tr>
<td></td>
<td>25 x 25</td>
<td>June–August</td>
<td>40 x 40</td>
</tr>
<tr>
<td></td>
<td>30 x 30</td>
<td>Not grown, no demand or sale</td>
<td></td>
</tr>
<tr>
<td>Spacing</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
EARLY CROP
FOR LATE HARVESTING
Sowing Mid-July
Growing period from planting in days
Planting Mid-August
    Early white      75-90
Harvesting September–October
    Early purple 80-96
    Medium early 110-120
Spacing 30 x 30 Late 130-150
Need to cultivate early cultivars that have small tubers, which is not profitable
Quality
• Tubers that are not cracked, have not bolted, do not have woody pulp, whose stalk is smoothly cut off, and that have a diameter of:
  • At least 50 mm with white kohlrabi with early kohlrabi leaves
  • At least 55 mm with purple kohlrabi with early kohlrabi leaves
  • At least 70 mm with kohlrabi without leaves (I.) late kohlrabi
  • At least 60 mm with kohlrabi without leaves (II.) late kohlrabi
Nowadays, it is a matter of agreement between the grower and the customer.
Differentiation of Seedlings of Cole Crops by the First True Leaf

Cabbage

Red Cabbage

Cauliflower

Brussels sprouts

Kohlrabi

Savoy cabbage
Physiological Disorders
Cauliflower, Broccoli, Kohlrabi, Cabbage
Whiptail

SYMPTOMS
• Hearts do not form, blades of young leaves are heavily distorted

CAUSES
• A lack of MOLYBDENUM in the soil, acidic soils (blocking Mo)
• (Presence of the kohlrabi midge)
• Spray seedlings with 0.1% ammonium molybdate or sodium molybdate, do some liming – adjustment of pH
Physiological Disorders
Cauliflower, Broccoli, Kohlrabi, Cabbage
Browning of the curd, hollow stem
- Browning of the curd
Hollow stem in broccoli
- A lack of BORON in the soil
- Spray with fertilisers containing B
- Spray seedlings with 0.2% boric acid
Physiological Disorders
Cabbage
Splitting of heads
• Cause
  – Physiological overmaturing (delayed harvesting of early cultivars)
  – Irregular water uptake – a sudden uptake after a dry season
Physiological Disorders
Kohlrabi
Splitting of tubers
• Uneven growth due to unequal soil moisture, irregular irrigation
– Fluctuations in irrigation, a long-lasting dry season
– It starts raining, there is no regular irrigation twice to three times a week
• Infestation by the weevil
Physiological Disorders
Kohlrabi Lignification
• Inner tissues drying out
• Fluctuations in irrigation, a long-lasting dry season
• The plant is trying to propagate and draws moisture from storage tissues in order to develop an inflorescence
• Some cultivars are obviously susceptible (Kozmanova modrá - "The Kozman Purple")
• Prevention – water regularly
Physiological Disorders
Cauliflower, Broccoli
Buttoning
• Small heads form
  – The plant is stressed by dry conditions – in fear of dying, it starts heading – the initial effort of the plant to propagate
• It happens that seedlings dry out or irrigation is neglected
• Young plants are better adapted to stress
• Younger seedlings (3-4 leaves) are hardier than older seedlings (5-6 leaves)
• Encouraged by dry, too warm weather
Physiological Disorders
Cauliflower, Broccoli, Kohlrabi
Bolting
• A quality edible portion does not develop
• Plants run to flower
• Seedling pre-cultivation at low temperatures below 10°C
• Specific condition in kohlrabi – if the temperature drops below 10°C for 3-4 hours, there are no consequences, but if this happens for 2-3 days, vernalisation occurs, it comes to bolting in all seedlings, which is only to see in the field — Do not plant at all!
• Dry, warm weather at the time of formation of the edible portion
Club root
Plasmodiophora brassicae
- Lumpy swellings on the roots, when cut open, the little "tumours" are filled with tissues; permanent spores contaminate the soil to a depth of 25 cm for more than 10 years
- Poor growth, wilting, lower yields; club root centres around focuses, on all brassicas including weeds
- Club root reduces the yield by 50% on cole crops
  - There is no drop in yields in the case of oilseed rape!
Rape is a vector
• Plant healthy seedlings, use healthy substrate
• Transmitted mainly via seedlings – contaminated substrate
• Alkaline soil reaction is of help
• Raise the soil pH to 7
• Discontinue growing host plants for 6-8 years
• Eradicate brassica weeds
• Apply 0.1 kg of lime nitrogen per m² before planting
All Cole Crops, Beijing cabbage, Chinese cabbage
Blackleg  Phoma lingam
• On the stem, leaves, root neck, and roots of young plants, there emerge grey-brown spots, leaves become yellow and prematurely die back; slimy rot occurs at storage; blackleg occurs in maturing plants
• Prevention: dress seeds, dispose of post-storage residues
• Spray – Ridomil, Pomarsol forte
• Blackleg is not frequent and symptoms appear when vegetables are placed in a storehouse
All Cole Crops, Peking cabbage, Chinese cabbage
Downy mildew (in brassicas) Hyaloperenospora parasitica
• Yellow spots on the upper surface of leaves, a grey-white growth on the lower surface of leaves, dark spots on older leaves
• The fungus survives in the seed and in post-harvest plant residues or winter brassicas
• Dress seeds, dispose of residues, spray – Ridomil, Pomarsol forte
• The disease does not occur frequently, only when there is a longer rainy season; to prevent it, spray shortly before formation of heads
• The disease spreads on post-harvest residues
• The disease affects Peking and Chinese cabbage

Lower surface
Upper surface
Cabbage, Kale, Cauliflower, Peking cabbage
Alternaria leaf spot  Alternaria brassicae
• Yellow spots with yellow edges on the upper side of leaves, tissues dry out and fall out; the disease mostly appears in weaker plants in wet weather
• At the edges of leaves first, whole leaves and heads dry out fast within 2-3 days
• The fungus is transmitted via seeds and soil
• Carried from infected stands by air
• Perform seed dressing, dispose of post-harvest residues
• Spray – Ridomil, Pomarsol forte
• A disease of wet autumn
• Mainly in Peking cabbage, one preventive spraying will do
  – If the forecast says there will be a rainy September, spray during the first ten days of September
• It is not necessary to spray during a sunny autumn
Concentrical circles in a spot
All Cole Crops, Especially Peking Cabbage
Bacterial soft rot Erwinia carotovora
- Watery, gradually rotting spots, a distinctive foul smell on damaged parts in storage, affected parts become mushy
- Perform seed dressing • Grow brassicas at minimum 5-year intervals
- Dispose of post-harvest residues (They cannot be composted)
- Low storage temperatures of 0-1°C slow down the course of the disease