



**BioGreenhouse**

# Guidelines for Experimental Practice in Organic Greenhouse Horticulture

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# Research





**The Editorial Board** This picture was taken at the final meeting to discuss these guidelines, held in Tori, Estonia in September 2015. A commercial organic greenhouse with a tomato crop is shown in the background. Left to Right: Pedro Gomez, Stella Cubison, Wolfgang Palme, Justine Dewitte, Martin Koller, Yüksel Tüzel, Francis Rayns, Ingrid Bender and Ulrich Schmutz.

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The guidelines were initially based on the following publication with many new chapters contributed by European and international authors:

Lindner, Ulrike and Billmann, Bettina (Eds.) 2006. Planung, Anlage und Auswertung von Versuchen im Ökologischen Gemüsebau. Handbuch für die Versuchsanstellung ["Planning, Setup and Evaluation of Trials on Organic Vegetable Cultivation. An Experimental Design Manual"]. Forschungsinstitut für biologischen Landbau (FiBL), Frick, Schweiz und Frankfurt, Deutschland, ISBN 978-3-906081-97-7, <http://orgprints.org/9863>.

#### **Pictures**

All pictures are by members of the Biogreenhouse COST Action FA1105. Contributors to the pictures (in alphabetical order) are: Ingrid Bender, Stella Cubison, Justine Dewitte, Pedro Gomez, Martin Koller, Carolyn Mitchell, Jérôme Lambion, Wolfgang Palme, Virginia Pinillos, Ulrich Schmutz, Yüksel Tüzel and Anja Vieweger.

#### **Disclaimer**

The information in these guidelines is based on the expert opinions of the various authors. Neither they, nor their employers, can accept any responsibility for loss or damage occurring as a result of following the information contained in these guidelines.

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#### 4.4.2 Kohlrabi

**By Martin Koller**

**Botanical name:** *Brassica oleracea* L. var. *gongylodes* (Brassicaceae)

**Other common names:** German turnip, turnip cabbage

With appropriate modifications the information in this section can also be used as a template for similar crops like Chinese cabbage, Pak-choi, Swiss chard or celery.

#### General crop requirements

Kohlrabi can be cultivated all year around with a low temperature requirement but in greenhouses, winter production is most important. Some varieties are sensitive to low temperature at the seedling stage in order to avoid leaf deformation and heartlessness. A uniform water supply prevents cracks and woodiness of the tuber. Kohlrabi in greenhouses are grown in Central and Northern Europe, but very rarely in the Mediterranean.

#### Experimental design

Recommended replicates: at least 4.

Table 4.47

*Typical kohlrabi plant spacing and number of plants required for trials.*

	North & central un-heated	North & central heated
Minimum number of plants/ core plot	30	40
Minimum size core plot (m <sup>2</sup> )	2.5 -3.5	2.5
Plant density / m <sup>2</sup>	12- 16	16
Row distance (cm)	25 – 30	25
Spacing within the row (cm)	25 – 30	25

Table 4.48

*Typical kohlrabi sowing and harvesting dates.*

Region - Production type	Sowing at	Planting at	Start of Harvest	End of harvest	Remarks
North & central - Unheated*	Dec Jul	Feb Aug	Apr Oct	Apr Nov	Spring crop Autumn crop
- Seasonal heated	Nov Aug	Jan Sept	March Dec	March Dec	Spring crop Autumn crop

\*Transplants are produced in heated greenhouses even if the production phase is unheated.

Table 4.49

*Kohlrabi temperature requirements for sowing and seedling development.*

Germination temperature °C Day/ Night	Days until germination	Temperature for seedlings in °C Day/ Night	Pots	Weeks until plantation
16 - 20/ 14 Ventilation from 20 - 25	6 – 12	12 - 16/ 10 Ventilation from 20 – 25	4 – 5 cm peat pot	4 – 8

Table 4.50

Optimal temperatures for plant growth after planting.

	Day	Night	Ventilation from
Planting in late February / harvest end April	10 - 15 °C	7 - 8 °C	20 - 24 °C

Table 4.51

Kohlrabi plant nutrient requirements.

Yield expectation (kg/m <sup>2</sup> )	N (g/m <sup>2</sup> )	P (g/m <sup>2</sup> )	K (g/m <sup>2</sup> )	Mg (g/m <sup>2</sup> )
2.5	8	1.5	9	2
4.5	14	3	17	3

Source: adapted from various sources, see Appendix B

### Irrigation

Regular irrigation of 15 to 20 mm is needed (on sandy soils). The soil must not be allowed to dry out in order to avoid cracks and woodiness.

### Disease and pest infestation, physiological disorders and other abiotic damage

To help identify diseases see e.g. "Compendium of Brassica Disease" (APS, ISBN 978-0-89054-344-3). Relevant pests and diseases, with link to relevant EPPO Guidelines, include:

- Downy mildew - *Peronospora parasitica* (PP 1/65(3) - Downy mildews of lettuce and other vegetables). Yellow spots on the leaf surface and grey-brownish sporangia's and the underside (also on cotyledons).
- Clubroot *Plasmodiophora brassicae* (PP 1/39(2)).
- Black leaf spot, *Alternaria brassicae* and *A. brassicicola* (PP 1/121(2) Leafspots of vegetables) Round, black spots on the leaf surface.
- Cabbage flea beetle *Phyllotreta* spp. (on rape) (PP 1/218(1)).
- Cabbage root fly (PP 1/9(3) *Delia radicum*).
- Caterpillars e.g. *Plutella xylostella*, *Pieris sp.*, *Mamestra brassicae*: (PP 1/83(2) - Caterpillars on leaf brassicas)
- Cabbage aphids *Brevicoryne brassicae*: (PP 1/24(2) Aphids on potato, sugar beet, pea, broad bean and other vegetables).

### Assessments during growth

See: UPOV Guidelines T/65/4

**Amount and size of leaves** The leaf mass is scored before the beginning of harvest (1 = very low, 3 = low, 5 = medium, 7 = high, 9 = very large).

**Leaf position** The leaf position of the majority of the leaves is assessed before the beginning of harvest. This scoring should be carried out in the morning. Kohlrabi with leaves in an upright position are easier to harvest and to put in boxes (3 = erect/upright, 5 = semi-erect/semi-upright, 7 = horizontal).

**Shape of bulb** (UPOV characteristic 21). Shape of bulb in longitudinal section, see UPOV page 13 (1 = transverse narrow elliptic, 2 = transverse elliptic, 3 = transverse broad elliptic, 4 = circular, 5 = broad elliptic).

**Colour of skin** (UPOV characteristic 20). 1 = white green, 2 = green, 3 pale violet, 4 = dark violet

**Stability of plants** 1 = very low, 3 = low, 5 = medium, 7 = high, 9 = very large

**Missing plants** Missing plants should be counted before harvest begins.

#### **Assessments at harvest**

Kohlrabi can be harvested as soon as a certain diameter is reached (e.g. Germany > 80 mm for spring crop, for autumn crop 70 mm). Some plants develop more quickly than others and so the whole crop requires more than one harvest. The cropping of a Kohlrabi variety in greenhouses should be finished after three harvests. More harvests are considered as uneconomic. The crop is sorted and weighed according to the quality standards for marketable and non-marketable produce. The non-marketable crop is divided into main reasons for rejection:

- Bulbs with cracks.
- Bolters.
- Others (rot, diseased, misshaped, too small, cracks because of weevils).

In addition to yield a number of other parameters can be determined:

**Stalk length** Before removing the root, the stalk length is scored. With a too short stalk, there is a risk that the bulbs get dirty and rot. Too long stalk may have unfavourable effect on the stability of the plant in the ground (1 = very short, 3 = short, 5 = medium, 7 = long, 9 = very long).

**Woodiness** On the day with the biggest harvest a slice of approximately 1 mm thickness is cut of the middle of 10 marketable bulbs. The woodiness is determined by chewing on the slice. In addition, the bulb halves can be dried for one to two days in a warm greenhouse. The fibres will afterwards be defined more clearly (1 = absent or very low, 3 = low, 5 = medium, 7 = strong, 9 = very strong).

#### **Overall value score**

This takes into account all criteria for the cultivation and marketing of the variety, based on expert opinion as evaluated by researchers using information from farmers, wholesalers and consumers (1 = very low, 3 = low, 5 = medium, 7 = high, 9 = very high).

#### **References and further information**

Rimmer S. R., Shattuck V.I. and Buchwaldt L.(Eds). 2007.

Compendium of Brassica Disease. American Phytopathological Society. (ISBN 978-0-89054-344-3)

International Union for the Protection of New Varieties of Plants (UPOV):

Kohlrabi TG/65/4 [www.upov.int](http://www.upov.int)