

# Internal Report



## The challenge of producing organic vegetable seeds of high quality in Denmark

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# **The challenge of producing organic vegetable seeds of high quality in Denmark**

## **Summary**

Organic vegetable seed production is possible in Denmark for some of the late maturing vegetable species – when performed in tunnels. At the Danish Institute of Agricultural Sciences (DIAS) different growing systems in tunnels have been studied in carrot (*Daucus carota* L.), cauliflower (*Brassica oleracea* var. *oleracea*) and leek (*Allium porrum* L.). Tunnel production of carrot and leek seeds increases yield and germination percentages compared to normal field conditions. Yields in the range of 100-250 g seeds/m<sup>2</sup> can be obtained in both species. A hybrid cauliflower seed production is possible in tunnels with a yield range of 9.7-67.6 g seeds/plant. In cauliflower problems with fungi on the seed and a resulting low germination percentage often occur and improved ways to reduce these problems are needed.

The lightweight tunnel production system can be widely used and modified for small-scale producers in e.g. developing countries.

## **Introduction**

The challenge in organic vegetable seed production is to obtain 'quality seeds' of species demanded by the users, however, organic seed is available only in a limited number of appropriate varieties.

Formerly, large quantities of seed of the late maturing species such as cabbage and carrot were produced in Denmark. However, this production is now mainly performed in other parts of the world, where late and humid harvest can be avoided. Yet, Denmark has an internationally recognised certification system and the seed industry has expertise in preventing cross-pollination and producing seeds of high purity. Therefore, an organic Danish vegetable seed production system is desirable. The beneficial effects of protected cropping in tunnels have been demonstrated for e.g. leek by Gray and Steckel (1986). For some years the seed industry has been engaged in producing high value seeds in tunnels with good results. The tunnel production prolongs the growing season and enhances the seed quality. Tunnel production is also a possible means of growing hybrids. A commercial cauliflower seed production of open-pollinated species is done under Danish field conditions, but at present no hybrid cultivars are grown in Denmark.

## **Methodology**

From 2000-2004 different experiments with organic seed production of carrot, leek and cauliflower in tunnels have been carried out at DIAS. The tunnel is a 5 m × 50 m lightweight tunnel with a plastic cover and insect-proof netting in the sides as ventilators. In general, the temperature in the tunnels increased by 2° C compared to normal field conditions (Deleuran and Boelt, 2002). Where necessary, the plants are supported from lodging by netting or wiring. Drip irrigation is done at the soil surface, which leaves the seed heads dry and thereby the risk of development and spreading of fungal diseases is reduced. All weed control is done by hand where needed, and larvae of lady beetles (*Coccinella septempunctata*) are used to control aphids. The pollination in the tunnels is done by honey bees (*Apis mellifera*).



Fertilization is either applied as degassed animal manure or as Binadan. Binadan is a dried and compressed poultry manure. All harvests (harvest of single plants and swathing) are made by hand.

### *Carrot*

In 2000, the open-pollinated cultivar Berlicum was grown in tunnel and under normal field conditions using the root-to-seed system. Specifications for the trial are listed in Table 1.

Table 1. Specifications for organic carrot seed production in 2000.

	Tunnel and field
Planting, date	14/4 2000
Root size, g	150-250
Row spacing, cm	72
Spacing between plants, cm	25
Manure applied, date, amount kg N	3/5 2000, 100 kg N

The carrot seeds were harvested at four times (five in the field), starting when the first umbel seeds were still immature. Ten individual plants were harvested at each time and divided into three fractions: primary umbels, secondary umbels of first four positions and ‘the rest’ of the plant. Additionally, at two times (three in the field) a general swathing of 20 plants was performed. The results from tunnel and field production cannot be directly compared with respect to time, but it gives a good indication of the potential of the two production systems.



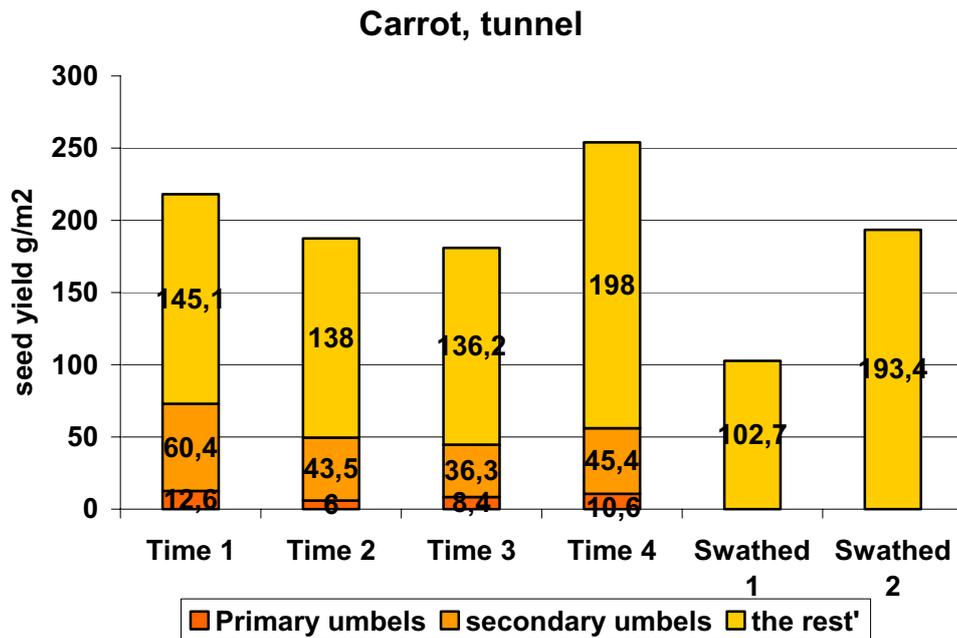


Figure 1. Carrot seed yield ( $\text{g/m}^2$ ) from four different harvest times and three plant fractions and seed yields from whole-plant swathing at two times (swathed 1 at the same time as 'Time 3', swathed 2 at the same time as 'Time 4').

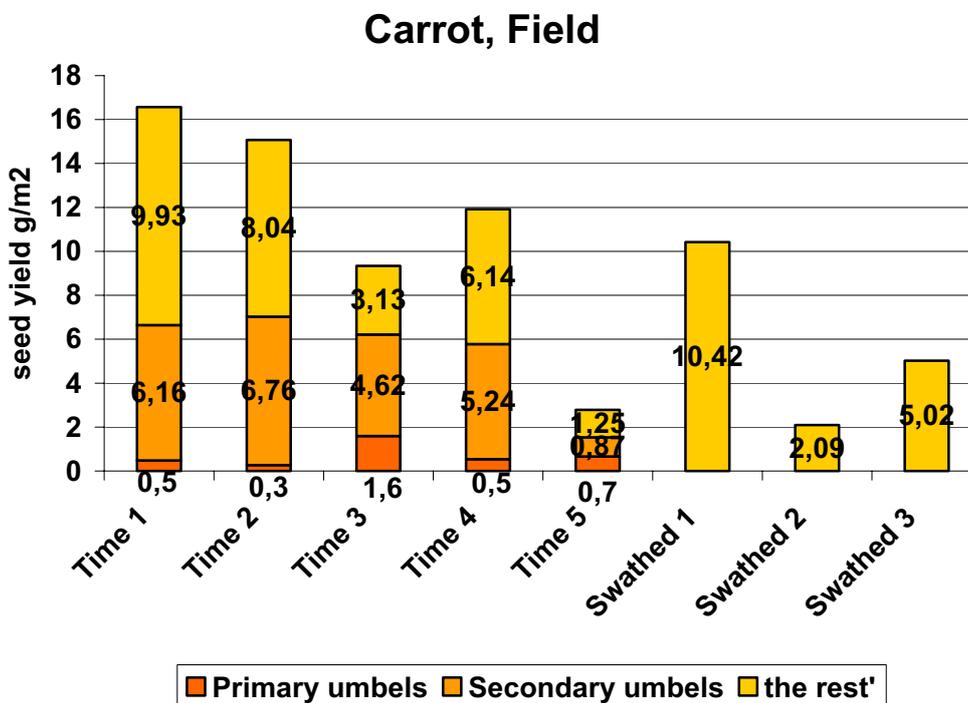


Figure 2. Carrot seed yield ( $\text{g/m}^2$ ) from five different harvest times and three plant fractions and seed yields from whole-plant swathing at three times (swathed 1 at the same time as 'Time 3', swathed 2 at the same time as 'Time 4' and swathed 3 at the same time as 'Time 5').

In the tunnel 100-250 g seeds/m<sup>2</sup> (1000-2500 kg seeds/ha) have been harvested (Figure 1). In the field the seed yield ranged from 2-17 g seeds/m<sup>2</sup> (20-170 kg seeds/ha, Figure 2). In the tunnel production the seed weight ranged from 1.07-1.49 g/1000 seeds and the germination percentage of the seeds ranged from 85-93 (Table 2) and in the field the seed weight ranged from 1.18-1.44 and the germination percentage ranged from 43-55 % (Table 2). In tunnel production seeds from primary and secondary umbels have a higher seed weight and germination percentage than under field production. The seed weight from ‘the rest’ was higher in field production than in tunnel production, but still the germination percentage was far from satisfactory.

Table 2. Tunnel and field production, carrot. Seed weight (g/1000 seeds) and germination (%). Data are shown for the third harvest time and the first swathing.

Harvest time	Primary umbels		Secondary umbels		‘the rest’	
	Seed weight g/1000 seeds	Germination %	Seed weight g/1000 seeds	Germination %	Seed weight g/1000 seeds	Germination %
Tunnel: Harvest 3 Swathing 1	1.49	93	1.34	93	1.07 1.21	85 91
Field: Harvest 3 Swathing 1	1.44	55	1.18	46	1.27 0.98	43 49

### Leek

Trials with leek (cv. Siegfried Frost) from 2002 also compared tunnel production and field production using a root-to-seed system. See Table 3 for specifications. Three plant densities have been tested (25 × 25 cm, 12.5 × 25 cm and 12.5 × 12.5 cm) and for each plant density ten plants were cut (selected after maturity). For comparison plants were randomly selected for swathing at three times. In the tunnel each trial had three replicates. In the field there were no replicates and the trial was only performed to give an indication of the potential level. In general, this kind of production is not considered realistic under Danish field conditions.



Table 3. Specifications for organic leek seed production in 2002.

	Tunnel	Field
Transplanting, date	25/4 2002	2/5 2002
Transplant size, g	50-100	50-100
Area per plant, cm <sup>2</sup>	25×25, 12.5×25, 12.5×12.5	25×25, 12.5×25, 12.5×12.5
Plants per m <sup>2</sup>	16, 32, 64	16, 32, 64
Binadan, date, amount kg N	23/4 2002, 120 kg N	28/5 2002, 120 kg N

Table 4. Tunnel production of leek. Registrations of seed yield (g seeds/m<sup>2</sup>), seed weight (g/1000 seeds) and germination percentage of swathed plants. Harvest of single plants and swathing (average of three times) at three plant densities.

Plant density	Seed yield g/m <sup>2</sup>		Seed weight g/1000 seeds		Germination %
	Single plants	Swathing	Single plants	Swathing	Swathing
12.5 × 12.5 cm	273	236	2.772	2.695	85.7
12.5 × 25 cm	167	190	2.885	2.782	87.7
25 × 25 cm	108	105	2.955	2.839	72.3

Table 5. Field production of leek. Registrations of seed yield (g seeds/m<sup>2</sup>) and seed weight of swathed plants. Harvest of single plants and swathing (average of three times) at three plant densities.

Plant density	Seed yield g/m <sup>2</sup>		Seed weight g/1000 seeds
	Single plants	Swathing	Swathing
12.5 × 12.5 cm	162	143	2.605
12.5 × 25 cm	89	90	2.688
25 × 25 cm	33	48	2.655

Seed yields in the tunnel production ranged from 105-273 g/m<sup>2</sup> (1050-2730 kg/ha) and in the field from 33-162 g/m<sup>2</sup> (330-1620 kg/ha). In both systems nearly no difference was observed between yields from single plant harvest and swathing (Table 4 and 5). The highest yields were harvested from 12.5 × 12.5 cm plant spacing, and the lowest yields from 25 × 25 cm plant spacing. Seed weight and germination percentage in the tunnel ranged from 2.695-2.955 g/1000 seeds and 72.3-87.7 %.

### *Cauliflower*

Different trials have been performed with respect to hybrid cauliflower seed production in tunnels from 2000-2004 at DIAS. Hybrid seed production is possible, but with varying results between plants and years (10-49.1 g/plant). In 2001 an analysis of seed weight and germination was made. On average of seven harvest times the seed weight was 4.21 g/1000 seeds and the germination percentage 82.

## Discussion and conclusions

Organic seed production in tunnels has a great potential in carrot, leek and hybrid cauliflower. It is possible to harvest good quality seeds with a high germination percentage and seed weight.

Seed yield and germination percentage of especially seeds from the primary and secondary umbels (first positions) of carrot increased considerably in tunnel production compared to field conditions. Germination percentage with respect to umbel origin has been further studied by Gray (1979). The carrot seed yield in tunnel production is more than five times higher than in field production, and 2-5 times higher than yields obtained in earlier years' conventional production (Nordestgaard, 1984).

In leek a high yield and germination percentage can be gained in tunnel production. The plant density  $12.5 \times 12.5$  had a negative effect on the seed weight compared to the other plant densities. Whereas Gray and Steckel (1986) found plant density to have little effect on seed weight.

Cauliflower production is difficult due to fungal diseases and special attention must be given to selecting areas free from *sclerotinia sclerotium*. No cauliflower seed production is done commercially in tunnels in Denmark, but from test sites the seed companies report cauliflower to give an approximate yield of 30 g seeds/plant. At DIAS, results in tunnels with organic hybrid seed production range from 10-49.1 g seeds/plants. In the field open-pollinated cultivars are grown for seed production, but no hybrid production is performed.

## Perspectives

The tunnel production system has the potential to be widely used and can be modified for small-scale producers in e.g. developing countries, thus ensuring the availability of a variety of species and cultivars of good quality (Deleuran and Boelt, 2005). In general, being a controlled/confined system, the tunnel production could be of major interest in organic seed production. Production in tunnels is likely to be more labour expensive than in open fields, but still it is interesting in productions, where healthy and high quality seeds are required such as in organic productions.

## Acknowledgements

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For some years the seed industry has been engaged in producing high value seeds in tunnels with good results. The tunnel production prolongs the growing season and enhances the seed quality. This production system can be widely used and can be modified for small-scale producers in e.g. developing countries, ensuring availability of a variety of species and cultivars of good quality.

Since 2000 experiments with organic seed production of carrot, cauliflower and leek in tunnels has been carried out at DIAS.

The lightweight tunnel has a plastic cover and insect netting in the sides as ventilators. In general the temperature in the tunnels are increased by 2 degrees C compared to normal field conditions. Drip irrigation is done at soil surface which leaves the seed heads dry. Pollination is done by honeybees. All weed control is done by hand and when needed aphids are controlled with larvae's of lady beetles.



Tunnel production of carrot seeds increases yield and germination percentages compared to normal field conditions. In cauliflower problems with fungi on the seed and a following low germination percentage often occurs and improved ways to reduce this problem is needed. In leek high yields and germinations percentages can be obtained and transplants of larger size is recommended.



