

Reproduction features of organically grown edible carrot cultivars (*Daucus sativus* Röhl.) in Lithuania

R. Karklelienė, A. Radzevičius, E. Dambrauskienė, L. Duchovskienė,
Č. Bobinas and D. Kavaliauskaitė

Lithuanian Institute of Horticulture, LT-54333 Babtai, Kaunas distr.,
Lithuania; e-mail: r.karkleliene@lndi.lt

Abstract. Investigations were carried out in the organic seed-growing greenhouse at the Lithuanian Institute of Horticulture. Seed stalks of two edible carrot (*Daucus sativus* Röhl.) hybrids ('Svalia' and No 2030) and two carrot cultivars ('Garduolės', 'Šatrija') were grown. Plantings of carrots' root-crop were stored in a stationary cellar. Investigations showed that cultivar genotype and growing conditions influenced morphological characteristics of the grown carrot seeds. An abundance of the pests and their natural enemies were found in the seed stalks of carrot cultivars, but they didn't differ significantly. It was established that cultivar 'Garduolės' is suitable for organic seed growing on organic farming. Good quality and high viability (viable – 75.0–83.0%) seeds are possible to grow in an organic seed-growing greenhouse.

Key words: quality, carrot, productivity, reproduction features, seed stalks

INTRODUCTION

Edible carrot is a bi-annual cross-pollinated plant. During the first year these vegetables produce juicy root crops; during storage they are vernalized; planted in spring, they start generative development (Hodkin, 1998; Gaučienė, 2001). The relevant literature indicates that the change of cultivar assortment often increases productivity 15–20%. Plants of the newly created cultivars better accumulate nutrients from the soil, and are more responsive to the agrotechnique means (Gaučienė, 2001; Karklelienė et al., 2007). Carrots are planted early in the spring, because strong root systems, leaf rosettes and flower stalks develop in cooler weather and sufficient humidity (Bobinas, 1999). In vegetable seed growing it is important to establish the optimal conditions of environmental factors during various stages of plant organogenesis. It was established that under our agroclimatic conditions, the greatest light intensity occurs in July-August. Therefore, under favourable soil humidity and mineral nutrition conditions it is possible to expect good quality seeds (Gray & Steckel, 1983; Gray et al., 1986; Duchovskis et al., 2001, Karklelienė et al., 2007). To obtain a larger carrot seed yield, beehives are built when seed stalks start flowering: pollinated flowers and seed stalks produce more seeds (Erikson et al., 1979; Atherton et al., 1990; Gaučienė, 2001). Seeds are highly sensitive to unfavourable growth conditions. With high temperature and little relational humidity pollen fertility decreases (Ugarova, 2003), and humid, warm weather stimulates the spread of diseases (Šidlauskienė, 2003). Therefore, growing seeds in specialized greenhouses prevents numerous problems.

The aim of the investigation was to select the most suitable carrot cultivars and hybrids for seed growing under the conditions of organic agriculture and to produce high quality carrot seeds.

MATERIALS AND METHODS

Investigations were carried out at the Lithuanian Institute of Horticulture, in ecological seed growing greenhouses covered with double polymeric film, in natural soil – IDg 4-k, /Calc(ar)i – Epihypogleyc Luvisols – LVg-p-w-cc with peat and compost substratum. Seeds grown were edible carrot (*Daucus sativus* Röhl.) Lithuanian selection cultivars ‘Garduolės’ and ‘Šatrija’ (2005–2006) and hybrid ‘Svalia’ (GS 3182 X No 473) and hybrid accession 2030 (ŠS 494 X No 1898) in 2007–2008 years.

The plantings of carrot cultivar and hybrid parental components were stored in the stationary cellar (at the temperature of +2 – +7°C and 90–95% relational humidity). In 2005–2006 carrots were planted in the greenhouse in the beginning of April, and in 2007–2008, at the end of March. Carrot cultivar plantings were planted in rows (70 x 30 m). Male and female components for the hybrid carrot seeds were grown separately and planted according to the scheme 2:1. To obtain the seeds of cultivars ‘Garduolės’ and ‘Šatrija’ and male component hybrid seeds, 30 carrot root crops in the variant (10 plants per each replication) were planted. To obtain female component carrot hybrid seeds 60 root crops (20 plants per each replication) were planted. Each experiment was carried out in three replications. Five plants selected occasionally from each replication were evaluated. Organically grown carrot seed stalks were fertilized with natural fertilizer “Biokal 01” and “Biojodis” (three times). When carrots sprouted and started forming flower stalks, they were fertilized with “Ekoplant” and, after one week, were watered with a solution of potassium sulphate and magnesium sulphate. At the end of July seed stalks were twice sprayed against pests with a biological preparation (“Nimazal” 0.5% concentration solution). During their growth period carrot seed stalks were watered every week. They were weeded and the soil was hoed with a manual instrument nine times. In order to obtain as large a seed yield as possible, bumblebeehives were built when seed stalks started flowering. In vegetable seed stalks the manifestation of pests was investigated and their calculation was carried out (Šurkus & Gaurilčikienė, 2002).

During the years of the investigation the number of the sprouted carrot plantings, development of seed stalks, number of seeds per single plant, weight of 1000 seeds, seed germination energy and viability were observed and recorded. The more important morphological parameters of carrot seed stalks and seed data were evaluated by dispersion analysis method (Tarakanovas & Raudonius, 2003).

RESULTS AND DISCUSSION

By carrying out experiments in the greenhouse, many problems which determine seed quality were solved. It was more difficult to solve plant protection problems. When growing seeds of cross-pollinated vegetables (carrots), it is necessary to isolate different cultivars. The aim of our investigations was to establish reproduction qualities of the edible carrot under the conditions of organic growing.

Table 1. Phenological observations of edible carrot. LIH, 2005–2008.

Parameters	Mother plants, pcs.			
	Seed stalks of cultivars			
	2005		2006	
	planting	sprouted	planting	sprouted
‘Garduolès’	30	30	30	30
‘Šatrija’	30	30	30	30
	Seed stalks of hybrids			
	2007		2008	
	planting	sprouted	planting	sprouted
‘Svalia’ F ₁ (GS 318 ₂)	60	60	60	60
Nr. 473	30	30	30	30
No 2030 F ₁ (ŠS 494)	60	60	60	60
No 1898	30	28	30	30

We planted 30 plants of each carrot cultivar and 60 plants of female component for hybrid seeds (Table 1). The data presented show that all plantings of all cultivars and accessions sprouted, with the exception of carrot No 1898 (sprouted 93.3%). We think that the plantings of this accession were influenced by the weaker root crop rosette, therefore two plantings didn’t form morphogenetic structures.

The development of the samples of the seed stalks investigated in different years differed only in several days per vegetation. The influence of meteorological conditions on plants grown in a greenhouse is small; plant development is slightly more influenced by temperature and the number of sunny hours. In 2005–2006 and in 2008 favourable conditions for carrot seed stalk growth and development prevailed because the multi-annual air temperature and the duration of sunshine were similar to multi-annual averages. In 2007 carrot seed ripening was longer because of a more humid and cooler July – the average air temperature that month was several degrees lower and sunshine lasted for 30 fewer hours (average multi-annual sunshine duration in July – 265 hours) in comparison with multi-annual averages. This might negatively influence plant flowering duration, but investigations showed that the development of seed stalks is influenced more by genetic properties of the cultivar (Fig. 1).

Evaluation of carrot cultivar and hybrid accession seed stalks showed that seed stalks of cultivar ‘Garduolès’ produce more sprouts than the other investigated samples (Table 2). Cultivar ‘Garduolès’ also produced the highest seed stalks, which essentially differed from the other cultivars and accessions. After evaluation of morphogenetic structures in carrot plants it was established that male and female components of hybrid plants produce almost the same number of sprouts.

Our investigations showed that the first umbellate plants ripen more seeds than second and third umbellate plants. The data by Gaučienė (2001) and Ugarova (2003) confirm this. Productivity of ecologically grown carrot seed stalks per one plant reached from 4.3 to 5.9 g. Growing vegetable seed stalks in the greenhouses established that greenhouse microclimate conditions are highly favourable for the development of mites (*Tetranychus urticae*). An abundance of the pests and their natural enemies were found in the seed stalks of carrot cultivars, but they didn’t differ significantly.

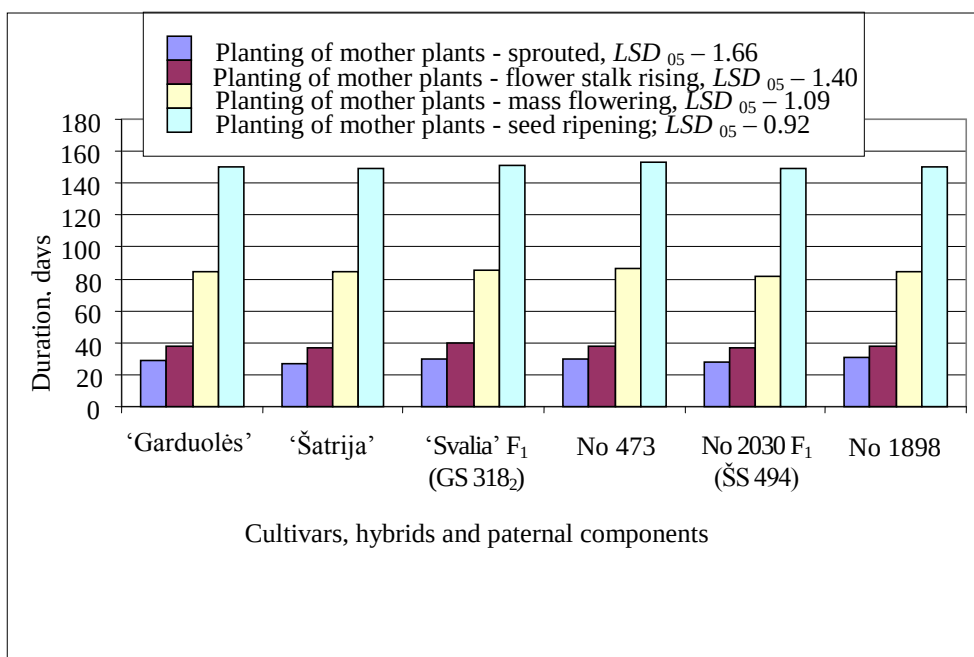


Fig. 1. Development of investigated carrot seed plants per days in 2005–2008.

Table 2. Morphological parameters of carrot seed stalks. LIH, 2005–2008.

Cultivars, hybrids, paternal components	Seed stalk height, cm	Morphogenetic structures of seed stalks, pcs.	Productivity of seed stalks, g
'Garduolès'	144.0	11.3	5.9
'Šatrija'	112.7	10.5	5.2
'Svalia' F ₁ (GS 318 ₂)	127.7	9.9	5.6
No 473	123.3	10.0	5.0
No 2030 F ₁ (ŠS 494)	121.6	9.5	4.3
No 1898	118.3	9.2	4.7
<i>LSD</i> ₀₅	10.46	2.11	1.18

Our data showed that the percent of these pests might also depend on plant genetic nature. Among greenhouse plants, only seed stalks of hybrid 'Svalia' F₁ and cultivar 'Šatrija' (Table 3) were injured.

Investigations showed that seed stalks of cultivar 'Garduolès' produced the biggest seeds of all the investigated carrots (1000 seed weight – 2.2 g) (Table 4). After evaluation of carrot seed quality parameters it was established that seeds of cultivar 'Garduolès' had good germination energy and viability. Seeds of hybrid accession also were distinguished for high quality reproduction properties (viability reached 83.0%). The least seed viability was of the male components of both carrot hybrids.

Table 3. Mite *Tetranychus urticae* infestation in carrot seed stalks. LIH, 2005–2008.

Cultivars, hybrids, paternal components	Damaged % (07–23)
2005–2006	
‘Garduolės’	-
‘Šatrija’	10.0
2007–2008	
‘Svalia’ F ₁ (GS 318 ₂)	34.0
No 473	10.0
No 2030 F ₁ (ŠS 494)	-
No 1898	-

Table 4. Biological parameters of carrot seeds. LIH, 2005–2008.

Cultivars, hybrids, paternal components	Parameters		
	Weight of 1 000 seeds, g	Germination energy, %	Viability, %
‘Garduolės’	2.2	75.5	83.0
‘Šatrija’	2.0	72.0	82.0
‘Svalia’ F ₁ (GS 318 ₂)	1.9	58.3	81.3
No 473	2.1	62.7	76.0
No 2030 F ₁ (ŠS 494)	1.8	63.3	83.0
No 1898	2.0	53.3	75.0
<i>LSD</i> ₀₅	0.18	5.83	4.76

CONCLUSIONS

1. The development of edible carrot seed stalks is influenced by their genotype and environmental conditions. In the specialized greenhouse for seed growing, germinable, high quality hybrid seeds (viability – 75.0–83.0%) were grown.
2. Carrot cultivar ‘Garduolės’ is suitable for organic seed growing. Seed stalks produce big (1000 seed weight – 2.2 g) and germinable seeds (viability – 83%).

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