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INFLUENCE OF SEEDLINGS QUALITY ON CONSUMER PARTS OF SELECTED SPECIES OF CABBAGES

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Abstract

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The aim of this work was to evaluate the influence of seedling preparation technology (seedling flats with cell size of 20 ml, 40 ml and seedlings pulled from patches) and of seedling age at the time of planting (development stages of 3–4 true leaves and 5–6 true leaves) to the qualitative characteristics of seedling of selected cabbage species: white cabbage (*Brassica oleracea* L. convar. *capitata* (L.) Alef. var. *alba* DC.) – *Aros, Avak*, *Midor*; cauliflower (*Brassica oleracea* L. convar. *botrytis* (L.) Alef. var. *botrytis* L.) – *Beta, Delta, Rober* and savoy cabbage (*Brassica oleracea* L. convar. *capitata* (L.) Alef. var. *sabauda* L.) – *Vega, Versus*. The diameter and weight of rosaces, resp. heads, was evaluated in the harvested production. After splitting the harvested crop into several groups, the percentage of non-standard portion of the yield was determined. The use of older seedlings (5–6 true leaves) for the white and savoy cabbage planting had a positive influence to both average yield and the harvest earliness. On the other hand, for the cauliflower conclusively better average crop of rosaces and earlier harvests were achieved with younger seedling transplanting (3–4 true leaves). Seedling flats proved to be the most suitable way of seedling preplantation; no differences were found between the characteristics of products cultivated from the seedling flats with 20 ml and 40 ml cell volumes. In average, smaller amount of non-standard harvest plant parts was, gained with the transplanting from larger seedling flats (40 ml cell volume).

cabbage, cauliflower, savoy cabbage, seedlings, seedlings technology, cell size, vegetables

Cabbages belong to the group of vegetables being grown mostly from seedlings. Because of that, the quality of preplanted seedlings is considered an important factor, which influences final production results. In the Czech Republic, the procedure of seed and seedlings production is regulated by the act No. 219/2003, on introducing seed and seedlings to the market and by it´s implementary regulation No. 175/2004. Among others, required size of vegetables seedlings, critical points monitored during the production process, critical points regarding supervision and the way of record keeping are given in this regulation. According to the regulation, the vegetable seedlings qualities must fulfil the customer demand and must be sufficiently accrued, healthy and free from pests, well-rounded, fresh, properly rooted and with balanced roots-stalk-and-leaves ratio. Similarly, harmful organisms and diseases are specified in the regulation, occurrence of which is impermissible in cabbages seedlings (for the *Brassica oleracea* genus, following pests are involved: *Aleyrodidae*, *Aphididae*, *Heterodera* sp., *Lepidoptera* – particularly *Pieris brassicae*, *Thysanoptera* – particularly *Frankliniella occidentalis*; *Pseudomonas syringae* pv. *maculicola*, *Xanthomonas campestris* pv. *campestris*; *Alternaria brassicae*, *Mycosphaerella* sp., *Phoma lingam*, *Plasmodiophora brassicae*, *Pythium* sp., *Rhizoctonia solani*; viruses and causes of viral diseases, particularly Cauliflower mosaic virus, Tospovirus and Turnip mosaic virus). While in some EU countries obligatory

directives were developed for seedlings quality (i.e. United Kingdom), in the Czech Republic no directive or standard obligatory determining other specific characteristics of seedlings (root system size, the leaves / root part ratio etc.) hasn´t been passed yet. Thus, the quality of seedlings depends mostly on the earnestness of producers, who respect only common requests for the seedlings quality (intact root ball, healthy roots, healthy above-ground part of plant of rich green colour, without indications of diseases or pests affection and in the development stage appropriate for given vegetable types). At the same time, many papers of both foreign and domestic authors indicate, that quantitative parameters of seedlings, depending on used technology of seedling production and on the „age" of young plants also can be factors having influence to the final production characteristics (Lorenz, Maynard, 1988; Marsh, Paul, 1988; Jones, Weston, Harmon, 1991; Lewandowska, 1992; Vavrina, 1998 etc.).

The aim of this work was to evaluate the cabbages seedlings production technologies commonly used in the Czech Republic from the seedling material characteristics viewpoint and to evaluate the impact of these technologies to the course of their formation and to the parameters of consumer parts in selected delayed types of cabbages – white cabbage, cauliflower and savoy cabbage.

MATERIAL AND METHODS

The influences of preparation technology and the length of seedlings preplanting to the characteristics of seedling plants and their relationship to the qualitative parameters of cabbages consumer parts were investigated in the years 2000–2002. The field part of the experiments took place in the experimental station of plant production of School Agricultural Company of the Mendel University of Agriculture and Forestry, in Žabčice (corn production region, zone K2, average altitude 184 m). Soil type of the experiment location was classified (Němeček *et al*., 2001) as gley fluvisoil (FLg). As for the grain class (Pokorný, Střalková, Podešvová, 1997), the soil is medium heavy to heavy, of the clay-loam to loam type, with the content of clayey particles 55 to 65%. The floricultural region is characterised as warm, mildly dry, with a mild winter and shorter sunshine in vegetation period. The course of weather during vegetation period in individual years after transplanting the plants to the field conditions is given in the Tab. II. Selected varieties of delayed cabbages were included into the experiments – white cabbage (*Brassica oleracea* L. convar. *capitata* (L.) Alef. var. *alba* DC.) – *Aros* (reg. 1996), *Avak* (reg. 1996), *Midor* (reg. 1997), cauliflower (*Brassica oleracea* L. convar. *botrytis* (L.) Alef. var. *botrytis* L.) – *Beta* (reg. 1999), *Delta* (reg. 1999), *Rober* (reg. 1997) and savoy cabbage (*Brassica oleracea* L. convar. *capitata* (L.) Alef. var. *sabauda* L.) – *Vega* (reg. 1996), *Versus* (reg. 1948).

I: *Characteristics of used varieties*

Variety	Days to maturity from transplanting	Head			Possible plant densities per 1 ha	Use
		Colour	Weight (kg)	Shape		
White cabbage (*Brassica oleracea* L. convar. *capitata* (L.) Alef. var. *alba* DC.)						
Aros	145–155	green	2.0–2.5	round	33 000	S
Avak	115–120	light green	2.5–4.0	flat-round	27 000	M, F, Ss
Midor	115–125	light green	3.0–4.0	slightly flattened	27 000	M, F
Cauliflower (*Brassica oleracea* L. convar. *botrytis* (L.) Alef. var. *botrytis* L.)						
Beta	54–59	white	-	firm	62 500	M
Delta	75–80	white	-	very bumpy	62 500	M
Rober	65–75	white	-	medium-bumpy	62 500	M
Savoy cabbage (*Brassica oleracea* L. convar. *capitata* (L.) Alef. var. *sabauda* L.)						
Vega	100–110	green	cca 1.0	round	40 000	M, Ss
Vertus	130–150	dark green	cca 1.2	flat-round	33 000	M, Ss, Fr

F – for fermentation, Fr – for freezing, M – fresh market, S – storage, Ss – short storage

The production of cabbages from the seedlings produced via three traditional ways were evaluated: seedling flats technology with cell volume 20 ml, the number of cells on flats was 160; seedling flats technology with cell volume 40 ml, the number of cells on flats was 96; and seedlings pulled from patches (picked) planted out in two terms according to stages of seedling plants development: in the stage of 3–4 true leaves and in the stage 5–6 true leaves. The sowing was performed in the same term each year for all seedlings production technologies (Tab. II).

II: *Terms of sowing and outplanting of cabbages in individual experimental years*

Year	2000	2001	2002
Sowing	14th April	17th April	16th April
Outplanted with 3–4 tr. leaves	15th May (31 days, i.e. 4.5 weeks after sowing)	24th May (37 days, i.e. 5.5 weeks after sowing)	17th May (31 days, i.e. 4.5 weeks after sowing)
Outplanted with 5–6 tr. leaves	31th May (47 days, i.e. 6.5 weeks after sowing)	7th May (51 days, i.e. 7.5 weeks after sowing)	31th May (45 days, i.e. 6.5 weeks after sowing)

Seedling flats were preplanted in a heated greenhouse. In this way of preplantation, the sowing was performed on plastic flats (size 25 x 40 x 5 cm) into horticultural substrate type B (contents of combustible matters in solid substance in weight percentage – min. 55%, pH in water suspension between 5.0 and 6.5; percentage of particles bigger than 20 mm – max. 5%). In the stage of developed cotyledonous leaves the plants were pricked out into plastic seedling flats with cell volume 20 ml and 40 ml. For the preparation of seedlings pulled from patches, seeds were sown to the experimental land in 25 cm drill distance. Sown area was covered with a unwoven fabric Pegas Agro UV 17 (17 $g.m^{-2}$). During seedlings preplantation phase irrigation was performed whenever necessary. Plant hardening was performed for the seedlings cultivated in the greenhouse a week before the transplanting.

Before transplanting, ten plants were taken out of each type of seedlings preplantation and the substrate was washed out from the root ball. Following characteristics were observed in these seedlings: *hypocotyl diameter* [mm], *leaves length* [cm], *roots length* [cm], *leaves weight* [g] and *roots weight* [g].

The transplanting was performed in 50 x 40 cm spacing. After the transplanting seedlings were covered with unwoven fabric Pegas Agro UV 17 for 14 days. During the vegetation, the plant cover was fertilized twice (50 $kg.ha^{-1}$ NPK – 12% N, 11% P, 11% K in the stage of 8–9 true leaves, 50 $kg.ha^{-1}$ 14 days later). During the vegetation, mechanical spud and chemical treatment against pests were performed if necessary. Spray irrigation was performed in the locations during the vegetation period. The harvest was carried out via thinning.

In the final production, *earliness* (the number of days from sowing to harvest), *consumer part diameter* [cm] and *consumer part weight* [g] were observed.

Results gained from three years of experiments were computer-processed with the software STATISTICA 7, multifactor analysis of variance. Average differences were tested according to Tukey test at the 95% and 99% level of significance (Rod, Vondráček, 1975).

RESULTS AND DISCUSSION

Results of the three-years experiments implies that from the viewpoint of seedlings parameters formation especially the type and time length of seedlings preplantation, had an important role in all of the investigated species. The most important indications are high rates of given factors in investigated characteristics variability (Tab. IV) and statistic conclusiveness of their influence. From the viewpoint of cauliflower seedlings production technology, statistically conclusively highest levels of value of all characteristics were reached for the plants from seedling flats with cell volume 40 ml (Tab. IX). This trend wasn´t so explicit for savoy and white caggabe seedlings, highest values of some characteristics were found also for seedlings pulled from patches (Tab. VIII, X). During the evaluation of differences in seedlings characteristics, it was found that the seedling flats plants showed much smaller differences among themselves in the values of investigated characteristics, than were the values found in the comparison of seedling flats plants with seedling plants pulled from patches. Also, the ratio of aboveground / underground plant parts was dramatically narrower for seedling flats than for picked seedlings pulled from patches (i.e. 2.1:1 for white cabbage, 1.7:1 for cauliflower and savoy cabbage; 1.1–1.5:1 for plants from flats). This disproportion, caused by mechanical „damage“ of root fytomass, can be considered the main cause of the phenomenon called „transplanting shock“ (Vogel, Hartmann, Krahnstöver, 1996). During the

III: *Average month temperatures and total rainfall in years 2000–2002, normal temperatures and rainfalls from years 1961–1990 and 1991–2000 (Žabčice; Svoboda, 2003)*

Month/Year	2000		2001		2002		1961–1990		1991–2000	
	°C	mm	°C	mm	°C	mm	°C	mm	°C	mm
January	–1.9	29.6	0.1	27.5	–0.9	5.2	–2.0	24.8	–0.6	15.6
February	3.1	22.7	1.5	17.6	3.7	21.8	0.2	24.9	0.7	14.6
March	5.4	60.4	5.5	55.2	5.8	22.2	4.3	23.9	4.9	28.5
April	14.0	1.6	9.1	36.7	10.0	30.9	9.6	33.2	10.7	30.8
May	17.4	39.7	17.2	41.6	18.1	41.2	14.6	62.8	15.7	48.7
June	20.3	16.0	17.1	33.1	20.0	106.3	17.7	68.6	18.9	56.6
July	18.6	113.3	21.4	66.1	21.8	114.0	19.3	57.1	20.6	78.3
August	21.2	45.5	21.3	61.7	20.7	100.5	18.6	54.3	20.5	56.7
September	14.6	42.5	13.8	102.9	14.1	36.8	14.7	35.5	15.2	50.7
October	12.8	21.4	12.9	9.6	7.9	88.2	9.5	31.8	9.5	27.8
November	7.4	56.6	3.1	22.6	6.8	45.0	4.1	36.8	4.1	39.9
December	1.4	39.0	–2.9	35.3	–2.5	47.0	0.0	26.3	–0.2	27.3
Veg. period	*17.7*	*258.6*	*16.7*	*342.1*	*17.5*	*429.7*	*15.7*	*311.5*	*16.9*	*321.7*
Average/Total	*11.2*	*488.3*	*10.1*	*510.1*	*10.5*	*659.1*	*9.2*	*480.0*	*10.0*	*483.0*

experiments, it was found that the shock reaction after seedling plants pull-out was specific according to the plant type, but there was always a decrease of average consumer plant part yield in comparison with the plants preplanted in seedling flats (most of all in the case of cauliflower – at least 23%, for savoy cabbage at least 10% and for white cabbage at least 4%). The plant development stage at the transplanting time was a factor, which statistically greatly influenced all investigated seedlings characteristics. Developmentally older seedlings (in the stage of 5–6 true leaves) statistically cogently showed all characteristics of much higher average values than the characteristics of developmentally younger seedlings (in the stage of 3–4 true leaves). From the viewpoint of characteristics values variability, variation was minimal (from 0 to 10%). Differences among the values of investigated seedlings characteristics can be caused by different seed provenience and vitality.

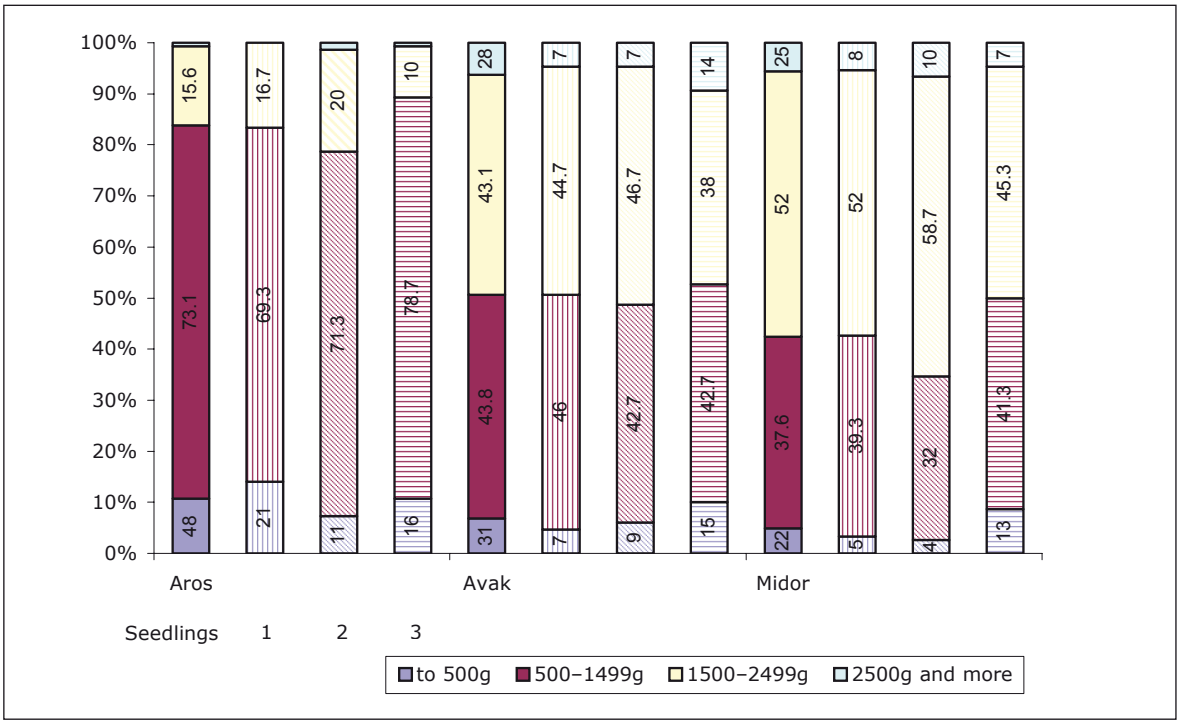
In the process of final production, variety proved to be a most important factor for white and savoy cabbage. The most important factor of the variability of cauliflower rosace diameter values was the time-length and seedlings preplantation technology, which greatly influenced also the weight of rosaces. The plant development stage in the time of transplanting was an important source of earliness variability for all cabbages (Tab. IV). The yield variability in individual years corresponded to average weather course and location conditions. Relatively highest yield level (Tab. VIII, X) was achieved in 2002 for white and savoy cabbage (average head weight was 1 532 g and 957 g, resp.), and in 2000 (Tab. IX) for cauliflower (average rosace weight 510 g).

The seedling production technology is a key factor influencing economic profitability of cabbage production. The experiments proved that the seedlings preparation technology is a factor of statistically high conclusive influence to the forming of consumer parts parameters of cabbages. The best from evaluated variants were seedling flats with the cell volume 40 ml, from which both heads and rosaces with highest average weight were grown (12% enhancement for white cabbage, 32% for cauliflower and 14.5% for the savoy cabbage in comparison to patch seedlings). Also the relatively lowest average amount of non-standard harvest parts of plants in the experiment series was achieved in the case of transplanting the seedlings from larger flats (Fig. 1 to 3). Morphologic and physiologic reactions of cauliflower plants preplanted in containers of various size were investigated in practice i.e. by Dufault and Waters (1985), but any conclusive decrease of the plants yield from any type of flats wasn´t found. On the other hand, a positive influence of larger container use to the yield of cauliflower and white cabbage was ascertained by Csizinszky and Schuster (1988) and Marsh and Paul (1988). In the three-year experimental series framework a specific reaction of white cabbage and cauliflower varieties to the way of seedlings production was found. The plants of Avak (Fig. 1) and Beta (Fig. 2) varieties, originating from smaller flats, produced

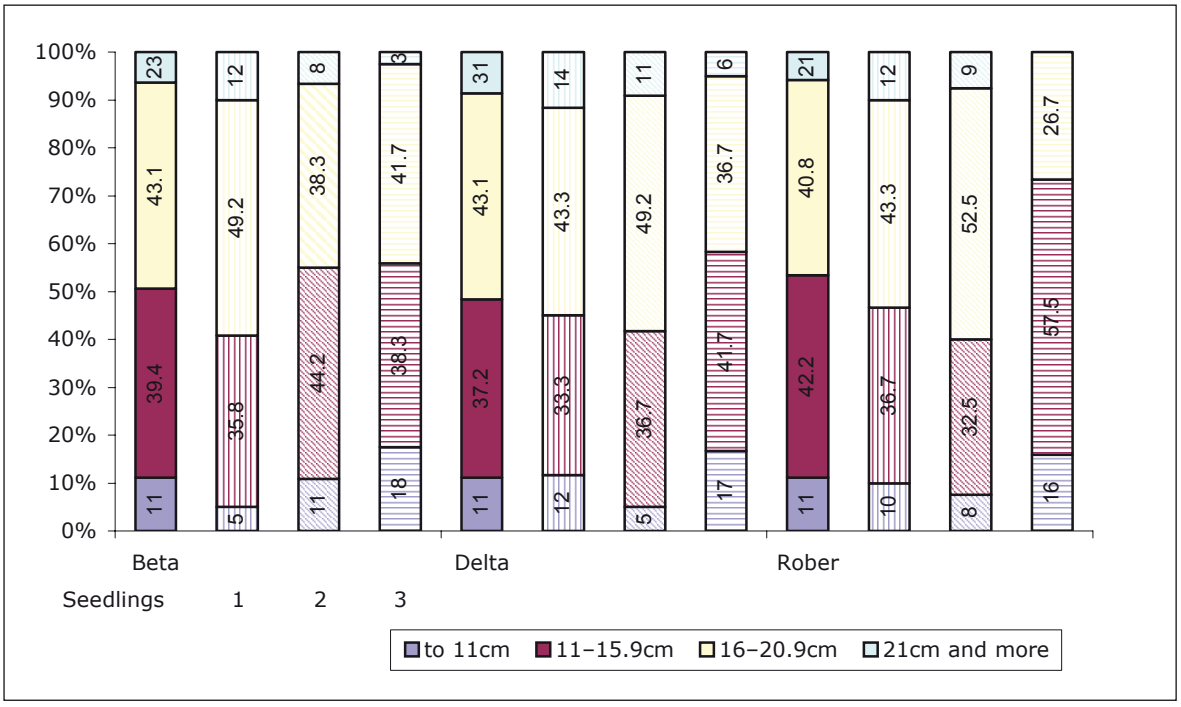
relatively smallest percentage of non-standard heads of quality class I. (up to 500 g, resp. 11 cm, according to the standards CTS 46 3112 and 46 3113). Statistically nonevidential shortening of vegetation period with the use of seedlings flats with larger cells (Bodnar, Garton, 1996) was observed during experiments with white cabbage, savoy cabbage and cauliflower (Tab. VIII, IX, X).

Jones, Weston and Harmon (1991) ascertained in two-year experiments that the age of white cabbage preplanted seedlings influences neither the earliness nor total yield of harvested heads. The results of our experiments proved that the use of developmentally older seedlings of white cabbage and also savoy cabbage for the transplanting had a positive influence both to the harvest yield and earliness (Tab. VIII, X). The same authors also found out that the transplanting of developmentally older cauliflower seedlings (5–7 weeks) influences positively both the earliness and rosaces yield. In our experiments, more early harvests and highest yields were reached, on the other hand, in the case of developmentally younger plants transplanting (Tab. IX), which is in accordance with the findings of Lewandowska (1992). According to Vavrina (1998) the suitable length of seedlings preplanting from the viewpoint of optimum development stage reaching for cabbages seedlings is 4 to 6 weeks, longer preplanting time can cause slow growth and yield depressions (Lorenz and Maynard; 1988, *in* Vavrina, 1998).

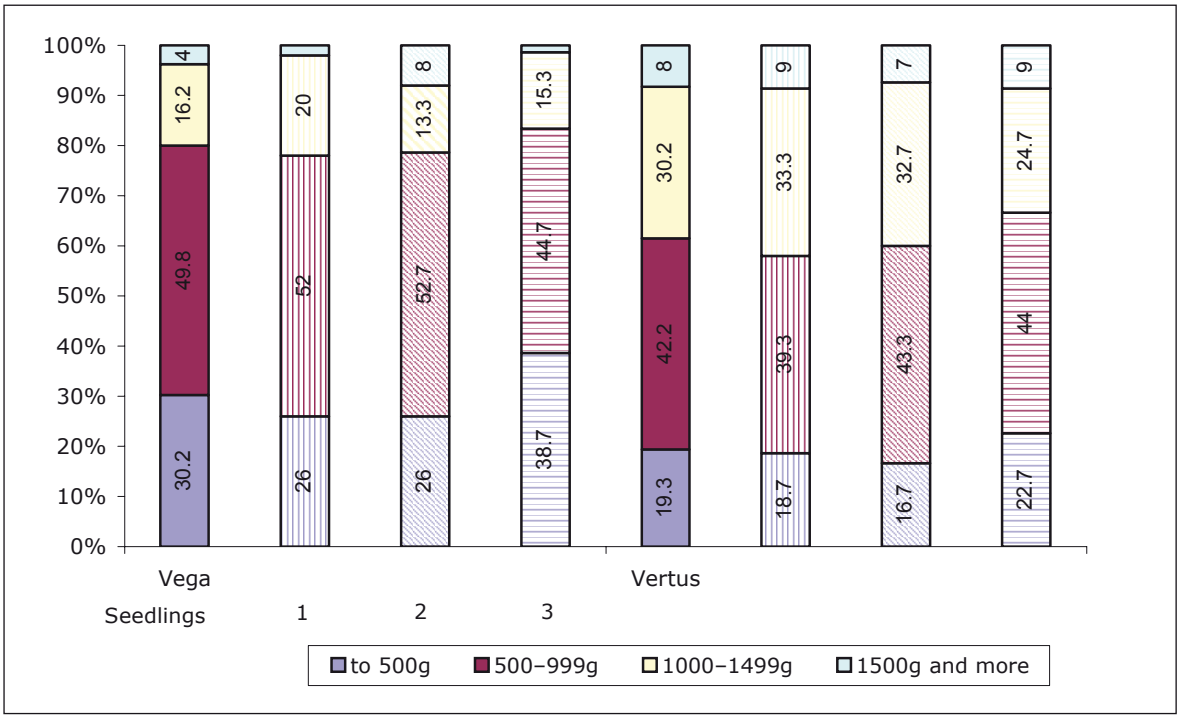
The results confirmed that the variety represents important factor for the cabbage production, having a fundamental influence to the variability of consumer plant parts values (in the range of 33 to 80% for white and savoy cabbage; Tab. IV). The genetic potential of varieties used in the series of experiments showed highly conclusive inter-varieties differences in the characteristics of harvested consumer plant parts in the interaction with environmental conditions (Tab. V, VI, VII). Consecutively, the interval classification of harvested plant parts proved (Fig. 1 to 3) that the lower percentage in the non-standard category and at the same time highest weight of harvested consumer parts was found for the white cabbage variety Midor (average head weight 1 554 g; non-standard percentage 22%) and for delayed savoy cabbage Vertus (894 g; 19.3%). As for the yield, the best cauliflower variety was Rober (490.5 g; the percentage of non-standard harvested rosaces was 11% for all varieties).



1: *The percentage of harvested heads of white cabbage classified into weight cathegories according to the variety and seedlings type used (2000–2002).*
Note: Seedlings 1 – seedling flats, cell 20 ml; seedlings 2 – seedling flats, cell 40 ml; seedlings 3 – pulled from patches



2: *The percentage of harvested cauliflower rosaces classified into size cathegories (rosace diameter) according to the variety and seedlings used (2000–2002).*
Note: Seedlings 1 – seedling flats, cell 20 ml; seedlings 2 – seedling flats, cell 40 ml; seedlings 3 – pulled from patches



3: *The percentage of harvested savoy cabbage heads classified into size cathegories according to the variety and seedlings used (2000–2002).*
Note: Seedlings 1 – seedling flats, cell 20 ml; seedlings 2 – seedling flats, cell 40 ml; seedlings 3 – pulled from patches

APPENDIX

IV: *The percentage of experimental factors in total variability of investigated characteristics of seedlings and consumer plant parts of cabbages (2000–2002)*

Parameters		Sources of variability					
		Species	**Year**	**Variety**	**Time of preplant.**	**Seedlings production technology**	**Interac. + error**
Seedlings	Hypocotyl diameter [mm]	White cabb.	23.0	1.3	41.7	13.7	20.4
		Cauliflower	42.9	2.8	37.7	7.7	8.9
		Savoy cabb.	46.1	0.1	34.7	1.8	17.3
	Leaves length [cm]	White cabb.	4.5	1.3	54.9	13.2	26.2
		Cauliflower	10.9	4.2	56.3	3.0	25.5
		Savoy cabb.	17.7	10.0	40.6	6.9	24.7
	Roots length [cm]	White cabb.	1.1	0.0	40.3	38.9	19.6
		Cauliflower	8.5	5.2	19.7	50.0	16.7
		Savoy cabb.	5.8	0.1	26.0	41.2	27.0
	Leaves weight [g]	White cabb.	6.5	0.9	60.2	11.4	21.0
		Cauliflower	13.2	1.3	60.2	16.2	9.1
		Savoy cabb.	22.1	0.0	50.0	3.9	23.9
	Roots weight [g]	White cabb.	15.1	0.0	40.8	28.2	15.9
		Cauliflower	24.1	9.6	16.9	38.4	10.9
		Savoy cabb.	23.6	0.8	45.0	17.8	12.7
Final production	Earliness [days]	White cabb.	22.6	26.6	37.6	0.3	12.8
		Cauliflower	1.5	11.1	72.6	0.2	14.6
		Savoy cabb.	3.4	6.2	70.0	2.4	18.1
	Head / rosace diameter [cm]	White cabb.	15.3	70.0	0.0	2.4	12.2
		Cauliflower	18.1	1.0	31.0	21.6	28.2
		Savoy cabb.	8.5	80.1	2.2	2.0	7.1
	Head / rosace weight [g]	White cabb.	19.4	60.2	4.6	4.2	11.6
		Cauliflower	10.7	4.6	5.0	25.5	54.1
		Savoy cabb.	28.2	33.4	13.5	4.7	20.1

V: *Variance analysis of investigated characteristics of seedlings and harvested heads of white cabbage (2000–2002)*

Source of variability/ parameters	d.f.	Seedlings					d.f.	Final product		
		Hypocotyl diameter [mm]	Length [cm]		Weight [g]			Earliness [days]	Head diameter [cm]	Head weight [g]
			leaves	roots	leaves	roots				
		MS						MS		
Y: Year	2	9.81 ***	281.4 ***	11.0 **	96.6 ***	2.9 ***	2	36417 ***	364.1 ***	12380545 ***
A: Variety	2	0.54 **	79.5 ***	0.1 NS	13.2 **	0.0 NS	2	42849 ***	1662.6 ***	38315470 ***
B: Transplant age	1	17.79 ***	3408.1 ***	401.7 ***	898.4 ***	7.7 ***	1	60494 ***	0.4 NS	2937947 **
C: Seedlings	2	5.87 ***	818.0 ***	387.5 ***	169.5 ***	5.3 ***	2	484 NS	57.5 ***	2674220 ***
YxA	4	1.41 ***	157.2 ***	6.1 *	31.1 ***	0.2 ***	4	4554 ***	75.2 ***	3330673 ***
YxB	2	1.66 ***	9.4 NS	10.9 **	18.5 ***	0.4 ***	2	6024 ***	74.4 ***	2465211 ***
AxB	2	0.03 NS	45.9 ***	11.9 **	1.5 NS	0.4 ***	2	4481 ***	102.5 ***	631989 NS
YxC	4	0.29 *	576.3 ***	122.3 ***	30.2 ***	0.7 ***	4	604 *	15.0 *	362965 NS
AxC	4	0.44 ***	21.7 ***	19.3 ***	9.0 ***	0.3 ***	4	789 **	7.4 NS	85537 NS
BxC	2	4.79 ***	811.2 ***	22.8 ***	221.5 ***	0.9 ***	2	3917 ***	8.9 NS	235014 NS
Error	514	*0.09*	4.4	2.3	1.8	0.0	1324	203	6.0	275626
Total	539						1349			

Legend: * α = *0.05* ** α = *0.01* *** α = *0.001* NS – not significant *MS – mean square*

VI: *Variance analysis of investigated characteristics of seedlings and harvested cauliflower rosaces (2000–2002)*

Source of variability/ parameters	d.f.	Seedlings					d.f.	Final product		
		Hypocotyl diameter [mm]	Length [cm]		Weight [g]			Earliness [days]	Rosace diameter [cm]	Rosace weight [g]
			leaves	roots	leaves	roots				
		MS						MS		
Y: Year	2	16.13 ***	580.8 ***	85.5 ***	60.6 ***	3.1 ***	2	4092 ***	367.6 ***	711619 ***
A: Variety	2	1.06 ***	225.8 ***	52.2 ***	6.1 ***	1.2 ***	2	30105 ***	20.2 NS	307773 **
B: Transplant age	1	14.19 ***	3003.8 ***	199.6 ***	275.6 ***	2.2 ***	1	197451 ***	627.9 ***	329177 *
C: Seedlings	2	2.90 ***	162.5 ***	505.6 ***	74.1 ***	4.9 ***	2	436 *	438.6 ***	1694598 ***
YxA	4	0.05 NS	74.6 ***	4.1 *	2.0 **	0.1 ***	4	499 **	67.1 ***	104625 NS
YxB	2	0.22 NS	15.1 NS	7.4 **	6.2 ***	0.4 ***	2	37237 ***	296.6 ***	2553513 ***
AxB	2	0.53 ***	18.3 *	13.1 ***	1.4 NS	0.2 ***	2	74 NS	85.5 **	580656 ***
YxC	4	1.78 ***	1117.4 ***	128.6 ***	19.0 ***	0.5 ***	4	1120 ***	49.6 **	180882 **
AxC	4	0.35 **	28.9 ***	4.5 *	2.1 **	0.1 ***	4	212 NS	43.6 **	103330 NS
BxC	2	0.34 *	103.8 ***	9.3 ***	10.6 ***	0.0 NS	2	465 *	16.5 NS	16640 NS
Error	514	0.08	5.0	1.5	0.5	0.0	1054	118	13.0	52046
Total	539						1079			

Legend: * α = *0.05* ** α = *0.01* *** α = *0.001* NS – not significant *MS – mean square*

VII: *Variance analysis of investigated characteristics of seedlings and harvested heads of savoy cabbage (2000–2002)*

Source of variability/ parameters	d.f.	Seedlings					d.f.	Final product		
		Hypocotyl diameter [mm]	Length [cm]		Weight [g]			Earliness [days]	Head diameter [cm]	Head weight [g]
			leaves	roots	leaves	roots				
		MS						MS		
Y: Year	2	14.77 ***	559.6 ***	40.1 ***	91.9 ***	4.1 ***	2	5095 ***	283.9 ***	5839240 ***
A: Variety	1	0.03 NS	315.8 ***	0.5 NS	0.2 NS	0.2 **	1	9319 ***	2663.6 ***	6915147 ***
B: Transplant age	1	11.13 ***	1281.4 ***	180.5 ***	208.3 ***	7.8 ***	1	105755 ***	72.6 **	2801160 ***
C: Seedlings	2	0.58 **	219.4 ***	286.4 ***	16.2 ***	3.1 ***	2	3642 ***	68.1 ***	974193 **
YxA	2	0.13 NS	67.3 ***	10.4 **	2.5 *	0.0 NS	2	11356 ***	46.1 **	1106131 ***
YxB	2	1.50 ***	62.8 ***	8.7 *	31.6 ***	0.6 ***	2	8385 ***	46.9 **	565619 *
AxB	1	0.41 *	12.6 NS	6.1 NS	2.1 NS	0.0 NS	1	3241 ***	30.0 NS	89800 NS
YxC	4	1.42 ***	433.4 ***	59.1 ***	28.2 ***	0.9 ***	4	440 NS	11.9 NS	207008 NS
AxC	2	0.44 **	60.6 ***	9.5 **	2.6 **	0.0 NS	2	4 NS	1.9 NS	89638 NS
BxC	2	1.55 ***	138.9 ***	92.1 ***	32.1 ***	0.6 ***	2	3678 ***	92.4 ***	1961620 ***
Error	340	0.09	5.7	1.9	0.7	0.0	880	230	8.4	146854
Total	359						899			

Legend: * α = *0.05* ** α = *0.01* *** α = *0.001* NS – not significant *MS – mean square*

VIII: *Average values of characteristics for white cabbage and results of factor level difference testing by Tukey test*

Experimental factor		Seedlings										Final product					
		Hypocotyl diameter [mm]		Leaves length [cm]		Roots length [cm]		Leaves weight [g]		Roots weight [g]		Earliness [days]		Head diameter [cm]		Head weight [g]	
		$\bar{x}$	V	$\bar{x}$	V	$\bar{x}$	V	$\bar{x}$	V	$\bar{x}$	V	$\bar{x}$	V	$\bar{x}$	V	$\bar{x}$	V
Year	2000	1.9 c	26.6	13.0 b	31.7	9.8 ab	34.6	2.3 b	76.2	0.3 c	67.6	174 a	9.4	14.0 c	26.7	1289 b	59.4
	2001	2.3 b	13.9	15.1 a	35.1	9.5 b	18.1	3.4 a	80.5	0.6 a	70.8	156 c	11.5	15.8 a	17.7	1215 b	40.6
	2002	2.5 a	17.1	15.2 a	31.6	10.0 a	15.5	3.6 a	68.5	0.5 b	56.6	165 b	12.9	15.0 b	38.0	1532 a	30.6
Variety	Aros	2.2 b	17.0	14.4 b	29.7	9.8 a	23.8	2.9 b	66.8	0.4 a	64.2	160 b	12.4	15.4 b	17.9	1471 b	42.7
	Midor	2.2 b	24.9	13.8 c	39.0	9.8 a	27.0	3.0 ab	98.2	0.5 a	71.8	160 b	13.9	16.4 a	17.5	1554 a	37.6
	Avak	2.3 a	19.9	15.1 a	31.9	9.8 a	21.9	3.4 a	66.4	0.5 a	76.2	177 a	6.4	12.9 c	44.8	1012 c	44.0
Transplant age	3-4 tr.l.	2.1 b	16.9	11.9 b	22.1	8.9 b	22.5	1.8 b	38.9	0.3 b	65.0	172 a	8.9	15.0 a	34.8	1299 b	46.6
	5-6 tr.l.	2.4 a	20.5	17.0 a	31.2	10.6 a	22.6	4.4 a	64.2	0.6 a	62.8	159 b	13.8	14.8 a	21.4	1392 a	43.5
Seedlings	20 ml	2.1 c	16.3	13.2 b	19.7	10.1 b	19.4	2.1 c	40.3	0.3 c	45.4	166 a	11.4	14.8 a	21.3	1334 b	43.0
	40 ml	2.2 b	12.9	13.2 b	20.2	11.1 a	17.2	3.1 b	42.9	0.6 a	52.7	164 a	12.7	15.2 a	20.3	1428 a	42.2
	Patch.	2.4 a	25.8	16.9 a	41.1	8.2 c	27.8	4.1 a	89.4	0.4 b	85.3	165 a	12.2	14.7 a	40.9	1276 b	49.6

Explanatory notes: Average values marked with different letters represent statistically important differences at the significance level 95%, V – variation coefficient (%)

IX: *Average values of characteristics for cauliflower and results of factor level difference testing by Tukey test*

Experimental factor		Seedlings										Final product					
		Hypocotyl diameter [mm]		Leaves length [cm]		Roots length [cm]		Leaves weight [g]		Roots weight [g]		Earliness [days]		Rosace diameter [cm]		Rosace weight [g]	
		$\bar{x}$	V	$\bar{x}$	V	$\bar{x}$	V	$\bar{x}$	V	$\bar{x}$	V	$\bar{x}$	V	$\bar{x}$	V	$\bar{x}$	V
Year	2000	1.8 c	25.8	11.7 c	51.7	8.6 c	37.0	1.4 c	83.9	0.2 c	97.3	122 b	8.8	16.5 a	29.5	510.3 a	66.4
	2001	2.2 b	11.8	15.1 a	21.3	9.2 b	17.4	2.5 a	57.8	0.5 a	56.8	128 a	23.1	15.7 b	24.5	422.3 b	43.5
	2002	2.4 a	14.1	14.5 b	28.7	10.0 a	15.5	2.3 b	46.5	0.4 b	50.8	128 a	13.8	14.5 c	19.7	455.0 b	43.1
Variety	Rober	2.1 b	20.5	12.6 c	36.1	8.9 b	24.0	1.9 b	66.2	0.3 b	72.7	131 a	15.7	15.4 a	24.8	490.4 a	56.4
	Delta	2.2 a	20.0	14.8 a	33.2	9.9 a	22.0	2.2 a	57.8	0.5 a	60.2	132 a	15.1	15.8 a	26.6	465.2 ab	55.7
	Beta	2.1 b	20.4	14.0 b	34.8	9.1 b	27.5	2.1 a	67.7	0.3 b	75.9	115 b	16.0	15.5 a	26.0	432.1 b	49.3
Transplant age	3-4 tr.l.	2.0 b	19.2	11.4 b	27.6	8.7 b	23.6	1.3 b	46.3	0.3 b	83.0	113 b	11.2	16.3 a	25.5	480.0 a	55.2
	5-6 tr.l.	2.3 a	18.8	16.1 a	31.7	9.9 a	24.3	2.8 a	52.1	0.4 a	58.9	140 a	13.5	14.8 b	25.2	445.1 b	53.3
Seedlings	20 ml	2.1 b	16.1	14.0 b	19.3	9.6 b	14.0	1.8 b	41.9	0.3 b	59.1	126 ab	16.1	16.4 a	25.4	496.8 a	52.3
	40 ml	2.3 a	14.9	14.6 a	26.6	10.8 a	16.4	2.8 a	52.8	0.5 a	53.7	125 b	16.8	16.0 a	24.4	507.3 a	53.8
	Patch.	2.1 b	27.4	12.7 c	53.7	7.5 c	31.4	1.6 c	82.8	0.2 c	68.4	127 a	16.9	14.3 b	25.8	383.6 b	51.7

Explanatory notes: Average values marked with different letters represent statistically important differences at the significance level 95%, V – variation coefficient (%)

X: *Average values of characteristics for savoy cabbage and results of factor level difference testing by Tukey test*

Experimental factor		Seedlings										Final product					
		Hypocotyl diameter [mm]		Leaves length [cm]		Roots length [cm]		Leaves weight [g]		Roots weight [g]		Earliness [days]		Head diameter [cm]		Head weight [g]	
		$\bar{x}$	V	$\bar{x}$	V	$\bar{x}$	V	$\bar{x}$	V	$\bar{x}$	V	$\bar{x}$	V	$\bar{x}$	V	$\bar{x}$	V
Year	2000	1.7 c	23.3	11.5 b	37.7	9.9 b	32.1	1.1 c	68.4	0.2 b	78.6	167 a	11.4	13.6 c	26.2	681.7 c	61.2
	2001	2.1 b	14.8	15.1 a	23.8	10.1 b	16.3	2.4 b	48.6	0.5 a	71.1	159 b	13.0	15.5 a	23.9	780.4 b	44.2
	2002	2.3 a	20.7	15.3 a	30.4	11.0 a	16.3	2.8 a	72.9	0.5 a	53.0	160 b	13.6	14.1 b	22.0	957.1 a	47.5
Variety	Vega	2.0 a	27.2	13.1 b	33.1	10.3 a	22.7	2.1 a	88.4	0.4 b	82.7	165 a	13.0	12.7 b	22.0	718.8 b	53.6
	Vertus	2.0 a	20.8	14.9 a	31.0	10.3 a	22.9	2.1 a	61.9	0.4 a	71.5	159 b	12.3	16.1 a	21.1	894.1 a	49.3
Transplant age	3-4 tr.l.	1.9 b	20.1	12.1 b	24.9	9.6 b	20.5	1.3 b	46.6	0.3 b	64.0	173 a	7.6	14.1 b	24.9	750.6 b	53.2
	5-6 tr.l.	2.2 a	24.1	15.9 a	31.9	11.0 a	22.5	2.9 a	65.8	0.6 a	63.9	151 b	14.1	14.7 a	24.3	862.2 a	51.0
Seedlings	20 ml	2.0 b	18.2	14.9 a	20.7	10.9 b	17.1	1.7 c	40.2	0.4 b	68.9	161 b	13.8	14.4 ab	24.4	828.3 b	49.8
	40 ml	2.0 b	18.3	12.4 b	22.5	11.4 a	18.4	2.1 b	51.1	0.6 a	65.6	159 b	13.5	14.8 a	23.2	849.2 a	51.7
	Patch.	2.1 a	32.0	14.6 a	44.3	8.5 c	23.0	2.5 a	97.3	0.3 c	68.1	166 a	10.7	13.9 b	26.2	741.7 c	55.4

Explanatory notes: Average values marked with different letters represent statistically important differences at the significance level 95%, V – variation coefficient (%)

SOUHRN

Vliv kvality sadby na parametry konzumních částí vybraných druhů košťálové zeleniny

Cílem práce bylo zhodnotit vztahy mezi znaky sadbového materiálu a kvantitativními parametry sklizňových částí rostlin u vybraných druhů a odrůd košťálové zeleniny: zelí hlávkového (*Brassica oleracea* L. convar. *capitata* (L.) Alef. var. *alba* DC.) – *Aros, Avak*, *Midor*; květáku (*Brassica oleracea* L. convar. *botrytis* (L.) Alef. var. *botrytis* L.) – *Beta, Delta, Rober* a kapusty hlávkové (*Brassica oleracea* L. convar. *capitata* (L.) Alef. var. *Sabauda* L.) – *Vega, Versus*. Polyfaktoriální pokusy byly zakládány v letech 2000 až 2002, polní část pokusů probíhala na pozemcích Školního zemědělského podniku Mendelovy zemědělské a lesnické univerzity v Žabčicích (kukuřičná výrobní oblast, podoblast K2, průměrná nadmořská výška 184 m n. m.). K výsadbě byly použity rostliny ve stadiu vývoje 3–4 a 5–6 pravých listů předpěstované třemi způsoby – technologií minisadby s počtem buněk na platě 160 a velikostí buňky 20 ml, minisadby s počtem buněk na platě 96 a velikostí buňky 40 ml a sadby trhané (záhonové). U sazenic byly před výsadbou hodnoceny následující znaky: šířka kořenového krčku [mm], délka listů a kořenů [cm] a hmotnost listů a kořenů [g]. Při sklizni byla sledována: délka vegetace – ranost [ve dnech], průměr [cm] a hmotnost konzumních částí rostlin [g]. Výsledky tříleté série pokusů prokázaly, že z hlediska utváření parametrů sadby sehrály u všech sledovaných druhů významnou roli především způsob a délka předpěstování sadby. V procesu tvorby ukazatelů finální produkce se jako nejvýznamnější faktor projevila u zelí hlávkového a kapusty hlávkové odrůda. Rozhodujícím faktorem variability hodnot průměru růžic květáku byla délka a technologie předpěstování sadby, která výrazně ovlivnila i variabilitu hmotnosti růžic. Relativně nejlepších výnosových výsledků bylo dosaženo v letech 2000 a 2002. Porovnání technologií výroby sadby ukázalo, že rostliny z minisadbovačů mezi sebou vykazovaly menší rozdíly v hodnotách znaků, než jaké byly zjištěny při srovnání minisadby se sadbou záhonovou. Mechanické „poškození“ kořenové fytomasy bylo hlavní příčinou jevu označovaného jako „přesazovací šok“. V porovnání s rostlinami předpěstovanými v minisadbovačích došlo u rostlin ze záhonové sadby k poklesu průměrného výnosu konzumních částí. Bylo zjištěno, že relativně nejmenší množství nestandardních sklizňových částí rostlin bylo v průměru získáno po výsadbě rostlin z větších minisadbovačů (objem buněk 40 ml, počet buněk na platě 96). Delší doba předpěstování (rostliny ve stadiu 5–6 pravých listů) znamenala i vyšší naměřené hodnoty sledovaných znaků sadbových rostlin a pozitivně ovlivnila výnos hlávek u zelí a kapusty. U květáku bylo v průměru průkazně lepších výnosů růžic a ranějších sklizní dosaženo po výsadbě mladších rostlin (3–4 pravé listy).

zelí, květák, kapusta, sazenice, sadba, technologie předpěstování sadby, zelenina

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