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YIELD AND CHEMICAL CONTENT OF CARROT STORAGE ROOTS DEPENDING ON FOLIAR FERTILIZATION WITH MAGNESIUM AND DURATION OF STORAGE

Jarosław Pobereżny, Elżbieta Wszelaczyńska, Anna Jadwiga Keutgen

Chair of Food Technology
University of Life Sciences in Bydgoszcz

Abstract

Yield amount, maturity stage, morphological as well as biological properties of carrot roots are cultivar-dependent. In 2007-2009, field experiments involving foliar fertilization of carrot with magnesium sulphate (acrid salts) on yield and selected yield constituents (dry matter, monosaccharides and total sugars) of carrot storage roots were conducted. Magnesium was applied in doses of 0, 45 and 90 kg MgO ha^{-1} in the form of 3% sprays during the intensive growth of carrot. The tested carrot belonged to five cultivars: medium-late Berjo and late Flacoro, Karotan, Koral and Perfekcja, all characterized by good shelf life.

The yields of carrot storage roots depended on a cultivar and foliar fertilization with magnesium. The cultivar Flacoro gave the highest yield of 60.82 t ha^{-1} and cv. Karotan – lowest (51.40 t ha^{-1}). The application of foliar magnesium fertilization during cultivation in the doses of 45 and 90 kg MgO ha^{-1} caused a significant increase of root yield of about 4.2 and 8.7%, respectively.

The content of dry matter, reducing sugars and total sugars was determined in carrot roots immediately after harvest and after six months of storage. Regardless of the experimental factors, storage roots of cv. Karotan contained the highest amount of dry matter (138.7 g kg^{-1}), reducing sugars (25.2 g kg^{-1}) and of total sugars (76.8 g kg^{-1}) based on fresh matter. Increasing fertilization with magnesium led to a significant increase in the content of all the analyzed constituents in carrot storage roots. The most successful was the dose of 45 kg MgO ha^{-1}, which caused the highest significant increment in dry matter, reducing and total sugars.

dr inż. Jarosław Pobereżny, Chair of Food Technology, University of Technology and Life Sciences in Bydgoszcz, Kordeckiego 20 bl. A, 85-225 Bydgoszcz, phone: 052 3749345, e-mail: poberezny@utp.edu.pl

The six-month storage of carrot roots caused a 2.6% increase in dry matter and an 11.2% rise in total sugars, but decreased reducing sugars by 11.1% (mean results for all cultivars and fertilization variants).

Key words: carrot, cultivar, foliar fertilization with magnesium, field, chemical content, storage.

PLONOWANIE I SKŁAD CHEMICZNY KORZENI SPICHRZOWYCH MARCHWI W ZALEŻNOŚCI OD NAWOŻENIA DOLISTEGO MAGNEZEM I CZASU PRZECHOWYWANIA

Abstrakt

Wielkość plonu, termin dojrzewania, cechy morfologiczne oraz biologiczne korzeni marchwi są zróżnicowane u poszczególnych odmian. W latach 2007-2009 przeprowadzono doświadczenie polowe dotyczące wpływu dolistnego dokarmiania siarczanem magnezu (sól gorzka) na wielkość plonu i wybrane składniki (sucha masa, cukry proste i ogółem) korzeni spichrzowych marchwi. Magnez zastosowano w dawkach: 0, 45 i 90 kg MgO ha^{-1} w formie 3% oprysku, w okresie intensywnego wzrostu marchwi. Obiektem badań było 5 odmian marchwi: średnio późna Berjo oraz późne: Flacoro, Karotan, Koral i Perfekcja, o dobrej trwałości przechowalniczej.

Plon korzeni spichrzowych marchwi zależał od odmiany i nawożenia dolistnego magnezem. Największy plon korzeni dała odmiana Flacoro – 60,82 t ha^{-1}, natomiast najmniejszy Karotan – 51,40 t ha^{-1}. Stosując podczas uprawy dolistne nawożenie magnezem w ilości 45 i 90 kg MgO ha^{-1}, uzyskano istotny wzrost plonu korzeni o 4,2 i 8,7%.

Zawartość suchej masy, cukrów redukujących i cukrów ogółem oznaczono w korzeniach marchwi bezpośrednio po zbiorze i po 6 miesiącach przechowywania. Niezależnie od czynników doświadczenia, korzenie spichrzowe marchwi odmiany Karotan zawierały najwięcej suchej masy – 138,7 g kg^{-1}, cukrów redukujących – 25,2 g kg^{-1} i cukrów ogółem – 76,8 g kg^{-1} w świeżej masie. Wzrastające nawożenie magnezem wpłynęło istotnie na wzrost zawartości wszystkich badanych składników w korzeniach spichrzowych marchwi. Najkorzystniejsza okazała się dawka 45 kg MgO ha^{-1}, która spowodowała najwyższy istotny wzrost zawartości suchej masy, cukrów redukujących i ogółem.

Okres 6 miesięcy przechowywania korzeni marchwi spowodował wzrost suchej masy o 2,6%, wzrost cukrów ogółem o 11,2% i spadek cukrów redukujących o 11,1% (średnio dla odmian i nawożenia).

Słowa kluczowe: marchew, odmiany, nawożenie dolistne magnezem, plon, skład chemiczny, przechowywanie.

INTRODUCTION

Vegetables are rich in nutrients, which stimulates a continuous rise in their production. Application of more intensive mineral fertilization certainly raises yields. But fertilization also has a significant influence on the biological value of vegetables. Excessive or deficient doses of fertilizers compared to the optimum, crop-specific requirements may cause physiological disorders and adversely influence the yield quality. One of the basic vegetables produced and consumed in Poland is carrot. The impact of basic NPK fertilization on yield and chemical content of carrot roots is thoroughly investigated (Kołota, Biesiada 2000, Nawirska, Król 2004, Wierzbicka et al. 2004, Smoleń et al. 2005, Dyśko, Kaniszewski 2007, Gajewski et al. 2007, Karkleliene et al. 2008, Gajewski et al. 2009, Smoleń, Sady 2009a,b, Gajewski et al. 2010, Majkowska-Gadomska, Wierzbicka 2010). It is also a well-known fact that carrot needs soils rich in magnesium, because a yield of 100 tons of fresh matter contains 21 kg of magnesium, of which about 15 kg falls on the marketable yield of roots. However, less is known about the influence of magnesium on changes occurring in carrot roots, and investigations in this area are rare (Smoleń, Sady 2009a,b).

Magnesium participates in the metabolism of carbohydrates, activates enzymatic changes and improves the resistance of plants to diseases, hence the present experiment was undertaken to evaluate the influence of foliar magnesium fertilization applied to chosen carrot cultivars on yield of storage roots and on their content on dry matter and sugars. Because most of the carrot yield is stored over autumn and winter, another aim of this study was to determine the yield quality over a prolonged storage period.

MATERIAL AND METHODS

The material was obtained from field experiments carried out at the Experimental Station in Mochełek (2007-2009), which belongs to the Faculty of Agriculture and Biotechnology at the University of Life Sciences in Bydgoszcz (the Province of Kuyavia and Pomerania). Field experiments were performed on light, slightly acid soil, poor in available P and K forms and very low in Mg (Table 1). Data about the temperature and precipitation during the vegetation time are presented in Figure 1. The year 2007 was most suitable for carrot cultivation. Less favourable for the growth and development of carrot was 2009, with much atmospheric precipitation and relatively low air temperatures. Furthermore, the worst was 2008, with prolonged droughts from April to June.

The experiments were set up in a split-plot design with three replications.

The Experimental design comprised:

I. Date of evaluation (after harvest, after storage)

II. Cultivars (medium-late Berjo, late: Flacoro, Karotan, Koral and Perfekcja)

III. Magnesium doses (0, 45, 90 kg MgO ha^{-1}) as magnesium sulphate (16%) under identical fertilization with nitrogen (70 kg N ha^{-1}), phosphorus (80 kg P_2O_5 ha^{-1}) and potassium (100 kg K_2O ha^{-1}). Foliar fertilization with magnesium was applied twice during the intensive growth of plants (July, August) as an aqueous solution of magnesium sulphate (3%) in the amount of 300 dm^3 ha^{-1}.

Table 1

Chemical content of soil before field experiments in 2007-2009

Parametr	Unit	Year of cultivation			Reaction/ /abundance
		2007	2008	2009	
pH H_2O	-	6.6	6.5	6.7	slightly acid soil
pH KCl	-	6.0	5.9	6.1	
Organic carbon	(g kg^{-1})	7.65	7.80	7.55	-
Total nitrogen	(g kg^{-1})	0.72	0.69	0.75	-
Available forms of phosphorus	(mg kg^{-1})	24.0	23.0	25.0	low abundance
Available forms of potassium	(mg kg^{-1})	42.0	43.0	45.0	low abundance
Available forms of magnesium	(mg kg^{-1})	18.5	20.0	17.0	very low abundance

Agro-technical treatments against plant diseases and pests were performed as required for carrot, i.e. in each year, seeds were treated with the seed dressing preparation Funaben T and the herbicide Stomp 330 EC was applied at the pre-emergence stage. During the growing season, carrot fields were manually weeded. Storage roots of carrots were harvested when fully ripe (the 1st decade of October). In order to evaluate the total yield in t ha^{-1}, the mass of roots after harvest was weighed and samples of roots from each plot were taken for analytical and storage investigations. Samples were stored in a traditional earthen mound for 6 months. Chemical content of carrot was determined with the following methods:

1. Dry matter content – oven method after Pijanowski,
2. Content of monosaccharides and total sugars – after PN-90/A-75101/07.

The results of the 3-year-long experiment were statistically verified using the method of variance analysis. The significance of differences was evaluated with the Tukey's multiple confidence intervals at the significance level of α=0.05. Coefficients of linear correlation were calculated between the evaluated quality parameters of carrot yields.

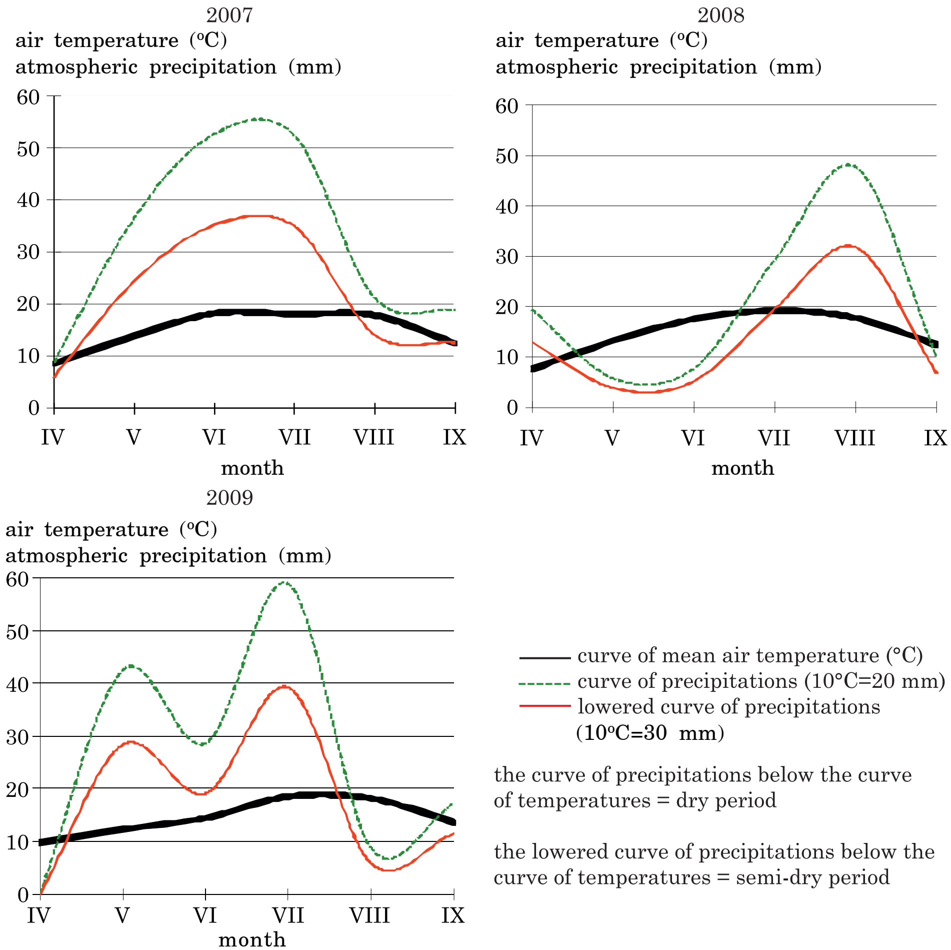

Fig. 1. Meteorological conditions according to Walter

RESULTS AND DISCUSSION

The main factors determining the yield and chemical composition of storage roots of carrot are the genotype, meteorological conditions and cultivation method (Kołota, Biesiada 2000, Alasalvar et al. 2001, Wierzbicka et al. 2004, Dyśko, Kaniszewski 2007, Majkowska-Gadomska et al. 2007, Kaniszewski, Dyśko 2008, Smoleń, Sady 2009a,b, Karkleliene et al. 2009, Majkowska-Gadomska, Wierzbicka 2010). Our results confirm the above because high significant differences were observed not only between the cultivars but also between years (Table 2). In 2007 and 2009, which were characterized by good climatic conditions for carrot cultivation (Figure 1), the yields were the highest: 67.42 and 55.36 t ha^{-1}, respectively These results confirm the findings by Dobrzański et al. (2008), who verified the influence of weather conditions on carrot yield volumes. These authors obtained the mean total carrot yield of 85.0 t ha^{-1} in 2007, favorable for carrot cultivation, and just 45.0 t ha^{-1} in less favourable 2006. Similar results were observed by Majkowska-Gadomska et al. (2007) in experiments with other cultivars in 2003-2004.

Irrespective of the year and magnesium fertilization level, out of the five cultivars, Flacoro and Berjo produced the highest yield of carrot storage roots: 60.82 t ha^{-1} and 58.22 t ha^{-1}, respectively. The lowest yield were produced by Karotan (51.40 t ha^{-1}). Majkowska-Gadomska et al. (2007), in their two-year-long experiments on yields of nine cultivars additionally fertilized with the multinutrient fertilizer Ekosol U during thegrowing season, found the highest mean yield for cv. Florida F_1 (77.2 t ha^{-1}) and the lowest one, same as in our research, for cv. Karotan (63.5 t ha^{-1}). Smoleń, Sady (2009a), who conducted an experiment in 2006-2007 on the cultivar Kazan F_1, determined the mean yield value at the level of 78.0 t ha^{-1} regardless of the applied factors. In another experiment, completed by of Majkowska-Gadomska et al. (2007), the cultivar Kazan F_1 yielded comparably high, that is 72.8 t ha^{-1}.

The applied foliar fertilization with magnesium caused a significant increase of yields of carrot storage roots from all the cultivars (Table 2). The increase was observed in each year. The highest yield was reached by the carrot cultivars Flacoro, Berjo and Perfekcja: 63.22, 60.99 and 60.95 t ha^{-1} (magnesium dose 90 kg MgO ha^{-1}), respectively. Majkowska-Gadomska, Wierzbicka (2010) observed a 6.2% increase in the total root yield and a high, 39.6% increase in the marketable yield of three carrot cultivars owing to the soil application of nutrients in the in form of the fertilizer Crop Care containing magnesium. Moreover, Smoleń et al. (2005), who used the complex fertilizer Supervit-R, also containing magnesium, demonstrated a positive influence of foliar nutrition on the total and marketable yield of carrot roots. There are also exists reports which indicate that foliar fertilization of some vegetables with multi-component fertilizers, in some combinations, decrease yields, which has been shown in the case of potato, parsley and cucumber by Jaskulski (2005).

The results of our analyses of the chemical composition of carrot roots showed some significant differences between the cultivars in the content of dry matter and total sugars (Tables 3, 4). However, no significant differences were found in the content of monosaccharides (Table 5). After Holden et al. (1999), carrot roots contain about 120.0 g kg^{-1} of dry matter and 45.0 g kg^{-1} of total sugars. In the present investigations, the highest content of dry matter and total sugars was determined in storage roots of the cultivar Karotan (137.2 and 82.0 g kg^{-1}) and the lowest one was in cv. Berjo (121.4 and 72.4 g kg^{-1}). Gajewski et al. (2007) investigated six cultivars of carrots, other than in the present experiment, but also found significant

Table 2

Yield of carrot storage roots – mean value for three years of experiment (t ha^{-1})

Cultivar (A)		Fertilization MgO kg ha^{-1} (B)			
		0	45	90	mean
Berjo	2007	68.57	69.67	73.00	70.41
	2008	44.37	48.57	50.57	47.84
	2009	53.40	56.41	59.41	56.41
	mean	55.45	58.22	60.99	58.22
Flacoro	2007	71.48	72.24	76.29	73.34
	2008	48.90	49.83	51.67	50.13
	2009	56.96	58.33	61.71	59.00
	mean	59.11	60.13	63.22	60.82
Karotan	2007	57.10	60.38	62.76	60.08
	2008	41.10	42.50	43.77	42.46
	2009	49.41	51.49	54.11	51.67
	mean	49.20	51.46	53.55	51.40
Koral	2007	57.24	64.48	64.86	62.19
	2008	47.9	51.17	52.67	50.58
	2009	51.64	56.74	57.37	55.25
	mean	52.26	57.46	58.30	56.01
Perfekcja	2007	68.43	69.52	75.33	71.09
	2008	44.83	45.33	49.57	46.58
	2009	52.43	53.04	57.94	54.47
	mean	55.23	55.96	60.95	57.38
Mean	2007	64.56	67.26	70.45	67.42
	2008	45.42	47.48	49.65	47.52
	2009	52.77	55.20	58.11	55.36
	mean	54.25	56.65	59.40	56.77
$LSD_{\alpha=0.05}$		B/A = 1.63 A/B = 8.21			

differences between the cultivars in the content of dry matter and total sugars. The mean content of dry matter and total sugars in the experiments of the aforementioned authors ranged from 95.0 g kg^{-1} to 150.0 g kg^{-1} of dry matter and from 40.0 g kg^{-1} to 70.0 g kg^{-1} of total sugars. Furthermore, the experiments showed that the cultivars containing most of dry matter were also characterized by the highest concentration of total

Table 3

Content of dry matter in carrot roots – mean of three years of experiments (g kg^{-1})

Date of investigation (A)	Cultivar (B)	Fertilization MgO kg ha^{-1} (C)			Mean
		0	45	90	
Immediate after harvest	Berjo	119.3	122.3	122.7	121.4
	Flacoro	118.2	123.1	127.7	123.0
	Karotan	131.8	137.9	141.8	137.2
	Koral	132.6	136.1	138.0	135.6
	Perfekcja	130.7	132.0	136.6	133.1
	mean	126.5	130.3	133.4	130.1
After storage	Berjo	122.3	125.1	125.9	124.4
	Flacoro	121.7	128.1	131.9	127.2
	Karotan	135.1	141.4	144.0	140.2
	Koral	134.2	141.4	142.2	139.3
	Perfekcja	133.1	136.4	138.5	136.0
	mean	129.3	134.5	136.5	133.4
Mean		127.9	132.4	134.9	131.7
$LSD_{\alpha=0.05}$		A = n.s.* B/A = n.s. A/C = n.s.	B = 7.29 A/B = n.s. C/B = n.s.	C = 1.51 C/A = n.s. B/C = n.s.	

*n.s. – not significant

sugars and this is in accordance with the results of our investigations. Similar dependencies were found by GAJEWSKI et al. (2010). PRĘDKA, GRONOWSKA-SENGER (2009), who examined carrot roots of the cultivar Nantejska grown in organic and conventional farming, found the content of dry matter 128.4 and 110.8 g kg^{-1} for raw and 121.8 and 112.3 g kg^{-1} for cooked carrot, respectively. RUTKOWSKA (2005) completed similar investigations with three cultivars Perfekcja, Koral and Regulska and obtained an average 137.2 g kg^{-1} of dry matter under organic farming and 127.8 g kg^{-1} in conventional cultivation. In her experiments, storage roots of cv. Perfekcja and Koral had less dry matter and total sugars than in our investigations, which can be the result of the positive response of carrot to foliar fertilization with magnesium, owing to the its role in the synthesis of sugars. However, DOBRZAŃSKI et al. (2008), who tested different growth stimulators on the carrot cultivar Nerac F_1, obtained an average of 123.0 g kg^{-1} of dry matter, 59.0 g kg^{-1} of total sugars and 18.2 g kg^{-1} of monosaccharides, irrespective of the experimental factors.

According to PRĘDKA, GRONOWSKA-SENGER (2009), the content of dry matter and sugars in vegetables depends not only on the cultivar, soil properties or

Table 4

Content of total sugars in fresh matter of carrot roots – mean for three yea of experiments (g kg^{-1})

Date of investigations (A)	Cultivar (B)	Fertilization MgO kg ha^{-1} (C)			Mean
		0	45	90	
Immediately after harvest	Berjo	65.8	74.2	77.3	72.4
	Flacoro	68.2	76.0	77.3	73.8
	Karotan	75.2	83.7	87.2	82.0
	Koral	75.9	79.2	84.1	79.7
	Perfekcja	71.5	73.2	75.1	73.3
	mean	71.3	77.3	80.2	76.3
After storage	Berjo	57.5	67.6	71.6	65.6
	Flacoro	61.7	68.2	69.4	66.4
	Karotan	65.9	71.2	77.5	71.5
	Koral	67.1	70.5	74.6	70.7
	Perfekcja	62.8	64.4	66.8	64.7
	mean	63.0	68.4	72.0	67.8
Mean		67.2	72.8	76.1	72.0
$LSD_{\alpha=0.05}$	A = 1.79 B/A = n.s. A/C = n.s.	B = 8.66 A/B = n.s. C/B = n.s.	C = 2.74 C/A = n.s. B/C = n.s.		

n.s. – not significant

weather conditions during the growing season, but also on the type and amount of mineral nutrition. Our own investigations confirm it, because the applied foliar fertilization caused changes in the content of the analyzed compounds. Each of the applied magnesium doses caused a significant increase in the content of dry matter and total sugars, which are its main component. Similar results were obtained in a trial by MAJKOWSKA-GADOMSKA, WIERZBICKA (2010), where carrots were soil fertilized with the multi-component fertilizer Crop Care. In the experiments of these authors, this increase was 5.4% for dry matter and 5.3% for total sugars. However, RUTKOWSKA (2005) claims that the chemical composition of vegetables is first and foremost determined genetically, and then by the method and conditions of cultivation. Although the author observed different content of dry matter and sugars in vegetables (potato, carrot) grown with different methods (organically and conventionally), the differences were not statistically proven.

Most of the carrot produced in Poland is stored before consumption, for up to 6 to 8 months, depending on a cultivar and the quality of carrot yield (GAJEWSKI et al. 2010). After KARKLELIENE et al. (2008), the lack of stable mois-

Table 5

Content of monosaccharides in fresh matter of carrot roots – mean for three years of experiments (g kg^{-1})

Date of investigations (A)	Cultivar (B)	Fertilization MgO kg ha^{-1} (C)			Mean
		0	45	90	
Immediately after harvest	Berjo	23.4	23.2	25.0	23.9
	Flacoro	23.1	24.1	25.9	24.4
	Karotan	21.6	22.5	25.0	23.0
	Koral	23.4	25.2	26.2	24.9
	Perfekcja	21.4	22.5	24.2	22.7
	mean	22.6	23.5	25.3	23.8
After storage	Berjo	23.7	24.7	26.0	24.8
	Flacoro	26.1	26.4	27.1	26.5
	Karotan	26.9	27.5	28.0	27.5
	Koral	26.2	26.6	27.3	26.7
	Perfekcja	25.1	26.9	27.2	26.4
	mean	25.6	26.4	27.1	26.4
Mean		24.1	25.0	26.2	25.1
$LSD_{\alpha=0.05}$	A = n.s. B/A = n.s. A/C = n.s.	B = n.s. A/B = n.s. C/B = n.s.	C = 0.65 C/A = n.s. B/C = n.s.		

n.s. – not significant

ture conditions during the intensive growth of carrot roots may impair the quality and resistance of these roots to decay during their storage. In turn, SUOJALA (2000), SELJASEN et al. (2001), GAJEWSKI et al. (2009, 2010) state that the storage conditions are among the most important factors affecting the quality of carrot roots. ZIMOCH-GUZOWSKA, FLIS (2006), BOMBIK et al. (2007), WSZELACZYŃSKA et al. (2007), POBEREŻNY, WSZELACZYŃSKA (2011) report that the scale of changes in dry matter and sugar content in vegetables depends first of all on a cultivar, fertilization during the vegetative growth, and on the duration and temperature of storage. In the present experiments, after six months of storage, the increase in the dry matter content was 2.2% for cv. Koral and Perfekcja to 3.4% for Flacoro (Figure 2). GAJEWSKI et al. (2010), in their storage experiment on eight carrot cultivars with different coloration (white, orange and purple), after 6 months of storage, obtained similar to our results with respect to the increase in the dry matter content (an average for all the cultivars 1.5%), but the results were not statistically proven. Such a small difference is probably the result of different storage conditions, because the water transpiration rate is higher in a mound than in a con-

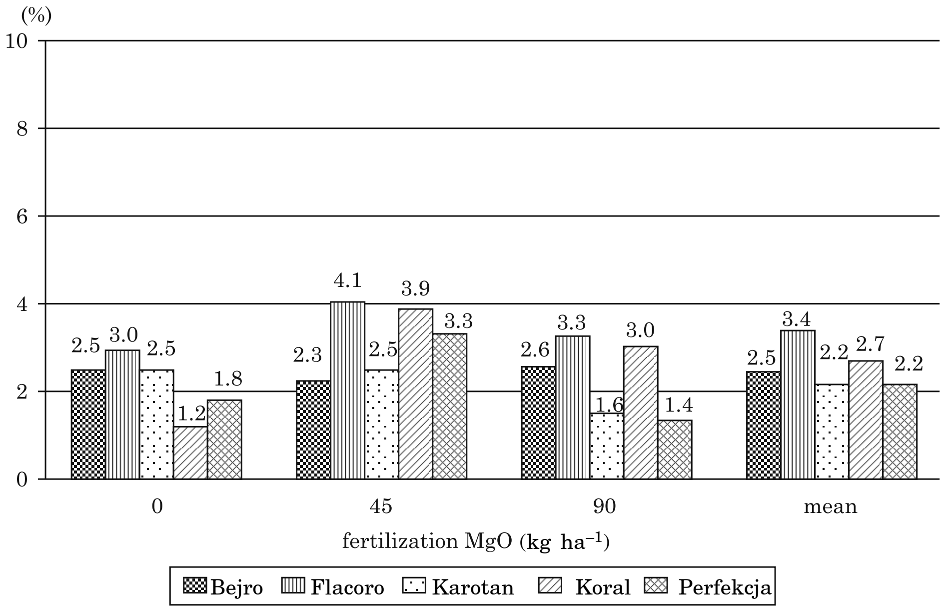

Fig. 2. Changes in percentages of dry matter content in carrot roots depending on a cultivar, fertilization and storage duration – mean value for 2007-2009

trolled environment. In the research by NAWIRSKA, KRÓL (2004), who analyzed the chemical content of roots of four carrot cultivars (Nantejska, Perfekcja, Dolanka, Flacoro) stored in a cool room for 60 days, detected a much lower mean value of the content of dry matter (21.9%) as well as the total sugars (20.7%) but a higher content of reducing sugars (8%) than in our experiment (Tables 3-5). In turn, the differences for the cultivars Perfekcja and Flacoro in dry matter and total sugars were 16.5 and 25.4 % as well as 0.6 and 34.9%, respectively. It can be presumed that such differences are caused by the cultivation method, mainly fertilization, which in our experiments was higher and more complex (additional fertilization with magnesium). It can be also concluded the above authors probably detected a lower content of dry matter and sugars in carrot roots immediately after harvest than in our research, although no such information is given in the cited articles.

The dry matter content in storage roots of the tested carrot cultivars after six-month storage in relation to the applied fertilization with magnesium was modestly different than after harvest. In this respect, 45 kg MgO ha^{-1} was most successful in raising the dry matter content after storage (Figure 2). However, it should be underlined that the presented dry matter losses are the calculated and not the real ones, which should also reflect the fresh mass losses of roots (POBEREŻNY, WSZELACZYŃSKA 2011).

The results on total sugars are contrary (Figure 3). After the long-term storage, a significant loss of total sugar was determined, which is in accordance with the results of SUOJALA (2000). In contrast, GAJEWSKI et al. (2010) obtained a significant increase in these compounds. This discrepancy could have been caused by higher temperature during the storage in a mound, which accelerates degradation of oligosaccharides

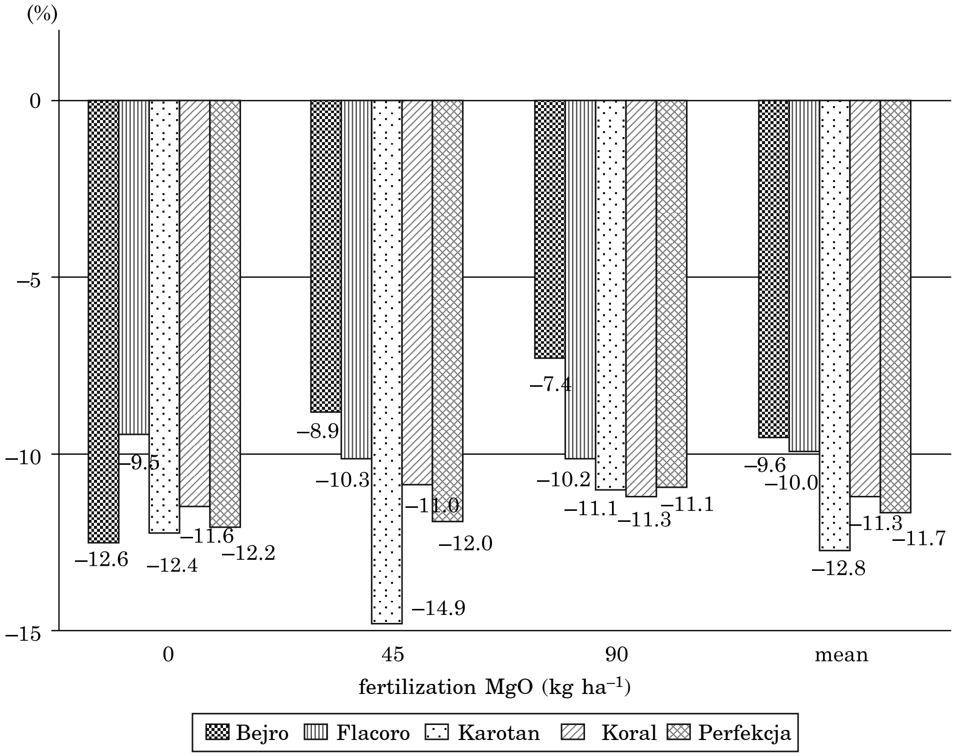

Fig. 3. Losses as percentage of total sugar content in carrot roots depending on a cultivar, fertilization and storage duration – mean value for 2007–2009

It is known that during storage decomposition exceeds synthesis. In contrast to the decrease in total sugars in all the investigated cultivars, the content of reducing sugars went up (Figure 4). This coincides with the opinion of SUOJALA (2000), who noticed that during storage the following changes in saccharides occur: there are less oligosaccharides but more monosaccharides. The increase in monosaccharides could be affected not only by a high and unstable temperature in a mound, accelerating respiration processes, but also by the intensive growth of leaves and forking at the end of storage.

The results of linear correlation are given in Tables 6 and 7. As seen in Table 6, the quantities of yield were negatively correlated with the content

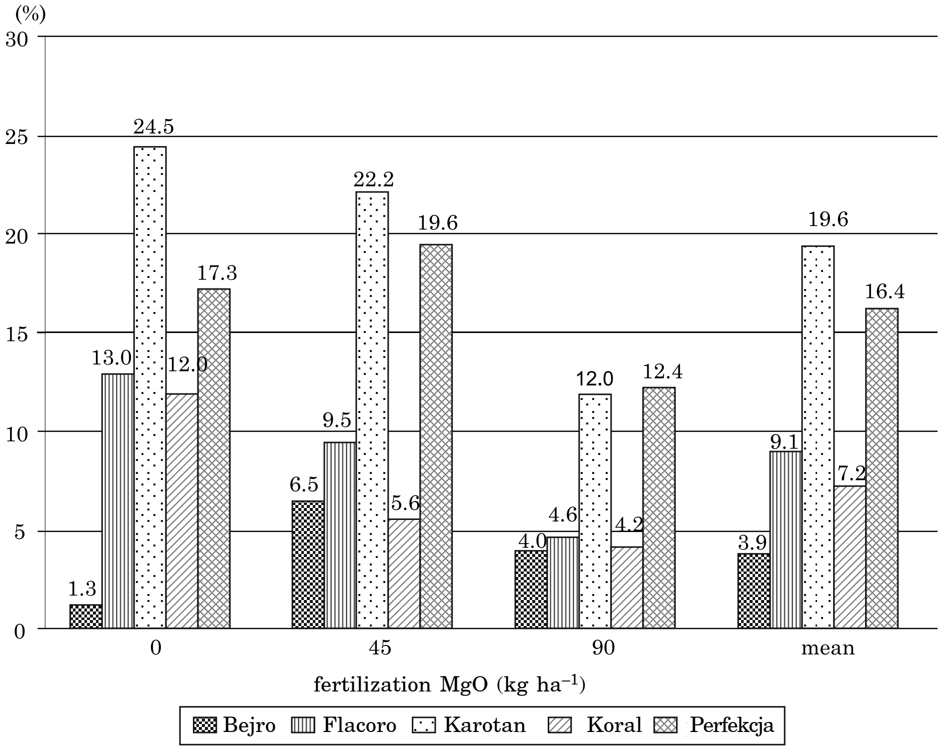

Fig. 4. Changes in percentage of monosaccharides in carrot roots depending on a cultivar, fertilization and storage duration – mean value for 2007-2009

Table 6

Significant correlation coefficients between the investigated parameters after harvest

Parameter		2.	3.	4.
1.	Field of storage roots	-0.498	0.614	
2.	Content of dry matter			0.773
3.	Content of monosaccharides			0.502
4.	Content of total sugars			

$P_{0.05}$ $r = 0.497$

Table 7

Significant correlation coefficients between the investigated parameters after harvest

Parameter		2.	3
1.	Content of dry matter	0.767	0.659
2.	Content of monosaccharides		
3.	Content of total sugars		

$P_{0.05}$ r = 0.497

of dry matter (r=-0.498) and positively with the content of monosaccharides (r=0.614). This means that the increase in the total yield of carrot storage roots resulted in lower dry matter but higher content of monosaccharides.

The total sugar content was positively correlated with the content of dry matter (r=0.773) and with reducing sugars (r=0.502). A similar albeit stronger dependency was also observed after storage (Table 7), i.e. r=0.767 for dry matter and r=0.659 for monosaccharides. This result is obvious because sugars are the main component of dry matter.

CONCLUSIONS

1. Irrespective of the years and magnesium fertilization level, the highest yield of storage roots of carrot was obtained from the cultivars Flacoro and Berjo; the lowest one was produced by cv. Karotan.

2. Each of the applied doses of magnesium resulted in a significant increase in the yield of carrot storage roots. The most successful was the dose of 45 kg MgO ha^{-1}, where the highest increase of yield was achieved.

3. Storage roots of carrot of cv. Karotan contained most of the dry matter and total sugars; the cultivar Berjo had the lowest content of dry matter and sugars.

4. Increasing fertilization with magnesium caused a significant increase in the dry matter content, reducing and total sugars in carrot storage roots, and the dependencies remained detectable after storage. The dose of 45 kg MgO ha^{-1} proved to be the most effective.

5. Six-month storage time caused an increase in dry matter and total sugars content and a decrease in reducing sugars in carrot roots.

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