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EFFECT OF DIFFERENT NITROGEN FERTILIZATION REGIMES ON THE CHEMICAL COMPOSITION OF FIELD-GROWN EGGPLANTS

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Abstract

Eggplant is a vegetable which deserves our interest owing to its high nutritive value and a wide range of possible cooking recipes. The biological value of this vegetable depends on several biotic and abiotic factors. The aim of this research has been to determine the effect of nitrogen fertilization methods on the quality of eggplant fruits.

Application of ammonium sulphate, ammonium nitrate and Entec 26, a slow-release fertilizer containing a nitrification inhibitor, was tested in a three–factorial experiment. The fertilizers were applied once, before planting, making use of the whole dose (100, 150 and 200 kg N ha^{-1}), or twice, divided into a dose given before the growing period and another one supplied as top dressing (75+25, 100+50, 100+100 kg N ha^{-1}). The eggplant fruits contained on average 6.80% – 8.06% of dry matter, 1.85-2.48% of reducing sugars and 2.00--2.56% of total sugars, 10.58 mg 100 g^{-1} f.m. of vitamin C, 4.27-6.56 mg 100 g^{-1} f.m. of anthocyanins, 50.70-71.06 mg 100 g^{-1} f.m. of polyphenols. The mean content of P in dry matter was 0.33%, K – 3.99%, Mg – 0.25% and Ca – 0.25%. Significant differences in the quality of eggplant fruits were demonstrated between particular years of cultivation. The biological value of eggplant fruits did not depend on the method of nitrogen fertilization.

Key words: *Solanum melongena* L., Entec 26, ammonium sulphate, ammonium nitrate, biological value.

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WPŁYW ZRÓŻNICOWANEGO NAWOŻENIA AZOTEM NA SKŁAD CHEMICZNY OWOCÓW OBERŻYNY W UPRAWIE POLOWEJ

Abstrakt

Oberżyna zasługuje na zainteresowanie ze względu na dużą wartość odżywczą oraz szerokie możliwości przygotowania do konsumpcji. Jej wartość biologiczna zależy od wielu czynników biotycznych i abiotycznych. Celem badań było określenie wpływu sposobu nawożenia azotem na jakość owoców tego warzywa.

W trzyczynnikowym doświadczeniu polowym zastosowano siarczan amonu, saletrę amonową i nawóz Entec 26 o przedłużonym działaniu, zawierający inhibitor nitryfikacji. Nawożenie wykonano jednorazowo przed posadzeniem roślin, stosując całą dawkę (100, 150 i 200 kg N ha^{-1}), lub podzielono ją na przedwegetacyjną oraz pogłówną (75+25, 100+50, 100+100 kg N ha^{-1}). Owoce oberżyny zawierały średnio 6.80-8.06% suchej masy, 1.85-2.48% cukrów redukujących oraz 2.00-2.56% cukrów ogółem, 10.58 mg 100g^{-1} ś.m. witaminy C, 4.27-6.56 mg 100 g^{-1} ś.m. antocyjanów, 50.70-71.06 mg 100 g^{-1} ś.m. polifenoli. Zawartość P w suchej masie wynosiła średnio 0.33%, K – 3.99%, Mg – 0.25%, Ca – 0.25%.

Wykazano istotne zróżnicowanie wartości biologicznej owoców oberżyny w poszczególnych latach uprawy. Nie zależała ona od sposobu nawożenia azotem.

Słowa kluczowe: *Solanum melongena* L., Entec 26, siarczan amonu, saletra amonowa, wartość biologiczna.

INTRODUCTION

Eggplant (*Solanum melongena* L.) is a vegetable that is not commonly grown in Poland, although it deserves much more attention owing to its excellent nutritive value and a wide range of culinary uses. Technologies for growing eggplants in plastic tunnels or greenhouses have been improved (Markiewicz et al. 2008, Michałojć, Buczkowska 2008, Buczkowska 2010), but field production under Poland's prevalent climatic conditions remains rather difficult. For eggplant cultivation to be successful, several conditions must be satisfied. Above all, a suitable cultivar must be selected (Raigon et al. 2010). Beside, the weather conditions (Chen, Li 1997, Kashyap et al. 2003), and the type and soil fertility should be adequate. Eggplant plantations are most successful on sandy loam with a high organic matter content and abundance of mineral compounds (Chen, Li 1997). Both biotic and abiotic factors influence the content of different components in vegetables (Biesiada, Tomczak 2012). Among the most important factors is the cultivation regime, mainly nitrogen fertilization, which determines the quality of vegetables. Kaufmann and Vorwerk (1971) reported that eggplants grown in plastic tunnels and greenhouses have a higher demand for nutrients than tomatoes. Rosati and Troisi (2001) determined the maximum dose of nitrogen for field cultivation at 250 kg ha^{-1}. With this dose of N fertilization, the N uptake reached 200 kg ha^{-1}, of which 39% was used up effectively. Aminifard et al. (2010) reported 100 kg N ha^{-1} as an optimum dose. For field cultivation, Rosati and MAGNIFICO (2001) recommend to divide the whole dose of nitrogen into two batches: one applied before the growing period and the other one given in a top dressing treatment early as possible.

Apart from splitting a nitrogen dose, another way to improve the efficiency of nitrogen fertilization to vegetables and to reduce nitrogen leaching from soil is by using slow-release fertilizers., e.g. Entec 26, which ensure good results of cultivation of different vegetables (HÄHNDEL, ZERULLA 2001, PASDA et al. 2001, KOŁOTA, ADAMCZEWSKA-SOWIŃSKA 2006a, b, 2007, 2008). The phytoavailability of slow-release fertilizer is adjusted to particular plant development stages. Entec 26 is a mixture of ammonium sulphate and ammonium nitrate containing 7.5% $N\text{-}NO_3$, 18.5% $N\text{-}NH_4$ and 13% S. In addition, it includes a stabilizer of the ammonium form of nitrogen, DMPP (3,4--dimethyl pirazole phosphate), which inhibits the nitrification process for about 4 to 10 weeks.

Considerable differences between recommended eggplant fertilization regimes appear because both specific conditions and the type of cultivation must be taken account of when making a fertilization plan. The scarcity of information about nutrition of this vegetable species or about the influence of fertilization on the biological quality of eggplant yield encouraged us to conduct a study whose aim was to determine effects of different nitrogen fertilization technologies on the chemical composition of eggplant fruits.

MATERIAL AND METHODS

The study was carried out in 2010-2011, at the Station of Research on Vegetables and Ornamental Plants, which belongs to the Department of Horticulture at the Wroclaw University of Environmental and Life Sciences. A three-factorial field experiment with nitrogen fertilization of eggplants was established in a randomized split-plot design with three replications. The first factor consisted of the following types of fertilizer: ammonium sulphate $(NH_4)_2SO_4$ (20.5% N, 25% S), ammonium nitrate N - NH_4NO_3 (34% N) and the slow-release fertilizer Entec 26 $N\text{-}NH_4NO_3^-$ $(NH_4)_2SO_4$, (26% N, including 7.5% $N\text{-}NO_3$ and 18.5% $N\text{-}NH_4$; 13% S). The second factor was a nitrogen dose (100, 150, 200 kg N ha^{-1}), while the third factor corresponded to how the nitrogen dose was applied. Fertilization was performed once, before planting eggplants, using the whole nitrogen dose, or twice, dividing the N dose into two batches: 75+25 kg N ha^{-1}, 100+50 kg N ha^{-1}, 100+100 kg N ha^{-1}, one applied before the plant growing season and the other one as a top dressing treatment. The experiment was conducted on black degraded soil, developed from medium clay soil of the soil class IIIa, with pH 7.8 and soil salinity equal 105.5 µs cm^{-1}. The soil contained 130 mg P dm^{-3} and 200 mg K dm^{-3}.

Seeds of the Epic F_1 eggplant cultivar were sown in a greenhouse on 26 March. After developing cotyledons, the seedlings were transplanted to pots 12 cm in diameter, filled with peat substrate. While growing the transplants, the plants were fertilized with the liquid fertilizer Florovit, 0.2% in concentration. On 28 May, the transplants were planted on a field, in stripes of 60x50 cm, with 90cm spacing. The size of a plot was 3m^2 (2x1.5m). The transplanting of eggplants was preceded by a nitrogen fertilization treatment with a rototiller, according to an appropriate method. Five weeks afterwards, a nitrogen top dressing treatment was applied. When rainfall was insufficient, the plants were irrigated with a single, 20 mm dose of water. Chemical analyses of fully mature fruits were carried out in mid-August. Eight fruits were collected from each plot. An analytic sample was a quarter slice, 1 cm thick, cut from the middle part of a fruit and composed of the parenchyme and peel. The following parameters were determined: dry matter – by drying at 105°C to the constant weight) (PN-90/A-75101/03), reducing and total sugars - using the method by Lane-Eynon (PN-90/A-7510107), vitamin C – with the Tillmans' method (PN-90/A-75101/11), N-NO_3 – by potentiometry, carotenoids – by the Lichtenthaller and Welburn's colorimetric method (1983), anthocyanins – according to Fuleka and Francis, polyphenols by the Folina-Ciocalteu's method, P and Mg – using the colorimetric method, K and Ca – with the flame photometric method. The results were subjected to statistical analysis using the Tukey's test at the significance level α=0.05.

RESULTS AND DISCUSSION

The results of the chemical analyses showed that the biological value of eggplant fruits varied between years of the experiment. In the second year, during the intensive plant growth after planting, i.e. in June and in the first and second third of July, the mean temperature fluctuated within 18.2-20.5°C (Table 1). Warm August and the first two thirds of September were favourable for the plants' flowering, fruit setting and ripening. In July, there was also much rainfall, which coincided with high air temperature, both stimulating intensive development of the plants. The leading role of ambient temperature as a factor in eggplant cultivation was stressed by Kashyap et al. (2003), while Lawande and Chavan (1998) reported that an optimum temperature for eggplant growth should be 22-30°C in the day and 18-24°C at night.

Higher mean air temperatures during the plant growing season in 2011 contributed to the fruits accumulating nearly twice as much Ca, 1.2-1.3-fold more reducing and total sugars, 3.5-fold more polyphenols and 60% more carotenoids than fruits harvested in 2010 (Table 2). The research proved

Table 1

Mean air temperature and sum of rainfall during the growing period of eggplant in 2010-2011

Months	Temperature (°C)					Rainfall (mm)				
	decade			mean monthly tempera-ture	deviation from mean monthly temperature for many years	decade			sums of rainfall	deviation from monthly sums of rainfall for many years
	1st	2nd	3rd			1st	2nd	3rd		
2010										
May	13.2	11.6	14.8	13.3	-0.2	29.8	77.2	27.5	134.5	77.5
June	18.6	16.0	17.9	17.5	1.2	13.4	11.4	-	24.8	-54.2
July	20.4	23.3	19.3	21.0	2.9	7.0	34.6	37.5	79.1	-11.9
August	19.8	19.3	17.5	18.8	1.0	16.2	14.0	43.8	74.0	10.0
September	12.6	12.5	12.2	12.5	-1.1	26.0	11.8	51.0	88.8	37.8
2011										
May	10.5	16.0	17.9	14.9	1.4	6.7	13.9	20.8	41.4	-15.6
June	20.4	18.7	18.3	19.1	2.8	3.9	4.5	13.5	21.9	-57.1
July	18.2	20.5	16.3	18.2	0.1	65.5	40.0	47.7	153.2	62.2
August	19.3	19.4	19.5	19.4	1.6	1.6	11.6	9.5	22.7	-41.3
September	17.3	16.1	14.5	15.9	2.3	20.9	0.9	-	21.8	-29.2

Table 2

Biological value of eggplants fruits independently of the method of fertilization, mean from 2010-2011

Components	2010	2011	$LSD_{\alpha=0.05}$
P (%)	0.40	0.25	0.08
K (%)	4.25	3.73	0.11
Mg (%)	0.24	0.25	n.s.
Ca (%)	0.17	0.33	0.02
Dry matter (%)	7.55	6.92	0.36
Reducing sugars (%)	2.02	2.42	0.25
Total sugars (%)	2.04	2.56	0.20
Carotenoids (mg 100 g^{-1} s.m.)	0.80	1.28	n.s.
Vitamin C (mg 100 g^{-1} f.m.)	11.60	9.54	0.76
Anthocyanins (mg 100 g^{-1} f.m.)	5.69	5.03	n.s.
Polyphenols (mg 100 g^{-1} f.m.)	27.19	96.05	5.00
NO_3-N (mg kg^{-1} f.m.)	126	101	12

that the species requires higher temperature, in particular a higher optimal temperature for synthesis of carotenoids (LESTER 2006). The 2010 season, with its high total precipitation and but lower mean temperature, resulted in a distinctly higher content of P and K as well as 21.6% more vitamin C determined in eggplant fruits. These data support the claim that a moderate climate with lower temperatures favours the accumulation of vitamin C in vegetables (LESTER 2006). KOWALSKI et al. (2003) also stressed significant changeability of the biological value of eggplant fruits in the years of their experiments conducted in an unheated foil tunnel.

The statistical analysis of our results did not prove any significant effect of the type of eggplant fertilization on the biological value of its fruits, which on average contained 6.80-8.06% of dry matter, 1.85-2.48% of reducing sugars and 2.00-2.56% of total sugars (Table 3). RAIGON et al. (2010) report the content of dry matter in field-grown eggplants at 8.35%. Investigations carried out in an unheated foil tunnel or in a greenhouse demonstrated that eggplant fruits accumulated higher amounts of reducing sugars (2.44-3.93%) and total sugars (2.65-4.31%), with an approximately same concentration of dry matter (6.63-9.88%) (CEBULA, AMBROSZCZYK 1999, KOWALSKI et al. 2003). In our experiment, the eggplant fruits contained an average 10.58 mg 100 g^{-1} f.m. of vitamin C and 1.04 mg 100 g^{-1} d.m. of carotenoids (Tables 3 and 4). In a cultivation trial under covers, KOWALSKI et al. (2003) recorded the content of vitamin C within the range 9.47-23.18 mg 100 g^{-1} f.m., while CEBULA and AMBROSZCZYK (1999) detected 4.51-6.15 mg 100 g^{-1} f.m. EL-QUDAH (2009) reported that the eggplant had such carotenoids as neoxanthine, violaxanthine, lutein and β-carotene e, which in total amounted to 0.13 mg 100 g^{-1}. KIM et al. (2007) detected that boiled eggplant contained only â-carotene and lutein in the total amount of 0.16 mg 100 g^{-1} f.m., while LAKO et al. (2007) reported that after boiling eggplant did not contain β-carotene.

Table 3

Dry matter, reducing and total sugars, and carotenoids content in eggplant fruits in relation to the fertilization method (mean from 2010-2011)

Type of fertilizer	Rate of N (kg ha^{-1})	Dry matter (%)			Reducing sugars (%)			Total sugars (%)			Carotenoids (mg 100 g^{-1} d.m.)		
		A*	B**	mean	A	B	mean	A	B	mean	A	B	mean
Ammonium nitrate	100	6.90	7.06	6.98	2.11	2.30	2.20	2.19	2.36	2.27	0.74	1.01	0.88
	150	7.44	7.25	7.35	2.30	2.18	2.24	2.40	2.28	2.34	1.03	1.02	1.02
	200	7.05	6.89	6.97	2.00	2.00	2.00	2.30	2.10	2.20	0.90	1.00	0.95
Mean		7.13	7.07	7.10	2.13	2.16	2.14	2.29	2.25	2.27	0.89	1.01	0.95
Ammonium sulphate	100	6.97	7.74	7.35	2.17	2.40	2.28	2.25	2.49	2.37	0.86	1.12	0.99
	150	7.99	7.17	7.58	2.39	2.18	2.28	2.49	2.26	2.37	0.94	0.93	0.93
	200	6.80	6.81	6.80	2.19	2.27	2.23	2.31	2.30	2.30	1.00	1.11	1.05
Mean		7.25	7.24	7.24	2.25	2.28	2.26	2.35	2.35	2.35	0.93	1.05	0.99
Entec 26	100	7.04	6.84	6.94	2.48	2.28	2.38	2.56	2.37	2.47	0.98	2.32	1.65
	150	7.18	8.06	7.62	1.85	2.19	2.02	2.02	2.24	2.13	0.89	0.89	0.89
	200	7.79	7.31	7.55	2.41	2.15	2.28	2.44	2.23	2.34	0.99	1.01	1.00
Mean		7.33	7.40	7.37	2.25	2.21	2.23	2.34	2.28	2.31	0.95	1.41	1.18
Mean for doses	100	6.97	7.21	7.09	2.25	2.33	2.29	2.33	2.41	2.37	0.86	1.49	1.17
	150	7.54	7.50	7.52	2.23	2.18	2.18	2.30	2.26	2.28	0.95	0.94	0.95
	200	7.21	7.00	7.11	2.20	2.14	2.17	2.35	2.21	2.28	0.96	1.04	1.00
Mean		7.24	7.24	–	2.21	2.22	–	2.32	2.29	–	0.92	1.16	–
LSD$_{\alpha=0.05}$ for:													
type of fertilizer (I)				n.s.			n.s.			n.s.			n.s.
rate of nitrogen (II)				n.s.			n.s.			n.s.			n.s.
mode of pplication (III)				n.s.			n.s.			n.s.			n.s

*A – preplanting application,**B – split application

The type of fertilization did not influence the content of anthocyanins or polyphenols in eggplant fruits either (Table 4). The quantity of anthocyanins ranged from 4.27 to 6.56 mg 100 g^{-1} f.m. GAJEWSKI et al. (2006) proved that the content of these compounds in an eggplant peel depended on the maturity stage of the fruit and varied from 3.49 mg g^{-1} f.m. in physiologically immature fruits to 1.12 mg g^{-1} f.m. in fully ripe fruits. LAVANDE and CHAVAN (1998) reported the anthocyanin content in different eggplant cultivars in the range from 6.90 to 752 mg 100 g^{-1} f.m. The data published by LAKO et al. (2007), OKMEN et al. (2009) and RAIGON et al. (2010) also imply a considerable content of polyphenols in an eggplant, i.e. from 41.1 to 138.9 mg 100 g^{-1} f.m. In our experiment, the amount of polyphenols was determined at 50.70 up to 71.06 mg 100 g^{-1} f.m. A decreasing tendency in the content of polyphenols occurred as the dose of nitrogen went up from 100 to 150 and 200 kg N ha^{-1}, by an average of 7.9% and 12.3%, respectively.

The high dietary value of eggplant fruits is attributed to their high concentrations of mineral compounds, especially potassium, magnesium, calcium and iron, present in proportions beneficial for the consumer's health. In our research, the content of P in dry matter was on average 0.33%, K – 3.99%, Mg – 0.25% and Ca – 0.25% (Table 5). RAIGON et al. (2010) determined the following mean amounts of mineral components in field cultivated eggplant: 0.35% P, 3.13% K, 0.10% Mg and 0.11% Ca. According to GOLCZ et al. (2005), eggplant fruits originating from an unheated greenhouse had higher quantities of phosphorus (up to 0.66%) and calcium (up to 0.5%), while the concentrations of K (3.5-4.0%) and Mg (0.25-0.35%) were quite similar. In the experiment by MICHAŁOJĆ and BUCZKOWSKA (2008), conducted in an unheated foil tunnel, eggplant fruits contained an average of 0.26-0.29% P, 2.26-3.02% K, 0.12-0.17% Ca and 0.11-0.15% Mg. MICHAŁOJĆ and BUCZKOWSKA (2008) reported a significant effect of the type of nitrogen fertilizer on the K and Ca content in eggplant fruits. Fertilization with ammonium sulphate stimulated the accumulation of macronutrients. ABDEL-MOUNTY et al. (2011) stressed the high importance of sulphur as a nutrient for eggplants. These authors stated that the quality of eggplant fruit yield improved with an increase in the fertilization dose of this element. Concurrently, the eggplant fruits nourished with more sulphur contained more N, P, K, Fe and proteins. RAIGON et al. (2010) noticed that the content of macronutrients depended on the eggplant cultivation system. In organic cultivation, eggplant fruits contained more K, Mg and Cu in comparison to those from conventional cultivation. In our experiment, the form of applied nitrogen fertilizer did not significantly affect the content of mineral components.

Many authors highlight the positive effect of fertilizers which contain an inhibitor of nitrification on the biological value of vegetables. This is especially true about the diminished content of nitrates in edible parts of plant species prone to the accumulation of this component, e.g. red beet harvested for leaves (KOŁOTA et al. 2007), common cabbage (KOŁOTA, ADAMCZEWSKA-SOWIŃSKA 2008), early leek (KOŁOTA, ADAMCZEWSKA-SOWIŃSKA 2007) as well as

Table 4

Vitamin C, anthocyanins, polyphenols and $N\text{-}NO_3$ content in eggplant fruits in relation to the fertilization method (mean from 2010-2011)

Type of fertilizer	Rate of N ($kg\ ha^{-1}$)	Vitamin C ($mg\ 100\ g^{-1}$ f.m.)			Anthocyanins ($mg\ 100\ g^{-1}$ f.m.)			Polyphenols ($mg\ 100\ g^{-1}$ f.m.)			$N\text{-}NO_3$ ($mg\ kg^{-1}$ f.m.)		
		A*	B**	mean	A	B	mean	A	B	mean	A	B	mean
Ammonium nitrate	100	11.22	10.08	10.65	5.50	5.60	5.55	65.89	61.84	63.87	129	88	109
	150	10.86	11.12	10.99	4.27	6.39	5.33	64.42	60.45	62.43	129	108	119
	200	10.50	10.12	10.31	6.56	4.72	5.64	65.20	57.19	61.20	120	126	123
Mean		10.86	10.44	10.65	5.44	5.57	5.51	65.17	59.83	62.50	126	108	117
Ammonium sulphate	100	10.76	9.88	10.32	5.83	4.38	5.11	66.25	71.06	68.66	115	83	99
	150	10.14	10.10	10.12	4.50	5.80	5.15	53.77	65.40	59.58	83	118	100
	200	10.34	11.34	10.84	5.53	5.12	5.32	56.57	50.70	53.64	106	152	129
Mean		10.41	10.44	10.43	5.28	5.10	5.19	58.86	62.39	60.63	101	118	109
Entec 26	100	10.50	11.62	11.06	6.01	5.97	5.99	67.43	63.85	65.64	116	102	109
	150	10.64	9.96	10.30	5.83	4.60	5.21	66.75	54.38	60.57	101	108	105
	200	11.38	9.76	10.57	4.78	5.16	4.97	54.63	63.42	59.02	125	138	131
Mean		10.84	10.45	10.64	5.54	5.24	5.39	62.94	60.55	61.74	114	116	115
Mean for doses	100	10.84	10.44	10.64	5.78	5.32	5.55	66.52	65.58	66.05	120	91	106
	150	10.86	10.44	10.65	4.86	5.60	5.23	61.65	60.08	60.86	104	111	108
	200	10.40	10.44	10.42	5.62	5.00	5.31	58.80	57.10	57.95	117	138	128
Mean		10.70	10.44	10.57	5.42	5.30	–	62.32	60.92	–	114	114	–
$LSD_{\alpha=0.05}$ for:													
type of fertilizer (I)				n.s.			n.s.			n.s.			n.s.
rate of nitrogen (II)				n.s.			n.s.			n.s.			n.s.
mode of pplication (III)				n.s.			n.s.			n.s.			n.s.

*A – preplanting application, **B – split application

Table 5

Macronutrient content in eggplant fruits in relation to the fertilization method (mean from 2010-2011)

Type of fertilizer	Rate of N (kg ha^{-1})	P (%)			K (%)			Mg (%)			Ca (%)		
		A*	B**	mean	A	B	mean	A	B	mean	A	B	mean
Ammonium nitrate	100	0.30	0.32	0.31	3.98	3.95	3.96	0.28	0.27	0.27	0.23	0.24	0.23
	150	0.30	0.32	0.31	4.01	4.03	4.02	0.26	0.30	0.28	0.28	0.22	0.25
	200	0.39	0.29	0.34	4.01	3.91	3.96	0.29	0.24	0.26	0.28	0.27	0.27
Mean		0.33	0.31	0.32	4.00	3.96	3.98	0.27	0.27	0.27	0.26	0.24	0.25
Ammonium sulphate	100	0.33	0.36	0.34	3.94	3.79	3.87	0.23	0.27	0.25	0.25	0.26	0.26
	150	0.31	0.35	0.33	3.91	4.15	4.03	0.25	0.23	0.24	0.28	0.25	0.26
	200	0.32	0.34	0.33	4.05	4.21	4.13	0.22	0.28	0.25	0.26	0.23	0.25
Mean		0.32	0.35	0.33	3.97	3.99	4.01	0.23	0.26	0.25	0.26	0.25	0.26
Entec 26	100	0.30	0.33	0.32	3.97	4.01	3.99	0.21	0.28	0.25	0.27	0.23	0.25
	150	0.36	0.28	0.32	4.05	3.81	3.93	0.22	0.20	0.21	0.23	0.21	0.22
	200	0.35	0.33	0.34	3.86	4.16	4.01	0.19	0.24	0.21	0.28	0.23	0.26
Mean		0.34	0.32	0.33	3.96	3.99	3.98	0.21	0.24	0.22	0.26	0.22	0.24
Mean for doses	100	0.31	0.34	0.32	3.96	3.92	3.94	0.24	0.27	0.26	0.25	0.24	0.25
	150	0.32	0.32	0.32	3.99	4.00	3.99	0.24	0.24	0.24	0.26	0.22	0.24
	200	0.35	0.32	0.34	3.97	4.09	4.03	0.23	0.25	0.24	0.28	0.24	0.26
Mean		0.33	0.33	–	3.98	4.00	–	0.24	0.25	–	0.26	0.24	–
$LSD_{\alpha=0.05}$ for:													
type of fertilizer (I)				n.s.			n.s.			n.s.			n.s.
rate of nitrogen (II)				n.s.			n.s.			n.s.			n.s.
mode of pplication (III)				n.s.			n.s.			n.s.			0.02

*A – preplanting application, **B – split application lettuce, spinach, lamb's lettuce and carrot (Hähndel, Zerulla 2001, Pasda 2001). Eggplant belongs to those vegetables which do not readily accumulate nitrates. In this research, the average level of nitrates was determined at 114 mg in 1 kg f.m. and did not depend on the type of fertilization (Table 4). However, elevated nitrogen doses, from 100 kg ha^{-1} to 150 and 200 kg ha^{-1}, caused an increase in the amount of accumulated nitrates, especially when the fertilization was performed twice: in a split dose applied before the growing period and as a top dressing treatment.

CONCLUSIONS

1. The weather conditions in the two years of the study significantly modified the chemical composition of eggplant fruits.

2. In 2011, when the thermal conditions were more favourable for eggplant, the vegetable accumulated nearly twice as much Ca, 1.2-1.3-fold more reducing and total sugars, 3.5-fold more polyphenols as well as 60% more carotenoids than in 2010.

3. The biological value of eggplant fruits did not depend on the type of nitrogen fertilizer nor on its dose and the way it was applied.

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