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EFFECT OF SUBSTRATE TYPE AND METHOD OF FERTIGATION CONTROL ON YIELD SIZE AND FRUIT QUALITY OF GREENHOUSE CUCUMBER

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Abstract. Yield and fruit quality of cucumber depend on such factors as plant cultivar, plant nutrition and the cultivation method. The presented paper contains results confirming the usefulness of rockwool and coconut fibre as well as the application of the fertigation system in cucumber growing. Studies on the growing of cucumber Onyks F1 cultivar were carried out in the years 2003–2005 in an unheated greenhouse. A two-factorial experiment was established. One experimental factor consisted in the fertigation control methods including Soltimer device and the starting tray. The other factor included substrate types: rockwool Agroban and coconut fibre Ceres. Plant distribution was 2 plants per one square metre. On the basis of the presented studies, it was found that greenhouse cucumber yielding was influenced by the frequency of nutrient supply, by climatic conditions in the given year and by the applied substrate type. The applied media of rockwool Agroban and coconut fibre Ceres did not exert any influence on plant yielding. On the other hand, a significant effect on the total and the marketable fruit yield was exerted by the cooperation between the fertigation control method and the substrate type.

Key words: cucumber, Soltimer, starting tray, rockwool, coconut fibre

INTRODUCTION

Fertigation represents fertilization combined with irrigation which ensures an even distribution and exact supply of nutrients to the plant root system [Jeznach and Treder 2006, Komosa 2002, Piróg 2004]. Correct preparation of nutrient is conditioned by analysis results of water used for irrigation and by the knowledge of the critical values of the nutrient for the given species [Komosa 1994, Komosa and Roszyk 1997]. Water quality including EC and pH values decide about their usefulness for fertigation. For glasshouse cultivation of cucumber, one can use the following organic substrates: fen mixed with pine bark, coconut fibre, fibre of coniferous trees, polyurethane or polyphe-

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nolic foams. Among substrates, one can apply: rockwool, keramsite (expanded clay) [Piróg 2001, 2004]. A high competition of vegetables offered on the market requires a constant search for new technical and biological solutions in order to obtain high yields, good quality and decreased production costs [Libik et al. 1996, Piróg 1998].

The problem of fertigation control with the use of the control device Soltimer, which operates basing on solar radiation, was discussed by Piróg [1999] and by Pudelski [1994a], while Piróg and Komosa [2006] applied in their studies the time control device Sterling 12.In intensive growing under cover, key important is the selection of an optimal substrate regarding the suitability of its type and quality for the given species [Michajłojć and Nurzyński 1998, Komosa 2008, Libik et al. 1996, Piróg 1998].

The objective of the presented studies was the determination of the influence of the applied substrate and the method of fertigation control on the yield size and on the fruit quality of greenhouse cucumber.

MATERIAL AND METHODS

Studies on cucumber were carried out in the years 2003–2005 in an unheated greenhouse of the Department of Vegetable Crops, University of Life Sciences in Poznań. The cucumber, Onyks F_1 cultivar, bred in „Spójnia" Agricultural Breeding and Seed Production in Nochowo, was used in the studies. A two-factor experiment in random block design was established in four replications. One factor consisted of two types of fertigation control: Soltimer and a starting tray. The second factor included two growing substrates: rockwool Agroban and coconut fibre Ceres in the form of foil-covered mats with 1000 × 200 × 75 m dimensions. Nutrient was supplied to the substrates by a system of individual drip-irrigation controlled by Soltimer or a starting tray. Soltimer operated basing on solar radiation by activating the nutrient supply after each determined number of new supplied calories.

This determined calory value amounted to 100 calories in the period from plant plantation to plant flowering, 90 calories – from flowering to yielding and 80 calories – in the period of cucumber yielding. The growing mats operated on the basis of a determined moisture degree. The time of each nutrient supply in both variants was 5 minutes in the period from plantation to yielding, and 4 minutes in the period of fruit yielding. Nutrient composition was determined on the basis of chemical analysis of water used for irrigation and on the basis of the critical values of macro- and microelements for cucumber.

The whole area of the greenhouse was covered with a white-and-black foil. The growing bed (80 cm wide) was prepared according to a belt-and-row design. It was divided into two rows which were covered with growing mats. Each mat had two openings for seedlings (the openings were cut out at a distance of 50 cm from each other) providing a density of 2 plants per one square metre of the plot. Eight plants were grown on one plot. Important treatments are shown in table 1.

Climatic conditions in the period of experiment were differentiated in the particular years of studies. The best light conditions for the plants existed in the year 2003. In that year, the highest values were recorded referring both to the mean solar radiation

(20.4 MJ·m^{-2}·d^{-1}) and to its sum in the period of growing (2020.7 MJ·m^{-2}). In 2005, these values were the lowest and they amounted to 19.0 MJ·m^{-2}·d^{-1} and 5631.5 MJ·m^{-2}, respectively. Inside the greenhouse, the mean air temperature oscillated between 20.7°C in 2003 and 18.7°C in 2005. On the other hand, the relative humidity showed 73.3 and 65.6%, respectively.

Table 1. Important cultivation treatments in the experiment
Tabela 1. Ważniejsze zabiegi uprawowe w doświadczeniu

Year Rok	Treatment date – Termin zabiegu				Length of harvest period in weeks Długość okresu zbiorów w tygodniach
	sowing date siew nasion	seedling plantation sadzenie rozsady	first harvest pierwszy zbiór	last harvest ostatni zbiór	
2003	07.04	05.05	28.05	11.08	12
2004	12.04	07.05	01.06	9.08	11
2005	15.04	12.05	07.06	22.08	11

The plants were guided by a supporting system made of strings reaching to the height of 2.2 m. Harvests of fruits from the particular plots were carried out 3 times in the week. The collected fruits were weighed, counted and sorted into classes (first clas – fruits 8 to 14 length, second class – fruit above 14 cm length and non marketable fruit). Yield results were statistically analysed using STAT program. Analysis of variance was carried out and the significance of differences between the mean values was determined using t- Student's test at the significance level of $\alpha = 0.05$.

Furthermore, fruits were subject to morphological, physical and chemical analyses and also regarding the contents of dry matter, extract, nitrates, nitrites, total acidity and total content of sugars. Nitrates and nitrites were determined by colorimetric method, dry matter was measured by weight, total acidity – by titrimetric method and sugars content – by Lane-Eynoma method.

RESULS AND DISCUSSION

Yielding. On the basis of the performed studies, it was found that an influence on yield differentiation of greenhouse cucumber was exerted by the frequency of nutrient supply, by the climatic conditions dominating in the given year and by the substrate type.

The highest influence on the total yield and on the first class fruits of greenhouse cucumber (expressed by empirical F 4.01 – for total yield – and by 4.58 – for first class fruit yield) was exerted by the climatic conditions in the experimental years (tab. 2 and 4). The highest yield obtained in 2003 amounted to 20.63 kg·m^{-2}, while the lowest yield of 17.23 kg·m^{-2} was obtained in 2004. These values differed significantly between each other because the LSD at $\alpha = 0.05$ amounted to 2.09 kg·m^{-2}. Similar relations in yielding were recorded in the yield of the first class fruit in the year 2003 amounting to 17.61 kg·m^{-2}, in the year 2005, it amounted to 14.91 kg·m^{-2}, while the least significant difference was 1.85 kg·m^{-2}. According to Gajc-Wolska et al. [2008], significant factors in cucumber growing include also climatic conditions and particularly the intensity of radiation, temperature and humidity.

Table 2. Total yield of greenhouse cucumber fruits, depending on the applied factors in the years 2003, 2004 and 2005
Tabela 2. Plon ogółem owoców ogórka szklarniowego w zależności od zastosowanych czynników badań w roku 2003, 2004 i 2005

Factor – Czynnik		Total yield in kg·m $^{-2}$ – Plon ogółem w kg·m^{-2}			
		2003	2004	2005	mean – średnie
Soltimer	Agroban	20.03	18.93	22.85	20.60
	Ceres	18.29	15.52	17.74	17.18
Starting tray	Agroban	22.59	18.75	16.77	19.37
Taca startowa	Ceres	21.62	17.75	19.46	19.61
Soltimer		19.16	17.22	20.30	18.89
Starting tray – Taca startowa		22.11	18.25	18.12	19.49
Agroban		21.31	18.84	19.81	19.99
Ceres		19.95	16.63	18.60	18.40
Mean for year – Średnia dla lat		20.63	17.73	19.21	
Factor – Czynnik		empirical F – F empiryczne		LSD $_{\alpha = 0.05}$ – NIR $_{\alpha = 0,05}$	
Years – Lata (A)		4.01*		2.09	
Control – Sterowanie (B)		0.51		1.71	
Substrate – Podłoże (C)		3.62		1.71	
A × B		3.20		2.96	
A × C		0.14		2.96	
B × C		4.79*		2.41	
A × B × C		1.62		4.18	

* significant deference – różnice znaczące

Actually, in greenhouse, vegetables are grown in inert substrates and among them, rockwool is dominating [Oświecimski 1996, Rumpel 1998, Piróg 2001, Kołota and Biesiada 2002]. In practice, coconut fibre is increasingly more frequently used as an alternative substrate for rockwool and as substitute of raised peat. Coconut fibre possesses good physical properties and it undergoes biodegradation [Rumpel 1998, Piróg 1998, Halmann aand Kobryń 2002, Komosa 2002]. Rockwool and coconut fibre was also used in tomato cultivation by Kołota and Biesiada [2002], Halmann and Kobryń [2002], Kobryń et al. [2007], while Piróg [2001, 2002] used those media in the growing of cucumber.

In the present studies, rockwool Agroban and coconut fibre Ceres did not exert any essential influence on the total, marketable yield and the first class fruit yield. However, study results have indicated a tendency showing that substrate type may exert an effect on yielding. Rockwool has shown to be a slightly better substrate for cucumber cultivation, as compared with coconut fibre because plants grown in it created higher total, and marketable yields and first class fruit yield reaching respectively the following values: 19.99; 18.02 and 16.75 kg·m^{-2} (tab. 2, 3, 4). Differences in the yielding of cucumber grown in rockwool and in coconut fibre indicated an increasing tendency in the total yield. Studies of Piróg [2001] on cucumber grown in different mineral and organic substrates showed that the highest yielding was obtained on rockwool. On organic substrates, cucumber yields were lower by about 9%, while on expanded clay, they were lower by about 30%, in comparison with the yields on rockwool.

In our own studies, a high influence on the total and marketable yields was exerted by the interaction between fertigation control method and the substrate type because the empirical F for the total yield amounted to 4.79, while LSD at α = 0.05 was 2.41 $kg \cdot m^{-2}$. On the other hand, for marketable yield, the empirical F amounted to 4.05 and the LSD at α = 0.05 was equal to 2.21 $kg \cdot m^{-2}$. The average commercial yield amounted to 18.32 $kg \cdot m^{-2}$ (depending on the interaction between Agroban rockwool and the fertigation control by Soltimer), while the lowest yield was shown when plants were grown on coconut fibre Ceres with fertigation controlled by the starting tray.

Table 3. Marketable yield of greenhouse cucumber fruits, depending on the studied factors in the year 2003, 2004 and 2005
Tabela 3. Plon handlowy owoców ogórka szklarniowego w zależności od badanych czynników w roku 2003, 2004 i 2005

Factor – Czynnik		Marketable yield in $kg \cdot m^{-2}$ – Plon handlowy w $kg \cdot m^{-2}$			
		2003	2004	2005	mean – średnie
Soltimer	Agroban	18.24	18.02	18.70	18.32
	Ceres	16.61	14.93	14.81	15.45
Starting tray Taca startowa	Agroban	20.12	18.04	15.02	17.73
	Ceres	19.33	17.03	17.49	17.95
Soltimer		17.43	16.47	16.75	16.89
Starting tray – Taca startowa		19.72	17.54	16.25	17.84
Agroban		19.18	18.03	16.86	18.02
Ceres		17.97	15.98	16.15	16.70
Mean for years – Średnia dla lat		18.58	17.00	16.50	
Fators – Czynnik		empirical F – F empiryczne		LSD $_{\alpha = 0.05}$ – NIR $_{\alpha = 0,05}$	
Years – Lata (A)		2.65		1.92	
Control – Sterowanie (B)		1.54		1.57	
Substrate – Podłoże (C)		2.97		2.71	
A × B		1.11		1.57	
A × C		0.26		2.71	
B × C		4.05*		2.21	
A × B × C		1.19		3.83	

* significant deference – różnice znaczące

A slightly smaller influence on cucumber total yield was exerted by the substrate and its interaction with the weather conditions dominating in the experimental year when the empirical F amounted to 3.62 and 3.20, respectively, while the LSD at α = 0.05 showed 1.71 and 2.96 $kg \cdot m^{-2}$, respectively.

A tendency to an increasing total yield was also observed when the weather conditions in the experimental year interacted with the type of fertigation control. Higher yields were obtained in the years 2003 and 2004, when fertigation was controlled by starting tray. An increasing tendency of marketable yield was shown by plants in the particular years of studies. In the year 2003, a higher yield was obtained (18.58 $kg \cdot m^{-2}$), in comparison with the yield from the year 2004 (17.00 $kg \cdot m^{-2}$) and the year 2005 (16.50 $kg \cdot m^{-2}$).

Table 4. First class yield of greenhouse cucumber fruits, depending on the studied factors in the year 2003, 2004 and 2005
Tabela 4. Plon kl. I owoców ogórka szklarniowego w zależności od badanych czynników w roku 2003, 2004 i 2005

Factor – Czynnik		First class fruit yield in kg·m^{-2} – Plon kl. I w kg·m^{-2}			
		2003	2004	2005	means – średnie
Soltimer	Agroban	17.25	16.83	16.66	16.91
	Ceres	15.91	13.96	13.16	14.34
Starting tray	Agroban	19.07	16.83	13.84	16.58
Taca startowa	Ceres	18.21	15.63	15.98	16.61
Soltimer		16.58	15.39	14.91	15.63
Starting tray – Taca startowa		18.64	16.23	14.91	16.59
Agroban		18.16	16.83	15.25	16.75
Ceres		17.06	14.79	14.57	15.47
Mean for years – Średnia dla lat		17.61	15.81	14.91	
Factor – Czynnik		empirical F – F empiryczne		LSD $_{\alpha = 0.05}$ – NIR $_{\alpha = 0,05}$	
Years – Lata (A)		4.58*		1.85	
Control – Sterowanie (B)		1.69		1.51	
Substrate – Podłoże (C)		2.94		1.51	
A × B		0.66		2.62	
A × C		0.29		2.62	
B × C		3.07		3.04	
A ×B × C		1.10		3.71	

* significant deference – różnice znaczące

The yield of the second class fruit and the non-marketable yield presented a negligible percentage of marketable yield (5–7%) and therefore, those yields have not been discussed here in details.

Fruit quality features. Morphological features of greenhouse cucumber such as: fruit length, fruit thickness, the width of seed case and the shape coefficient of fruit showed some differentiations depending on the years of studies. On the other hand, the substrate and the type of fertigation control influenced the above mentioned features in a very similar way. In the year 2005, on the average, longer fruits were harvested (19.5 to 20.4 cm) than in the year 2003 (16.0 to 18.1 cm) and in 2004 (15.7 to 16.6 cm). However, the differences were small and not statistically proven (tab. 5). Similar dependences were observed in the fruit thickness which in 2005 showed from 5.0 to 5.1 cm; in 2004 – 4.1 to 4.4 cm and in the year 2003 – 4.3 to 4.5 cm. One can also speak about an increasing tendency in reference to the seed case which in 2005 showed from 3.0 to 3.1 cm, in 2004 , the mean value was 2.5 cm, and in the year 2003, it ranged from 2.4 to 2.8 cm (tab. 6). The fruit shape coefficient was very similar in all combinations (3.6 to 4.2 cm). Woźniak et al. [1999] and Piróg [2001] found that the length and thickness of fruits and the cucumber shape coefficient grown in different substrates were also different. The occurring differences were small and statistically not proven.

In the years 2003–2005, the **contents of dry matter** in the fruits of cucumber Onyks F_1 grown in greenhouse in mineral and organic substrates were more or less equal and they ranged from 3.7 to 4.1% (tab. 7). The least amount of dry matter was obtained in fruits collected in the year 2004 from plants grown in coconut fibre. In the experiment

Table 5. Effect of substrate type and fertigation control method on the length and width of cucumber fruits
Tabela 5. Wpływ podłoża i sposobu sterowania fertygacją na długość i szerokość owoców ogórka

Factor – Czynnik		Firut length – Długość owocu, cm				Fruit width – Szerokość owocu, cm			
		2003	2004	2005	mean-średnia	2003	2004	2005	mean średnia
Substrate Podłoże	Agroban	18.1	16.6	19.5	18.1	4.3	4.1	5.1	4.5
	Ceres	16.0	15.7	20.4	17.4	4.5	4.3	5.0	4.6
Control Sterowanie	Soltimer	16.8	16.1	20.2	17.7	4.3	4.1	5.1	4.5
	starting tray taca startowa	17.3	16.2	19.7	17.7	4.5	4.4	5.0	4.6

Table 6. Effect of substrate type and fertigation control method on the shape and width coefficients of fruit seed case in cucumber
Tabela 6. Wpływ podłoża i sposobu sterowania fertygacją na współczynnik kształtu i szerokość komory nasiennej owoców ogórka

Factor – Czynnik		Shape coefficient (length/thickness) of fruits Współczynnik kształtu (długość/grubość) owocu				Width of seed case Szerokość komory nasiennej, cm			
		2003	2004	2005	mean średnia	2003	2004	2005	mean średnia
Substrate Podłoże	Agroban	4.2	4.0	3.8	4.0	2.6	2.5	3.0	2.7
	Ceres	3.6	3.7	4.1	3.8	2.6	2.5	3.1	2.7
Control Sterowanie	Soltimer	3.9	3.9	4.0	3.9	2.4	2.5	3.0	2.6
	starting tray taca startowa	3.8	3.7	3.9	3.8	2.8	2.5	3.1	2.8

Table 7. Effect of substrate type and fertigation control metod on dry mater and extract of cucumber fruits
Tabela 7. Wpływ podłoża i sposobu sterowania fertygacją na suchą masę i ekstrakt owoców ogórka

Factor – Czynnik		Dry mater – Sucha masa, %				Extract – Ekstrakt, %			
		2003	2004	2005	mean-średnia	2003	2004	2005	mean średnia
Substrate Podłoże	Agroban	3.9	3.9	4.1	4.0	3.3	3.3	3.3	3.3
	Ceres	4.1	3.7	4.1	4.0	4.0	3.4	3.5	3.6
Control Sterowanie	Soltimer	3.9	3.8	4.0	3.9	3.8	3.3	3.5	3.5
	starting tray taca startowa	4.1	3.8	4.2	4.0	3.5	3.4	3.3	3.4

carried out by Woźniak et al. [1999], the content of dry matter depended on the substrate type and it ranged from 3.9 to 4.2% on different types of expanded clay. On the other hand, Piróg [2001] obtained 3.8% of dry matter in cucumber fruits, when plants were grown in rockwool and in coconut fibre, while from plants grown in expanded clay, the dry matter showed the value of 3.9%. Martyniak-Przybyszewska and Wierzbicka [1996] stated that substrate type did not exert any influence on the content of dry matter in cucumber fruits. Taking into consideration the type of fertigation system control, the content of dry matter in fruits showed differentiated values ranging from 3.8% to 4.2%.

Content of extract in plants grown in rockwool ranged on the level of 3.3% in all years of studies, while in plants grown in coconut fibre, it ranged from 3.4% (in 2004) to 4.0% (in 2003) (tab. 7). On the other hand, in cucumber fruits grown on different types of expanded clay, Woźniak et al. [1999] found that the extract content showed from 3.2 to 4.09%. In the studies carried out by Piróg [2001], a differentiated extract content in cucumber was obtained when the plants were grown in rockwool (2.6 to 2.8%), on coconut mats (3.1%) and in expanded clay (3.4%). The method of fertigation control differentiated the extract content in fruits. The least amount of extract (3.3%) was found in fruits collected in 2004 from plants which received nutrient supply controlled by Soltimer, while in the year 2005, the extract was lower when nutrient supply was controlled by the starting tray. The highest content of extrat (3.8%) was recorded in 2003, in fruits originating from plants grown under the control of Soltimer device.

Table 8. Content of nitrates in the fruits
Tabela 8. Zawartość azotanów w owocach

Factor – Czynnik		Content of nitrates, mg $NaNO_3 \cdot kg^{-1}$ f.m. Zawartość azotanów, mg $NaNO_3 \cdot kg^{-1}$ św.m. 2003	2004	2005	Mean – Średnia
Substrate Podłoże	Agroban	363.3	312.8	136.5	270.8
	Ceres	539.3	183.3	146.0	289.5
Control Sterowanie	Soltimer	455.0	223.5	86.0	254.8
	starting tray taca startowa	447.5	272.5	196.5	305.5
Mean – Średnia		451.28	248.02	141.25	

Independent of the applied substrate type or the method of fertigation control type, the pH value was very similar and it amounted from 5.6 to 5.7 (tab. 8). Similar results were obtained by Piróg [2001] in his studies on greenhouse cucumber grown in different organic and mineral substrates where pH showed the value of 5.4–5.7.

General acidity of fruits was changing in the successive years of cultivation. In 2005, the lowest acidity of fruits originating from plants of greenhouse cucumber grown in rockwool showed on the average 0.44%. The highest acidity was recorded in the year 2004 (0.60%)

Acidity of fruits harvested from plants grown in coconut fibre displayed a high diversity and it ranged on the average from 0.50% (in 2005) to 0.60% (in 2004). Woźniak et al. [1992] found a much lower total acidity of cucumber fruits ranging from 0.11 to 0.18%. Similar results were obtained analyzing the effect of the fertigation control method exerted on the total acidity of cucumber fruits. In the successive three years of studies, fruits collected from plants grown in a substrate, where the nutrient supply was controlled by Soltimer, were characterized by variable acidity. In the year 2003, it amounted to 0.51%, in 2004 it showed 0.63% and in 2005 – it was 0.48%. The use of starting tray for fertigation control contributed to a more equalized general fruit acidity. In the two first years of experiment, acidity showed 0.57%, while in the third year of growing, it was 0.45%.

The highest content of **total sugars** was shown by fruits collected in the year 2005. In fruits originating from plants grown in rockwool, 1.44% of total sugars was found, while in plants grown in coconut fibre, the value of total sugars was 1.52%. In fruits collected in 2005 from plants grown in substrates, where nutrient was supplied with Soltimer control, there was 1.51% of total sugars, while in fruits from plants, where the starting tray was used, the sugar content showed 1.45%. In the year 2004, it was found that some influence was exerted by the Soltimer control which decreased the amount of sugars in the studied fruits.

Table 9. Content of nitrites in the fruits
Tabela 9. Zawartość azotynów w owocach

Factor – Czynnik		Content of nitrites, mg $NaNO_2 \cdot kg^{-1}$ f.m. Zawartość azotynów, mg $NaNO_2 \cdot kg^{-1}$ św.m.			Mean – Średnia
		2003	2004	2005	
Substrate Podłoże	Agroban	0.15	0.03	0.04	0.07
	Ceres	0.13	0.01	0.04	0.06
Control Sterowanie	Soltimer	0.14	0.02	0.03	0.07
	starting tray taca startowa	0.13	0.02	0.05	0.06
Mean – Średnia		0.14	0.02	0.04	

The **content of nitrates** in cucumber fruits in the performed experiments was rather high and it oscillated between 141.25 and 451.2 mg $NaNO_3 \cdot kg^{-1}$ fresh matter (tab. 8). Those values were admissible, because the critical value is 500 mg $NaNO_3 \cdot kg^{-1}$ fresh matter. The highest value of nitrates was recorded in fruits obtained in the year 2003, while the lowest value was found in 2005. The cooperation of the substrate type with the fertigation control did not exert any effect on the differentiation of nitrates content and this value oscillated between 254.8 and 305.5 mg $NaNO_3 \cdot kg^{-1}$ fresh matter. In the studies of Piróg [2001], in cucumber fruits grown in such substrates as fen mixed with pine bark, VapoGro, Cocovita, cocomats, Flormin, Vitagreen, Agroban, polyurethane foam and expanded clay, the content of nitrates amounted from 156 to 430 mg $NaNO_3 \cdot kg^{-1}$ fresh matter, it means that it was below the admissible value.

The **content of nitrites** in the fruits of all experimental years was small and it amounted from 0.01 to 0.15 mg $NaNO_2 \cdot kg^{-1}$ fresh matter (tab. 9). In the studies of Piróg [2001], the content of nitrites was similar as in the here presented experiment amounting from 0.09 to 0.31 $NaNO_2$ mg$\cdot kg^{-1}$ fresh matter.

CONCLUSIONS

1. Devices controlling the fertigation process in the form of Soltimer device and the starting tray, which have been used in the experiment, can be successfully applied in the growing of greenhouse cucumber under covers.
2. Soltimer ensured a high and comparable yield in the particular years of studies, depending on climatic conditions. The starting tray ensured a high yield only in the year with the highest solar radiation, but in conditions of poor light, the plants gave smaller yields.
3. The growing substrrate in the form of rockwool and coconut fibre used in the studies provided equally good media for cucumber growing in the fertigation system and the grown plants gave a high and good quality yield.
4. Climatic conditions and the interaction between fertigation control and the substrate type exerted an influence on the general yield, the marketable yield and the first class fruit yield.
5. Morphological and chemical features of fresh cucumbers such as: dry matter, extract content, total sugars, total acidity and pH value did not differ significantly.
6. The content of nitrites in the studied cucumber fruits was very small, while the content of nitrates was within the admissible values.

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WPŁYW PODŁOŻA I STEROWANIA FERTYGACJĄ NA WIELKOŚĆ PLONU I JAKOŚĆ OWOCÓW OGÓRKA SZKLARNIOWEGO

Streszczenie. O plonie ogórka i jakości jego owoców decydują takie czynniki, jak: odmiana, podłoże, odżywianie roślin i pielęgnacja. W pracy tej sprawdzano przydatność wełny mineralnej i włókna kokosowego przy zastosowaniu fertygacji. Badania nad ogórkiem przeprowadzono w latach 2003–2005 w szklarni nieogrzewanej. Do badań użyto odmianę Onyks F_1. Założono doświadczenie dwuczynnikowe. Jednym czynnikiem były rodzaje sterowania fertygacją: Soltimer i taca startowa, a drugim podłoża: wełna mineralna Agroban i włókno kokosowe Ceres. Zagęszczenie wynosiło 2 rośliny na 1 m^2. Na podstawie przeprowadzonych badań stwierdzono wpływ częstotliwości podawania pożywki w zależności od warunków klimatycznych w danym roku i od podłoża na zróżnicowanie plonowania ogórka szklarniowego. Zastosowane podłoża z wełny mineralnej Agroban i włókna kokosowego Ceres nie miały wpływu na plonowanie roślin. Natomiast istotny wpływ na plon ogólny i handlowy miało współdziałanie sterowania fertygacją z podłożem.

Słowa kluczowe: ogórek, soltimer, taca startowa, wełna mineralna, włókno kokosowe

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