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EFFECT OF A SUBSTRATE ON YIELDING AND QUALITY OF GREENHOUSE CUCUMBER FRUTIS

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Abstract

Cucumber has high climatic demands especially in relation to temperature. Humidity, air temperature and UV light intensity are main factors affecting cucumber crop quality and quantity. Due to the instability of the above during the changing seasons in Poland, all-year-round cultivation of cucumber is difficult. In our experiment we used three types of substrates: rock wool, perlite and wood fibre. Cucumber cultivation was carried out in three times of the year. These two were main changing factors of the experiment. Our research proved that the best quality cucumbers was obtained in the second cultivation period – between April and August, due to the optimum climatic conditions for that species. The type of a substrate also affected the quantity of crops – the highest crops were on wood fiber, slightly lower on perlite. Higher content of dry matter, vitamin C, total sugars, calcium and phosphorus was observed in cucumber fruits from summer cultivation and a high content of nitrogen and potassium was found in cucumber fruits from autumn cultivation.

Key words: rock wool, perlite, wood fiber, term cultivation, chemical composition.

WPŁYW PODŁOŻY NA PLONOWANIE I JAKOŚĆ OWOCÓW OGÓRKA SZKLARNIOWEGO

Abstrakt

Ogórek jest gatunkiem o wysokich wymaganiach klimatycznych, szczególnie w stosunku do temperatury. Temperatura powietrza, wilgotności, oraz natężenie napromieniowania są czynnikami wpływającymi na plonowanie i jakość owoców. Zmienność parametrów w ciągu roku w

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Polsce utrudnia uprawę całoroczną tego gatunku. Doświadczenie prowadzono w całorocznym cyklu produkcyjnym, w trzech terminach uprawy, z zastosowaniem trzech podłoży: wełny mineralnej, perlitu, włókna drzewnego. Termin uprawy oraz zastosowane podłoże były głównymi czynnikami doświadczenia. Największe plony oraz najlepszej jakości owoce otrzymano w drugim terminie uprawy (kwiecień – sierpień) charakteryzującym się optymalnymi warunkami dla tego gatunku. Na wielkość plonowania miało również wpływ zastosowane podłoże. Największe plony otrzymano w uprawie na włóknie drzewnym, nieznacznie mniejsze w uprawie na perlicie. Największą zawartość suchej masy, cukrów ogółem, witaminy C, wapnia i fosforu miały owoce ogórka z uprawy w terminie letnim, a wyższą zawartość azotu i potasu owoce z uprawy w terminie jesiennym

Słowa kluczowe: wełna mineralna, perlit, włókno drzewne, terminy uprawy, skład chemiczny.

INTRODUCTION

Cucumber is one of the vegetable species which are often grown under covers. Production profitability is conditioned by the volume of yield per 1 m^2 of surface. Yielding in turn depends mainly on the time of cultivation and the substrate type used. The main advantage of growing vegetables on inert substrate is high yielding. The most popular substrate in cucumber cultivation is rock wool, which is difficult to utilize (BENOIT, CEUSTERMANS 1998). Thus, investigations are carried out on the usefulness of other substrates, both natural (organic, mineral) and synthetic (PIRÓG 1999, SHINOHARA i in. 1997, KOMOSA 2005), such as perlite, wood fibre or polyurethane foam. MARTYR (1982), WILSON (1984) i OŚWIĘCIMSKI (1996) recommend growing tomato and cucumber in perlite placed in polypropylene sacks of 40–60 dm^3 capacity. This conclusion results from the investigations carried out by SCHNITZER et al (1996) on wood fibre, which showed that the greenhouse cultivation of cucumber in hydroponics gave yields comparable with those obtained on other substrates. Compared with other species cultivated under covers, cucumber fruits have the highest content of water (96-97%), the lowest energy value (about 56 kJ (14 kcal) per 100 g of fresh matter) but are rich in mineral salts (KUNACHOWICZ et al. 2005).

The aim of the present investigation was to assess yielding and fruit quality of cucumber fruit in the all-year-round cultivation on rock wool, perlite and wood fibre.

MATERIAL AND METHODS

The investigations were performed in the greenhouse of the Department of Vegetable and Medicinal Plants, Warsaw University of Life Sciences

– SGGW in 2006. They were performed on two greenhouse cucumber cultivars (Pacto F_1 by De Ruiter Seeds and Melen F_1 by Enza Zaden) cultivated in an all-year-round production cycle on three substrates: rock wool (Grodan), perlite (Pelar Poland) and wood fibre (Steico).

Times of cultivation: 1 – spring sowing 21.12.2005, planting 27.01.2006, folding up 24.04.2006; 2 – summer sowing 29.03.2006, planting 25.04.2006, folding up 7.08.2006; 3 – autumn sowing 12.07.2006, planting 8.08.2006, folding up 22.11.2006.

For each cultivation period seedlings were produced in blocks of rock wool. Substrate for the cultivation of seedlings was prepared from single fertilizers according to the standard recommendations for this cucumber growth stage. Plants were grown as one shoot and during the cultivation they underwent systematical clearing (removal of side shoots and low leaves) and shoot lowering. During the vegetation fruits were picked successively and the total yield was determined ($kg \cdot m^{-2}$).

Chemical analysis of fruits included the determination of dry matter by drying at 104ºC, the content of vitamin C by the titration method, total sugars by Luffa-Schoorl's method and the contents of basic macroelements: N was determined by the flow method at a wavelength of 560 nm, P was determined by spectrophotometry at a wavelength of 460 nm, whereas K and Ca were assayed by the flame method using a flame photometer.

Statistical analysis of the test parameters was done with the help of Statgraphics Plus programme. Detailed comparison of means was performed by the Tukey's test at α=0.05

RESULTS AND DISCUSSION

One of the essential factors in vegetable cultivation under covers is the season. This is connected with climatic conditions, especially irradiation intensity. Light deficit causes a decrease in the number of fruits set and their proper growth. Under optimum cultivation conditions, plants are better developed and they yield earlier (MEDRANO et al. 2005). Our results point to the fact that the time of cultivation significantly affected yielding. In summer, which is characterized by high irradiation intensity (97 sunny days), the yield was much higher than in spring (37 sunny days) and autumn (38 sunny days) – Table 1. The investigations by VERWER (1978) and OS (1981) as well as PIRÓG (2001) prove that in cucumber greenhouse cultivation, the type of a substrate used is not insignificant. The results of the present investigations prove that the highest yield was obtained from the cultivation on wood fibre, slightly lower yield was characteristic for plants grown on perlite and the lowest yield was obtained on rock wool (Table 1). According to KOMOSA (1994) the quality of cucumber

Table 1

The total yield of fruit ($kg \cdot m^{-2}$) – mean for two cultivars

Terms	Substrats			
	rock wool	perlite	wood fiber	mean
Spring	9.612 *b**	9.610 *b*	11.95 *a*	10.38
Summer	24.52 *a*	28.63 *a*	27.10 *a*	26.75
Autum	12.42 *a*	14.18 *a*	13.24 *a*	13.28
Mean	15.51	17.47	17.43	

* values with the same letter do not differ significantly at $a = 0.05$

Table 2

The content of dry matter, vitamin C, total sugars in cucumber fruit (mean for two cultivars)

Terms	Substrats								
	rock wool			perlite			wood fiber		
	dry matter ($g\ 100\ g^{-1}$)	vitamin C ($mg\ kg^{-1}$)	total sugars ($g\ kg^{-1}$)	dry matter ($g\ 100\ g^{-1}$)	vitamin C ($mg\ kg^{-1}$)	total sugars ($g\ kg^{-1}$)	dry matter ($g\ 100\ g^{-1}$)	vitamin C ($mg\ kg^{-1}$)	total sugars ($g\ kg^{-1}$)
Spring	3.220 *a**	0.067 *b*	932 *b*	3.240 *a*	0.071 *b*	871 *b*	3.121 *a*	0.067 *b*	931 *b*
Summer	3.850 *a*	0.108 *a*	1661 *a*	3.561 *a*	0.118 *a*	1510 *a*	3.932 *a*	0.112 *a*	1821 *a*
Autum	2.840 *b*	0.076 *b*	1220 *a*	2.921 *b*	0.091 *b*	1271 *a*	3.012 *a*	0.0911 *b*	1142 *a*
Mean	3.330	0.084	1271	3.240	0.093	1217	3.355	0.090	1298

* see Table 1

Table 3

The content of phosphorus and calcium ($g \cdot kg^{-1}$) in fruit cucumber (mean for two cultivars)

Terms	Substrats							
	rock wool		perlite		wood fiber		mean	
	P	Ca	P	Ca	P	Ca	P	Ca
Spring	0.639 *a**	0.080 *a*	0.628 *a*	0.060 *a*	0.592 *a*	0.067 *a*	0.619	0.069
Summer	0.541*b*	0.053 *b*	0.585 *b*	0.053 *a*	0.523 *a*	0.061 *a*	0.549	0.056
Autum	0.488 *b*	0.053 *b*	0.536 *b*	0.047 *b*	0.459 *b*	0.047 *b*	0.494	0.049
Mean	0.556	0.062	0.583	0.053	0.524	0.058	-	-

* see Table 1

fruits depended, to a high degree, on substrate, fertilization and the state of plant nutrition. The present investigations revealed that the time of cultivation is another very important factor of fruit quality. Higher dry matter content, vitamin C and total sugars were characteristic for fruits obtained in the summer harvest (Table 2). Fruits picked in the spring time showed a higher content of calcium and phosphorus and fruits from the autumn cultivation were richer in nitrogen and potassium (Tables 3 and 4).

Table 4

The content of nitrogen and potassium ($g \cdot kg^{-1}$) in fruit cucumber (mean for two cultivars)

Terms	Substrats							
	rock wool		perlite		wood fiber		mean	
	$N\text{-}NO_3$	K	$N\text{-}NO_3$	K	$N\text{-}NO_3$	K	$N\text{-}NO_3$	K
Spring	0.492 *b**	0.716 *a*	0.391 *b*	0.701 *a*	0.564 *b*	0.706 *a*	0.482	0.707
Summer	0.359 *b*	0.725 *a*	0.472 *b*	0.737 *a*	0.431 *b*	0.754 *a*	0.420	0.738
Autum	0.741 *a*	0.768 *a*	0.548 *a*	0.743 *a*	0.672 *a*	0.743 *a*	0.653	0.751
Mean	0.530	0.736	0.470	0.727	0.555	0.734	-	-

* see Table 1

CONCLUSIONS

1. Low intensity of irradiation during spring time was a significant cause of much lower yielding as compared to summer and autumn cultivations.

2. The substrate used in the experiment was a factor affecting the yielding volume. The highest crops were obtained from plants cultivated on wood fibre and perlite.

3. Cucumber fruits obtained from summer cultivation were characterized by the highest content of dry matter, total sugars, vitamin C, calcium and phosphorus and a higher content of nitrogen and potassium was observed in fruits from autumn cultivation.

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