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CONCENTRATIONS OF SOME BIONUTRIENTS IN PARTHENOCARPIC CUCUMBER FRUITS IN FORCED CULTIVATION

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Abstract. Cumbers of a parthenocarpic variety Marinda F_1 were grown in the field under protective shields, i.e. a perforated PE sheet and PP needled cloth (17 $g \cdot m^{-2}$), during the years 2001–2003. Unshielded plots served as the control treatment. It was found that the concentrations of nitrogen, calcium and iron increased significantly in cucumber plants grown under PP needled cloth. The edible parts of cucumbers were characterized by widened K : Ca, K : (Mg+Ca) and K : Mg ratios, as well as by favorable Ca : Mg ratios.

Key words: cucumber, parthenocarpic variety, dry matter, bionutrients

INTRODUCTION

In Poland about 21 000 ha of the total cropland area is devoted to cucumber production, which means that it occupies the fifth position in the country and third in Europe [Kaniszewski 2006]. A growing interest in parthenocarpic varieties of cucumber has been observed recently. Such varieties are characterized by the domination of female fruits on a plant. When grown in the field, they set fruits even under less favorable weather conditions [Siwek et al. 1998]. A positive field-forming effect can be also achieved when cucumber seedlings are grown in the field under protective shields, i.e. a perforated PE sheet and PP needled cloth [Wierzbicka et al. 2003, Wierzbicka and Majkowska-Gadomska 2005].

The aim of the present study was to compare the influence of protective shields on the concentrations of some macro- and micronutrients as well as on their ratios in cucumbers of a parthenocarpic variety Marinda F_1.

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MATERIALS AND METHODS

Field and laboratory experiments were conducted during the years 2001–2003 at the Department of Horticulture, University of Warmia and Mazury in Olsztyn. The field trial was established on brown soil of a good rye complex, developed from loamy sand formed on loam with pH 6.7, containing 2.8% of humus. The concentrations of mineral components were as follows: $N\text{-}NO_3$ – 38, K – 127, P – 90, Ca – 1840, Mg – 194 ($mg \cdot dm^{-3}$). Prior to plant growing, manure was applied in the fall, at a rate of 40 $t \cdot ha^{-1}$. The experimental materials comprised pickle-type cucumbers of a parthenocarpic variety Marinda F_1 (Royal Sluis). Each year between May 4 and 6 cucumber seeds were sown into pots filled with peat substrate, in a greenhouse. Seedlings at the fourth-leaf stage were planted out in stripes and rows. Row spacing and stripe spacing was 60 cm and 120 cm respectively, whereas plant spacing in the row was 30 cm. The experiment was performed in a randomized block design, in four replications. There were 10 plants in two rows in each plot. Protective shields were installed on a 0.6 m plastic tunnel immediately after the seedlings had been planted out. A perforated polyethylene (PE) sheet with 100 meshes per m^2 (mesh diameter – 1 cm) and polypropylene (PP) needled cloth (17 $g \cdot m^{-2}$) were applied. Unshielded plots served as the control treatment. The perforated sheet and needled cloth were removed after three and four weeks respectively. Cucumber fruits were harvested twice a week, from the first week of July to the last week of August. Chemical analysis was made at the fruiting stage (at the end of July and at the beginning of August), to determine the dry matter content by the oven-drying method. Cucumber fruits were mashed and dried to constant mass at 652°C in a drier, model KBC G 65/250, and then milled in an electric mill. Next the material was mineralized at the laboratory of the Chemical-Agricultural Station in Olsztyn, to determine the concentrations of the following macronutrients: total nitrogen – by the potentiometric method, phosphorus – by the vanadium-molybdenum method, potassium – by flame photometry, magnesium – by atomic absorption spectrometry (AAS), calcium and sodium – by flame photometry. The concentrations of micronutrients, copper and iron, were determined by atomic absorption spectrometry (AAS). The study was granted accreditation (Accreditation Certificate no. AB 277) by the Polish Accreditation Center in Warsaw.

The results were verified statistically by analysis of variance. The significance of differences was estimated at the 5% level with the Tukey's test, establishing confidence intervals.

RESULTS AND DISCUSSION

Weather conditions significantly affect the yield and quality of crops, including cucumbers [Muchow et al. 1990, Kirby 1995, Heins et al. 2000]. Over the experimental period, the growing season 2002 was found to be the most favorable to cucumber growing. The mean temperature from June to August was 18.8°C, and precipitation total was 137.1 mm, whereas in 2001 and 2003 the mean daily temperatures were lower and precipitation totals – higher (tab. 1).

Table 1. Climatic conditions during vegetation of ground cucumber in the years 2001–2003
Tabela 1. Warunki klimatyczne w trakcie wegetacji ogórka w latach 2001–2003

Year – Rok		Month – Miesiąc			
		June czerwiec	July lipiec	August sierpień	average June–August średnia czerwiec–sierpień
Temperature, Temperatura, °C	2001	13.9	20.0	18.1	17.3
	2002	16.5	20.1	19.8	18.8
	2003	15.5	19.9	18.6	18.0
Precipitation, Suma opadów, mm	2001	77.9	148.6	53.0	279.5
	2002	48.6	27.5	61.0	137.1
	2003	72.0	90.0	56.5	218.5

The average dry matter content of cucumbers var. Marinda F_1 ranged between 3.50 and 3.90%. The highest dry matter concentration was recorded in the edible parts of cucumbers grown under needled cloth, while cucumber plants protected with a perforated PE sheet contained the least dry matter (tab. 2). These results are consistent with those obtained by other authors [Siwek et al. 1998, Kunachowicz et al. 2006].

Table 2. Content of basic chemical components in fruits of cucumber (average 2001–2003)
Tabela 2. Zawartość podstawowych składników chemicznych w owocach ogórka (średnia z lata 2001–2003)

Elements Pierwiastek / Method of growing Metoda uprawy		Control Kontrola	Covering plants with perforated film Osłanianie roślin folią PE	Covering plants with non-woven Osłanianie roślin włókniną PP	Average Średnio	$LSD_{\alpha=0.05}$ $NIR_{\alpha=0.05}$
Dry matter Sucha masa (%)		3.80	3.50	3.90	3.73	0.19
Macroelements, %d.m Makropierwiastki, %s.m.	N	3.08	3.18	3.39	3.22	n.i.
	P	0.99	1.03	1.12	1.05	n.i.
	K	5.44	5.38	6.37	5.73	n.i.
	Mg	0.31	0.31	0.34	0.32	n.i.
	Ca	0.57	0.67	0.74	0.66	0.12
	Na	0.07	0.06	0.07	0.07	n.i.
Microelements $mg \cdot kg^{-1}$d.m. Mikropierwiastki $mg \cdot kg^{-1}$s.m.	Fe	272.80	309.00	360.30	314.03	1.64
	Cu	23.60	22.80	22.90	23.10	n.i.

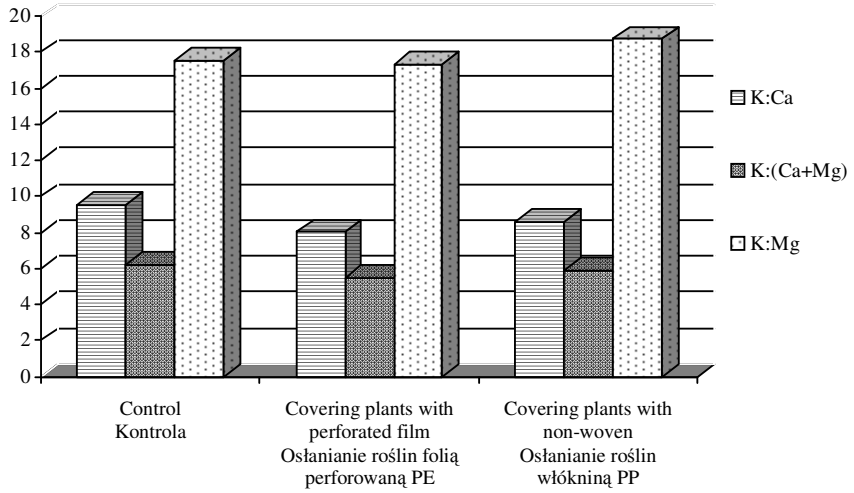

Fig. 1. K : Ca, K : (Ca+Mg) and K : Mg ratios
Ryc. 1. Stosunek pierwiastków K : Ca, K : (Ca+Mg) oraz K : Mg

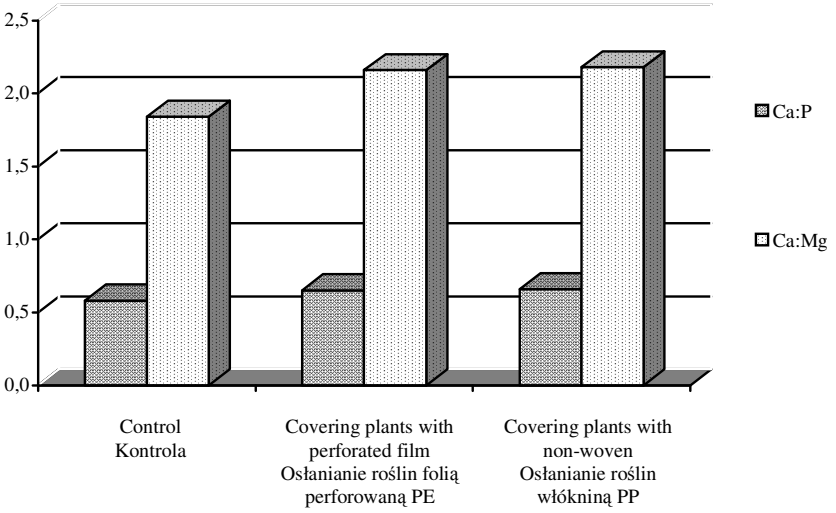

Fig. 2. Ca : P and Ca : Mg ratios
Ryc. 2. Stosunek pierwiastków Ca : P oraz Ca : Mg

The chemical analysis of major mineral components in cucumbers of a parthenocarpic variety Marinda F_1 revealed that their levels were comparable to reference data [Kunachowicz et al. 2006]. Their mean concentrations were as follows: nitrogen – 3.22% d.m., phosphorus – 1.05% d.m., potassium – 5.73% d.m., magnesium – 0.32% d.m., calcium – 0.66% d.m., sodium – 0.07 % d.m., iron – 314.03% d.m., copper – 23.10% d.m (tab. 2). The methods used in the study significantly affected the concentrations of calcium and iron, which substantially increased significantly in the edible parts of cucumbers grown under PP needled cloth. The lowest levels of these nutrients were observed in the control (unshielded) treatment.

Kotowska and Wybieralski [1999] demonstrated that the quality of the edible parts of crops depends not only on the concentrations of macro- and micronutrients, but also on their ratios. Proportions between K : Ca, K : (Ca+Mg), K : Mg, Ca : P and Ca : Mg (figs. 1 and 2) are of primary importance. According to Radkowski et al. [2005], the ratios between these elements should be as follows K : Ca – 2 : 1, K : (Mg+Ca) – 1.6 : 2.2, K : Mg – 6 : 1, Ca : P – 2 : 1, Ca : Mg – 3 : 1. In the present study it was found that cucumber fruits were characterized by widened K : Ca, K : (Mg+Ca) and K : Mg ratios, as well as by favorable Ca : Mg ratios (2.06). The above equivalent ionic ratios, K : (Mg+Ca) and K : Mg, were higher than the equivalent ionic ratios determined for onions by Suchorska-Orłowska [1998].

CONCLUSIONS

1. The concentrations of nitrogen, calcium and iron increased significantly in cucumbers of a parthenocarpic variety Marinda F_1 grown under PP needled cloth.
2. The edible parts of cucumbers were characterized by widened K : Ca, K : (Mg+Ca) and K : Mg ratios.
3. Cucumber fruits had favorable Ca : Mg ratios.

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ZAWARTOŚĆ WYBRANYCH BIOPIERWIASTKÓW W OWOCACH OGÓRKA PARTENOKARPICZNEGO Z UPRAWY PRZYSPIESZONEJ

Streszczenie. W latach 2001–2003 przeprowadzono badania nad uprawą ogórka partenokarpicznego odmiany 'Marinda F_1' uprawianego w polu pod osłonami z folii PE perforowanej oraz włókniny PP 17 g·m^{-2}. Kontrolę stanowił obiekt, w którym nie osłaniano roślin. W wyniku przeprowadzonych badań wykazano istotne zwiększenie poziomu zawartości wapnia oraz żelaza w owocach ogórka z uprawy roślin pod włókniną PP. Części jadalne roślin charakteryzowały się rozszerzonym, na korzyść potasu, stosunkiem K : Ca, K : (Mg+Ca) i K : Mg oraz korzystną dla organizmu ludzkiego proporcją wapnia do magnezu.

Key words: ogórek, odmiana partenokarpiczna, sucha masa, biopierwiastki

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