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CONTENT OF MACROELEMENTS IN EGGPLANT FRUITS DEPENDING ON NITROGEN FERTILIZATION AND PLANT TRAINING METHOD

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Abstract

Eggplant fruits are known for being low in calories but rich in minerals, which is good for human health. They are rich in potassium, whose content ranges from 200 to 600 mg $K \cdot 100\ g^{-1}$ of fresh mass, depending on a cultivar. Eggplant fruits are also a source of magnesium, calcium and iron. Research on the agro-techniques of eggplant culture in a plastic tunnel has implicated that, on account of a very intensive growth of the plant, both plant pruning and training have a decisive influence on the final amount of fresh mass. Since we lack information concerning the fertilization recommendation for growing eggplants under a plastic tunnel, a study has been undertaken to specify such nutritional needs of this vegetable. The aim of this work has been to determine the influence of nitrogen forms and plant training methods on the content of nitrogen, phosphorus, potassium, calcium and magnesium in eggplant fruits. The experiment on cv. Epic F_1 eggplant was carried out in years 2004-2005, with eggplants growing in an unheated plastic tunnel. The eggplants were cultivated in cylinder plastic wraps of 10 dm^3 volume, in peat. The experiment was carried out in two stages, in a completely random design, with each stage examining different factors. The following factors were examined: I – nitrogen forms: NH_4^+ (ammonium sulphate – $(NH_4)_2SO_4$ (20,5% N); NO_3^- (calcium nitrate – $Ca(NO_3)_2$ (15,5% N); NH_2 (urea – $CO(NH_2)_2$ (46% N), II – plant training method: natural form of the plant, 3 shoots.

Nitrogen was used in the amount of 10 g $N \cdot plant^{-1}$. Samples of fruits used for further laboratory tests were collected in the 2nd decade of August, in the middle of fructification. The fruits were harvested at the marketable stage. N-total, P, K, Ca, Mg were determined in the fruits. The results were elaborated statistically using analysis of variance. Generally, considerably higher content of nitrogen was determined in eggplant fruits fertilised with the N ammonium form; also the content of potassium and magnesium was much higher in comparison to

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the other nitrogen forms examined. Moreover, significant influence of the plant pruning method on the content of the elements was found, independently of the applied nitrogen fertilization.

Key words: eggplant fruits, nitrogen form, plant training, chemical composition.

ZAWARTOŚĆ MAKROSKŁADNIKÓW W OWOCACH OBERŻYNY W ZALEŻNOŚCI OD FORMY ZASTOSOWANEGO NAWOZU AZOTOWEGO I SPOSOBU PROWADZENIA ROŚLIN

Abstrakt

Owoce oberżyny odznaczają się niską kalorycznością oraz korzystnym dla człowieka składem mineralnym. Są przede wszystkim zasobne w potas, którego zawartość waha się w zależności od odmiany od 200 do 600 mg K·100 g^{-1} świeżej masy. Są również źródłem magnezu, wapnia i żelaza. W badaniach nad agrotechniką oberżyny uprawianej pod folią wykazano, że ze względu na intensywny wzrost roślin, zabiegiem plonotwórczym kształtującym ilość zielonej masy jest cięcie i formowanie roślin. Z powodu braku informacji o zaleceniach nawozowych do uprawy oberżyny pod osłonami, podjęto badania nad określeniem potrzeb nawożenia tego warzywa. Celem pracy było określenie wpływu formy nawozu azotowego oraz sposobu prowadzenia roślin na zawartość azotu, fosforu, potasu, wapnia i magnezu w owocach oberżyny. Badania oberżyny odmiany Epic F_1 wykonano w nieogrzewanym tunelu foliowym w latach 2004-2005. Oberżynę uprawiano w torfie ogrodniczym, w cylindrach z folii sztywnej o pojemności 10 dm^3. Doświadczenie dwuczynnikowe przeprowadzono w układzie kompletnej randomizacji. Badano wpływ czynników: I – forma azotu: NH_4^+ [siarczan amonu – $(NH_4)_2SO_4$ – 20,5% N]; NO_3^- [saletra wapniowa – $Ca(NO_3)_2$ – 15,5% N]; NH_2 [mocznik – $CO(NH_2)_2$ – 46% N]; II – sposobu prowadzenia roślin: forma naturalna; 3 pędy. Azot zastosowano w ilości 10 g N·$roślina^{-1}$. Próby owoców do badań laboratoryjnych pobrano w 2 dekadzie sierpnia, w połowie okresu owocowania. Owoce zbierano w fazie dojrzałości użytkowej i oznaczono w nich N-og., P, K, Ca, Mg. Wyniki opracowano metodą analizy wariancji. Największą zawartość azotu ogółem, potasu i magnezu stwierdzono w owocach roślin nawożonych siarczanem amonu, w porównaniu z pozostałymi zastosowanymi nawozami. Ponadto stwierdzono wyższą zawartość makroskładników w owocach roślin prowadzonych na 3 pędy.

Słowa kluczowe: owoce oberżyny, formy azotu, prowadzenie roślin, skład chemiczny.

INTRODUCTION

Interest in eggplant cultivation and consumption has recently been growing in Poland. Eggplant fruits are low in calories and have mineral composition which is beneficial for human health. They are abundant in potassium: from 200 to 600 mg K·100 g^{-1} of fresh matter. They are also a rich source of magnesium, calcium, and iron (HERRMANN 1996, LAWENDE, CHOWAN 1998, KOWALSKI et al. 2003, MARKIEWICZ, GOLCZ 2003, GOLCZ et al. 2005).

Studies on agronomic aspects of covered eggplant culture have revealed that as the plants grow intensively, the pruning and forming of eggplants are the yield-forming operations that mostly shape the green matter quantity (Ambroszczyk, Cebula 2000, 2003, Passarakli, Dris 2003). There is little information in the available literature on nutritional requirements of eggplants grown in covered culture. Up-to-date fertilization recommendations for this vegetable are based on the tomato's nutritional needs (Uliński, Glapś, 1998). At present, experiments have been undertaken to evaluate fertilization requirements of eggplants with a view to achieving quality yields (Golcz et al. 2005, Michałojć, Buczkowska 2007).

The present paper aims at evaluating the influence of nitrogen form and plant training on nitrogen, phosphorus, potassium, calcium, and magnesium content in eggplant fruits.

MATERIAL AND METHODS

In 2004-2005, trials on cv. Epic F_1 eggplant under unheated plastic tunnel were carried out at the Experimental Farm in Felin, University of Agriculture, Lublin. Potted eggplant seedlings were prepared in accordance with the commonly accepted recommendations for this species. In both years, plants were set under the covering at the beginning of June. The cultivation period from seed sowing until harvest was about 7 months (beginning of March – mid of September).

Eggplants were cultivated in plastic cylinder wraps of 10 dm^3 volume on horticultural peat (initial pH_{H_2O} 4.6) limed with $CaCO_3$ to pH 6.5. A two-factorial experiment was set in a completely random design. Every experimental object was represented by 8 experimental units.

The influence of the two following factors was studied:

nitrogen form: NH_4^+ – ammonium sulfate [$(NH_4)_2SO_4$ (20.5% N)]; NO_3^- – calcium nitrate [$Ca(NO_3)_2$ (15.5% N)]; NH_2 - urea [$CO(NH_2)_2$ (46% N)];

plant training system: natural form; 3 shoots.

Fertilization expressed in $g \cdot plant^{-1}$ was: nitrogen (N) – 10; phosphorus (P) – 7.0 as superphosphate [$Ca(H_2PO_4)_2 \cdot H_2O$ – 20.2% P]; potassium (K) – 16 as potassium sulfate [K_2SO_4 – 41.6% K]; magnesium (Mg) – 7.0 as magnesium sulfate ($MgSO_4 \cdot H_2O$ 17.4% Mg). The microelements were applied as: EDTA – Fe, $CuSO_4 \cdot 5H_2O$, $ZnSO_4 \cdot 7H_2O$, $MnSO_4 \cdot H_2O$, H_3BO_3, $(NH_4)_2Mo_7O_{24} \cdot 4H_2O$ at the rates recommended for peat substrates. When preparing the growing medium, all the microelements, half a phosphorus dose and 1/7 nitrogen, potassium, and magnesium doses were applied before planting the seedlings. The remaining amounts of nitrogen, potassium, and magnesium were subsequently sown in 6 doses every 10 days, while the remaining phosphorus was added at the beginning of eggplant ripening.

Plants were trained in two systems: in their natural form with no pruning and with 3 main shoots left. The pruning was gradually performed as the shoots were growing. Eggplant fruits were harvested at the marketable stage, i.e. when the skin was glossy, deep purple (the weight of harvested fruits ranged from 250 to 300 g). The harvest repeated every 7-10 days since the end of July to the end of September.

Fruit samples for laboratory analyses were collected in the 2^{nd} decade of August, in the middle of fructification. The following elements were determined after wet digestion: N – total with Kjeldahl's method (Kjel-Foss) and after dry combustion at 550°C; P – colorimetrically using ammonium molybdenate; K, Ca, Mg – applying the AAS technique (Perkin–Elmer). All determinations were made in 3 replications and the final results of N, P, K, Mg, and Ca were expressed in $g \cdot kg^{-1}$ of dry matter.

The results were statistically processed using analysis of variance. Significant differences were found by Tukey's multiple confidence intervals at 5% level.

RESULTS AND DISCUSSION

Total nitrogen content in eggplant fruits was from 17.7 to 22.1 g $N \cdot kg^{-1}$ d.m. The nitrogen forms and plant training methods examined significantly differentiated the level of nitrogen in eggplant fruits. Considerably more nitrogen was found in plants fertilized with the reduced ($N\text{-}NH_4$, NH_2) rather than oxidized nitrogen form ($N\text{-}NO_3$) – Table 1. Higher conversion rate of reduced nitrogen forms in eggplant can account for such a dependence, which was confirmed by ASIEGBU et al. (1991), GOLCZ et al. (2005), MICHAŁOJĆ, BUCZKOWSKA (2007).

The content of phosphorus was from 2.7 to 2.9 g $P \cdot kg^{-1}$ d.m. No significant influence of the applied nitrogen forms on its concentration in eggplant fruits was observed. SEVIADER, MORSE (1982) found a similar content of the element in their studies on phosphorus fertilization of eggplant.

The level of potassium ranged from 22.6 to 30.2 g $K \cdot kg^{-1}$ d.m. and, like nitrogen, was significantly differentiated by the experimental factors. Considerably more potassium was found in eggplant fruits from plants fertilized with ammonium sulfate (27.9 g $K \cdot kg^{-1}$ d.m.), as compared to those fertilized with other nitrogen forms. Potassium is easily taken up and transported within a plant, thus it is found in high concentrations in plants' generative parts. ABDEL HAFEEZ, CORNILLON (1976), SAVVAS i LENZ (1994), RUSSO (1996) found similar or even higher levels of potassium in eggplant fruits.

The concentration of calcium level was from 1.2 to 1.7 g $Ca \cdot kg^{-1}$ d.m. Significantly more calcium was found in plants fertilized with ammonium sulfate, less in the objects where calcium nitrate was applied as a fertilizer.

Table 1

The content of macroelements in eggplant fruits depending on nitrogen fertilization and plant training method

Nitrogen fertilization	Plant training method 1* natural form 2* 3 stems	Content of mineral elements ($mg \cdot kg^{-1}$ d.m.)				
		N - total	P	K	Ca	Mg
$(NH_4)2SO_4$	1*	22.1	2.90	25.60	1.50	1.30
	2*	21.8	2.80	30.20	1.70	1.50
	average	22.0	2.90	27.90	1.60	1.40
$Ca(NO_3)_2$	1*	17.7	2.60	24.60	1.30	1.30
	2*	21.6	2.90	27.70	1.40	1.30
	average	19.6	2.70	26.10	1.30	1.30
$CO(NH_2)_2$	1*	19.8	2.70	22.60	1.20	1.10
	2*	21.9	2.90	25.60	1.70	1.30
	average	20.9	2.80	24.10	1.50	1.20
Average	1*	19.9	2.70	24.30	1.30	1.20
	2*	21.8	2.90	27.80	1.60	1.40
	average	20.9	2.80	26.00	1.50	1.30
LSD p=0.05 for kind of nitrogen fertilization		1.910	n. s.	2.340	0.19	n. s.
LSD p=0.05 for plant training method		1.290	0.130	1.610	0.13	0.19
LSD p=0.05 for interaction (a x b)		3.330	n. s.	4.130	0.34	n. s.

Magnesium content in eggplant fruits was similar to that of calcium: from 1.1 to 1.5 g $Mg \cdot kg^{-1}$ d.m. No significant influence of the nitrogen fertilizer on magnesium level in eggplant fruits was found. Tests by GOLCZ and MARKIEWICZ (2005) on eggplants cultivated on organic soils used several times revealed similar calcium and magnesium levels.

Regardless of the nitrogen form applied, significant influence of the plant training method on the total nitrogen, phosphorus, potassium, calcium, and magnesium contents in eggplant fruits was observed. Considerably higher levels of these elements were found in fruits of plants trained for 3 shoots than growing in the natural form. There are no data on the influence of a plant training methods on mineral content in eggplant fruits in available literature; nonetheless, AMBROSZCZYK and CEBULA (2000) demonstrated that the regulation of fruit bud number trained for a single shoot affected the biological value of eggplant fruits.

CONCLUSIONS

1. The highest concentrations of total nitrogen, potassium, and magnesium were determined in fruits of plants fertilized with ammonium sulfate as compared to other fertilizers.

2. Higher contents of macroelements were found in fruits of plants trained for 3 shoots.

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