The Effect of Fertilization Method on Selected Elements Content in Tomatoes (*Lycopersicon lycopersicum*)

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Abstract: Fermented pig slurry was used for two kinds of tomatoes fertilisation as a replacement of industrial mineral fertilisers in three-year experiment and selected elements (Pb, Cd, As, Zn and Hg) content were monitored by the AAS method. The results obtained showed that anaerobically fermented pig slurry can be a suitable alternative to mineral fertiliser use. Its use as an organic fertiliser also did not decrease the hygienic quality and safety of the grown vegetable products, and all tomato samples fulfilled the heavy metals legislation limits for Pb, Cd, As, Zn and Hg content. Statistically significant ($P < 0.05$) influences of the year, cultivar and fertilisation method were found in case of zinc content. No statistically significant differences in case of arsenic were discovered. Statistically significant influence ($P < 0.05$) of the year was found in case of cadmium and mercury contents.

Keywords: tomato; anaerobically fermented pig slurry; fertilisation; food quality

INTRODUCTION

Intensified agriculture and increasing industrialisation have resulted in the release of various pollutants, including metals, into the environment (Svete *et al*. 2001). The contaminants may enter the food chain (Fichet *et al.* 1999) and consequently elevated concentrations of heavy metals and organic substances can be found in foodstuffs (Nasreddine & Parent-Massin 2002). Therefore, it is important to pay great attention to avoid soil pollution and the danger of introducing harmful substances in the food chain of the growing media. One criterion of soil fertility and stability is soil organic matter content. The need for improving soils and growing media productivity has highlighted the necessity of the utilisation of organic wastes in production (Picollo *et al.* 1997). The addition of organic fertilisers is recommended, as they increase organic carbon availability stimulating biological O_2 demand (Rochette *et al.* 2000) and provide better utilisation of nutrients in the soil.

Al-Lahham *et al.* (2007) and Bletsos and Gantidis (2004) conducted experiments to investigate the extent of translocation of heavy metals to tomato fruit irrigated with potable water and municipal sewage sludge. Results of analyses showed the accumulation of heavy metals in fruit below the standard limits.

Anaerobically fermented pig slurry as the waste from basic farm industry belongs among organic fertilisers with the high improvement efficiency Vallejo *et al.* (2006). But at present, we have limited information about utilisation of digestate from biogas station for growing of vegetables, respective fermented pig slurry or other types of manure which were used as the fuel for biogas production.

In this paper, we discussed the effects of anaerobically fermented pig slurry as the fertiliser on selected elements (Pb, Cd, As, Zn and Hg) con-

tents in tomatoes. The objective of this study was to find out if anaerobically fermented pig slurry could be a suitable replacement to mineral inorganic fertilisers.

MATERIAL AND METHODS

Seeds of tomato (*Lycopersicon lycopersicum* L.) cultivars: Start F1 (marked S) and Tornádo (marked T) were purchased from Semo Company (Smržice, Czech Republic) and grown in greenhouses. Tomato plants (size 30 cm) were then planted out into 20 l vessels, in Peat-bark substrate RKS I (Agro CS, a.s.). Ten plants were grown for each of the following fertilising treatments: Control (marked N) – no added fertilisers. Mineral (marked M) – 15 g $(NH_4)_2SO_4$ and 9 g K_2HPO_4 were added to each vessel (20 l) prior to planting. 7.5 g $(NH_4)_2SO_4$ per each vessel was added 30 days later. Organic (marked O) – 0.8 l of fermented pig slurry was added to each vessel which prior to planting. 2 l of the same organic fertiliser per each vessel was added 30 days later. Combined (marked C) – 50% of mineral and 50% of organic fertilisers were added.

The composition of the anaerobically fermented pig slurry obtained from biogas station ČOV Třeboň (R.A.B. spol. s.r.o., Czech Republic) was: 595 mg NH_4^+ per litre, 755 mg PO_4^{3-} per litre and 1.1 – 1.25 g K_2O per litre. The analysis of heavy metals was

Table 1. Heavy metals concentrations (mg per kg dry matter) in tomatoes in 2005, 2006 and 2007

Sample	Hg (mg/kg)		As (mg/kg)		Cd (mg/kg)		Zn (mg/kg)	
	mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.
2005								
NS	0.0104	0.0040	0.012*	0.002	0.079	0.042	18.2*	0.7
OS	0.0356**	0.0034	0.038	0.003	0.038*	0.020	55.3**	0.5
CS	0.0060	0.0047	0.033	0.006	0.126	0.041	29.5	1.5
MS	0.0073	0.0004	0.024	0.003	0.193**	0.009	29.2	3.3
NT	0.0089	0.0014	0.029	0.004	0.038*	0.022	20.6	1.1
OT	0.0011	0.0003	0.028	0.004	0.056	0.004	21.7	1.3
CT	0.0123	0.0040	0.040**	0.005	0.145	0.013	34.4	2.6
MT	0.0010*	0.0003	0.012*	0.002	0.093	0.016	19.3	1.4
2006								
NS	0.0008	0.0000	0.034	0.016	0.119	0.011	21.8	1.2
OS	0.0005*	0.0001	0.023*	0.009	0.183	0.051	38.2**	4.2
CS	0.0009	0.0003	0.030	0.012	0.145	0.015	31.7	2.8
MS	0.0004	0.0000	0.031	0.007	0.161	0.017	34.2	0.3
NT	0.0013	0.0002	0.036	0.027	0.171	0.035	19.3*	1.7
OT	0.0009	0.0007	0.025	0.011	0.103*	0.013	29.3	0.2
CT	0.0017**	0.0002	0.028	0.004	0.162	0.060	25.2	9.2
MT	0.0011	0.0003	0.039**	0.006	0.252**	0.046	28.7	0.4
2007								
NS	0.0010	0.0002	0.089**	0.002	0.056	0.008	21.83	0.27
OS	0.0003*	0.0001	0.003*	0.003	0.051	0.009	24.33	0.39
CS	0.0021	0.0006	0.029	0.015	0.057	0.006	25.20	0.29
MS	0.0005	0.0001	0.071	0.011	0.053	0.003	28.51**	0.43
NT	0.0007	0.0004	0.010	0.002	0.040*	0.003	19.19*	0.09
OT	0.0006	0.0005	0.032	0.029	0.054	0.002	19.72	0.33
CT	0.0022**	0.0011	0.068	0.008	0.070**	0.015	23.25	4.57
MT	0.0004	0.0002	0.009	0.002	0.066	0.001	23.15	0.14

*lowest values; **highest values

done by the AAS method (Miholová *et al.* 1996). All results were statistically analysed by ANOVA method (Statistica Ver. 8, StatSoft Inc.).

RESULTS AND DISCUSSION

The obtained results (mean and standard deviation S.D.) of selected elements (Hg, As, Cd and Zn) contents are given in Table 1. Analytically found concentrations contents are in agreement with literature data (Castaldi & Melis 2004; Demirezen & Aksoy 2006). All tomato samples fulfilled the heavy metals limits for tested elements (Czech Directive No. 305/2004, Regulation 1881/2006/EC). The lead content values of all samples did not exceed 0.1 mg/kg of fresh matter, therefore the fertilisation with pig slurry does not increase the amounts of lead found in tomatoes, which confirms the results published by Al-Lahham *et al.* (2007).

Statistically significant ($P < 0.05$) influences of the year, cultivar and fertilisation method were found in case of zinc content. No statistically significant differences in case of arsenic were discovered. Statistically significant influence ($P < 0.05$) of the year was found in case of cadmium and mercury contents.

CONCLUSION

Our study shows that anaerobically fermented pig slurry could be a suitable alternative to conventional mineral fertilisers, because all tomato samples fulfilled the heavy metals limits for tested elements. Though the used amounts of both inorganic and organic fertilisers contained the same level of N, P and K, the difference in growth and elements contents might be due to a change in soil conditions produced by fermented pig slurry.

Acknowledgements: Supported by the Ministry of Education, Youth and Sports of the Czech Republic, Project No. MSM 6046070901.

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