THE EFFECT OF ORGANIC RESIDUES FROM DIFFERENT SOURCES ON SOIL PROPERTIES, FRUIT PRODUCTION AND MINERAL COMPOSITION OF PEPPER CROP

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ABSTRACT

A pot experiment with pepper crop (*Capsicum annum* L. cv. Sonar) was conducted to study the effect of organic residues (OR) from different sources on soil properties (Cambic Arenosol), pepper fruit production and mineral composition. The OR tested were: municipal solid waste compost (MSWC), pulp mill sludge (PS), poultry manure (PM) and three mixtures consisting of: 50%MSWC+50%PS, 50%MSWC+50%PM and 50%PS+50%PM (on a dry weight basis). Experimental data supports that OR led to significant increases of soil pH values, which were particularly evident for MSWC. The use of this residue also led to a significant increase of soil sodium (Na) content. Although the use of OR increased the amounts of soil extractable copper (Cu), iron (Fe), zinc (Zn) and manganese (Mn) (Lakanen & Ervio method), the content of these micronutrients on fruits composition was lower than those from control. Further, OR treatments allowed the higher fruit production although no significant differences were detected between treatments. The lower production obtained to control was likely due to a decrease of soil pH caused by the mineral basal nitrogen fertilization.
Keywords: *organic residues; soil properties; pepper fruit production; fruits mineral composition.*

INTRODUCTION

Land application of organic residues (OR), can recycle nutrients back onto agricultural land and thus reduce the need for mineral fertilizers. In fact, organic amendments can supply nutrients required for maximum crop production and quality, trough proper timing and placement and optimum rates of addition, namely using the most adequate mixtures of several OR. Other potential benefits arise from an improvement of soil properties, resulting in a better soil environment for root development and nutrient uptake (Mbagwu et al., 1994; Cabral et al., 1998, Vasconcelos et al., 1999).

The scope of this study was to investigate the effect of OR from different sources, on the properties of a Cambic Arenosol. Effects on fruit production and mineral composition were also evaluated.

MATERIAL AND METHODS

A pot experiment with pepper crop (*Capsicum annum* L. cv. Sonar) was conducted in pots filled with 10.5 kg (fraction<5mm) of a Cambic Arenosol - FAO classification (sandy texture, pH (H_2O) - 5.4, organic matter - 5.2 g kg^{-1}, extractable P, K, Zn, Mn, Cu and Fe, 22.7, 29.1, 4.5, 8.5, 15.1 and 43.4 mg kg^{-1}, respectively). In every treatment (**B** - municipal solid waste compost - 100% MSWC; **C** - poultry manure - 100% PM; **D** - pulp mill sludge - 100% PS; **E** - 50%MSWC+50%PS; **F** - 50% MSWC+50%PM and **G** - 50%PS+50%PM), an amount of each OR (Table 1) equivalent to 0.67 g of nitrogen (N) per pot was thoroughly mixed with the soil. A control (treatment **A**) with the same amount of N as ammonium sulfate was performed. All pots received a basal fertilization consisting of 0.44 g phosphorus (P), 0.83 g potassium (K), and

0.3 g magnesium (Mg). One seedling was planted per pot, and 30 days after plantation soil samples were taken up and all pots received a weekly top dressing fertilization consisting of 0.075g N and 0.05 g K as nutrient solution containing potassium nitrate and calcium nitrate. During the experiment ripe fruits were counted, harvested, weighted and dried for further analysis. At the end of the experiment soil samples were collected to be analyzed.

***Table 1**. Chemical composition of different organic residues (dry matter).*

Determinations	MSWC	PM	PS
Org. matter g kg^{-1}	419.0	725.0	856.0
N - Kjeldahl g kg^{-1}	18.6	42.6	42.4
P g kg^{-1}	5.9	16.5	4.3
K g kg^{-1}	8.1	20.6	3.1
Ca g kg^{-1}	58.8	72.0	29.7
Mg g kg^{-1}	4.8	5.8	1.4
Na g kg^{-1}	8.0	3.9	5.6
Fe g kg^{-1}	19.4	2.3	1.7
Zn mg kg^{-1}	522.1	430.4	32.1
Mn mg kg^{-1}	269.5	306.7	810.8
Cu mg kg^{-1}	255.5	43.8	11.7
pH (dil. 1:5)	7.97	8.4	6.8

Soil organic matter was calculated using a StrÖhlein apparatus. Organic matter of OR was determined by loss-on-ignition at 350-400ºC for 7-8 hours. Soil extractable phosphorus (P) and potassium (K) were determined by the Egner-Riehm method (Egner *et al*., 1960), while soil extractable Zn, Mn, Cu, Fe by the Lakanen and Ervio method (1971). Nitrogen (N) of OR and fruits was determined by the Kjeldahl method (Horneck and Miller, 1998). Elemental composition of OR and fruits was determined by atomic absorption spectrophotometry, except for P, which was determined by the yellow color method (Koenig and Johnson, 1942). Results from the study were subjected to a one-way ANOVA, followed by Schefe F-test at $p < 0.05$ (Danzart, 1986).

RESULTS AND DISCUSSION

One month after plantation soil samples were taken to investigate eventual changes on soil properties as a result of OR application (Table 2). Treatment B (100% MSWC) shows a significant increase of soil pH. Moreover, an increase of Na content occurs in every MSWC treatment. By contrast, a significant decrease of soil pH was detected for control indicating the nitrification of ammonium nitrogen applied as basal fertilization. Only MSWC treatments led to an increase of soil extractable Fe that is consistent with the high amounts of this element in that residue. Despite differences on OR composition, its effects on soil properties in a short time period were negligible. OR treatments achieved much greater yields than control (Table 3), due to the decrease of soil pH caused by nitrogen mineral fertilization (Table 4). OR treatments always led to significant increases of soil pH.

***Table 2**. Some physical and chemical characteristics of the soil after one month experiment.*

Treatment	pH	O.M. g kg^{-1}	Ca mg kg^{-1}	Na mg kg^{-1}	Cu mg kg^{-1}	Fe mg kg^{-1}	Zn mg kg^{-1}	Mn mg kg^{-1}
A	4.8c	0.065a	177.0a	12.40b	18.30a	43.13b	6.10a	6.50a
B	6.0a	0.063a	146.1a	47.10a	21.33a	64.73a	8.23a	7.60a
C	5.3b	0.054a	139.2a	19.00b	18.03a	43.50b	5.73a	7.27a
D	5.4b	0.071a	149.1a	16.50b	22.67a	45.63b	5.57a	7.23a
E	5.4b	0.071a	147.3a	46.80a	20.73a	58.37a	6.93a	7.83a
F	5.4b	0.064a	167.0a	37.10a	18.00a	54.30ab	6.37a	8.10a
G	5.7ab	0.062a	148.2 a	25.50b	18.90a	45.33b	6.77a	7.13a

Means in the same column followed by different letters are significantly different at $p< 0.05$.

***Table 3**. Yield obtained to pepper fruits.*

Treatment	Fresh yield/ pot (g)	Dry yield/ pot (g)	Fresh yield /pepper fruit (g)
A	193.8b	14.7b	44.8b
B	477.4a	31.1a	95.5a
C	407.7a	26.4a	101.9a
D	396.9a	24.3a	110.1a
E	473.0a	26.4a	119.7a
F	403.9a	26.9a	101.0a
G	435.3a	28.8a	97.0a

Means in the same column followed by different letters are significantly different at $p< 0.05$.

***Table 4**. Physical and chemical characteristics of the soil at the end of the experiment.*

Treatment	pH	O.M. g kg^{-1}	Na mg kg^{-1}	Cu mg kg^{-1}	Fe mg kg^{-1}	Zn mg kg^{-1}	Mn mg kg^{-1}
A	5.03d	0.058a	19.50b	18.37b	43.73b	4.20ab	7.60b
B	6.23a	0.068a	60.33a	23.93a	60.40a	5.30a	8.90ab
C	5.73bc	0.064a	22.83b	21.27ab	46.13ab	4.67ab	10.10a
D	5.60c	0.065a	24.00b	19.33b	42.80b	3.93b	9.03ab
E	5.97ab	0.066a	25.67b	20.60ab	49.93ab	4.67ab	9.50ab
F	5.87bc	0.071a	28.33b	19.70b	48.40ab	4.60ab	9.13ab
G	5.70bc	0.072a	19.50b	20.87ab	48.30ab	4.53ab	10.30a

Means in the same column followed by different letters are significantly different at $p< 0.05$.

At the end of the experiment (Table 4), an increase of Na on soil solution and on soil extractable Cu, Fe and Zn was observed for MSWC treatments, as well as of extractable Mn for PM additions. No significant differences between treatments were detected for fruit mineral composition (Table 5) when OR were applied. Control produced fruits with the highest amounts of nutrients, except for calcium and sodium. This fact, can likely be related to a concentration effect due to the lower yield obtained to control, resulting from the greatest availability of micronutrients cations as a consequence of the lower soil pH. Although MSWC application led to higher amounts of micronutrients and sodium in the soil, this fact is not reflected on fruits' composition.

***Table 5**. Mineral composition of pepper fruits (dry matter).*

Treatment	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Na (%)	Cu (mg kg^{-1})	Zn (mg kg^{-1})	Mn (mg kg^{-1})
A	2.74a	0.44a	2.28a	0.10b	0.12a	0.02a	16.07a	51.23a	97.12a
B	1.72b	0.34b	2.04ab	0.12ab	0.06b	0.02a	9.36b	21.27b	16.07b
C	1.61b	0.35b	1.91b	0.13a	0.09ab	0.02a	10.03b	24.77b	18.59b
D	1.63b	0.33b	1.88b	0.13a	0.08b	0.02a	10.05b	24.76b	26.02b
E	1.75b	0.34b	2.06b	0.14a	0.09ab	0.03a	11.58ab	27.07b	15.54b
F	1.57b	0.34b	1.93b	0.13a	0.09ab	0.03a	10.85ab	27.42b	13.73b
G	1.68b	0.38b	1.82b	0.13a	0.08b	0.03a	10.60ab	30.57b	17.14b

Means in the same column followed by different letters are significantly different at $p< 0.05$.

CONCLUSIONS

Experimental data supports that for the soil studied, which has a sandy texture and shows a very low buffer capacity, the use of ammonium sulfate as basal dressing fertilization is not recommended. This fact resulted on a decrease of soil pH that significantly affected pepper fruits production.

OR treatments always led to an increase of soil pH values. Concerning other physical and chemical properties of the soil an increase of extractable iron (Fe), copper (Cu) and zinc (Zn) as well as sodium (Na) water soluble was detected. Poultry manure (PM) additions to soil led to an increase of extractable manganese (Mn). However and despite the changes observed on soil characteristics as a result of OR application, pepper yield as well as fruits mineral composition were not affected.

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