Use of the sugarcane pulp residue as a soil organic amendment and its possible use as a horticultural substratum

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Abstract: - In the present work it was studied the use of sugarcane residues as an organic corrective and the possibility to be applied as a substratum in the green pepper culture *Capsicum annuum* L.
Mixtures of soil and sugarcane residues were used with increasing doses in the following percentages 0%, 25%, 50%, 75% and of 100% of sugarcane residues.
Weekly evaluations of the biometrical parameters in the plant of each treatment were determined, such as the height, the stem diameter, the number of leaves and number of floral buttons, the SPAD units in new and old leaves and the number of developed fruits.
Laboratorial analysis were determined to evaluate chemical parameters both in plants and in the treatments at the end of the experiment - pH, the electric conductivity and the concentration of N, P, K, Mg, Ca, Fe, Cu, Mn e Zn soil and sugarcane residues mixtures.
It can be concluded that sugarcane residues have characteristics of a good soil organic compost, and can be used in soils poor in organic matter, and contribute to increase the soil fertility level.
Moreover, it was observed some root development, in accordance with the increase of sugarcane applied in the mixtures.
Plants growing in the 100% sugarcane residues mixture showed a satisfactory behavior, probably due to a better soil aerification, which had promoted root production.

Keywords: – sugarcane residues, organic amendment, substratum, physical and chemical parameters

1 Introduction

The population increase and the industrial development produce an enormous amount of organic residues that nowadays generate great environmental problems. The appropriate agricultural use of these residues can become advantageous for the mankind because it allows nutrients recycling, improve crop production, less pollution problems, and as well the improvement of the physical, chemical and biotic conditions of the soils.
In certain areas, the soil is poor in organic content, and therefore needs organic amendment. According to [2], in the last decades, the substratum growth crops is winning prominence in the world scenery, due to the problems originated by the traditional crops in soil. It can decrease the proliferation of pathogens, the salinity of the soils, the use of water and nutrients; hence, the use of less aggressive production systems is applied to the environment.
An excellent substratum depends on the techniques used on its production, on the type of the vegetable material, climatic conditions, water content and some economical aspects.
The sugarcane is a grassy crop that produces, in a short period, a high income of biomass, energy and fibres, being considered one of the plants with larger photosynthetic efficiency. Its plantation, in a wide scale, is traditional in several countries of the tropical and subtropical regions for the production of sugar, alcohol and other bio-products. Several tons of sugarcane residues are produced and need to be conditioned. Experiments have been conducted to study the viability of those residues on wheat production [1], as horticultural substrates mixes [6], as nematicide on mandarin culture [4], or as fish feeds [8]. Sugarcane bagasses are a source of vegetal fibres that have potential use on the industry of polymeric composites [7]. All these potential uses have the major goal of resolve the disposal problems of sugarcane residues production.
This work had as main objective to study the use of the sugarcane pulp, final residue of the processing

of the sugarcane as an organic soil amendment and simultaneously to verify its possibility as a substratum. The culture chosen for the experiment was green pepper (*Capsicum annuum* L.), a horticultural plant well adapted to high temperatures.

2 Material and methods

2.1 Experimental procedure
The study was carried out in an investigation greenhouse, in the "Horto" of the Faculty of Natural Resources Engineering at the University of Algarve.
The crop used in this experiment was *Capsicum annuum* L., variety *Lamuyo*, sowed in alveolated nursery. It was used a topsoil layer from a Haplic Arenosol (ARha) according to World Reference Base for Soil Resources [5]. The straw pieces were pressed and the dimensions of the sugarcane residues were reduced, through the use of pruning scissors. The experiment was accomplished in a 24 cm diameter pots (5 L volume), distributed randomly in three replications, according to the following treatments (v/v):
Treatment 1 - 0% of sugarcane residue (SR); Treatment 2 - 25% of SR + 75% of soil; Treatment 3 - 50% of SR + 50% of soil; Treatment 4 - 75% of SR + 25% of soil; Treatment 5 - 100% of SR (as a horticultural substratum)

2.2 Plant growth measurements
Plant growth was evaluated along the experimental period. At weekly interval it was recorded plant height (cm), the number of leaves, the diameter of stems and the green colour intensity (chlorosis degree) of the new and old leaves (SPAD measurements).

2.3 Laboratorial analyses
On the end of the experiment, the separation of the leaves and of the stem was done and their weights were registered and the biomass of the aerial part was determined. Organic matter content, pH, EC, N, P, K, Ca, Mg, Fe, Zn, Cu and Mn, of the soil, sugarcane residues and soil-sugarcane residues mixtures were analysed.

2.4 Statistical analysis
Chemical analyses and plant biometric values had been submitted to a variance analysis (ANOVA); differences were considered significant when $p<0.05$. Normality of sample distribution and homogeneity of variances were verified before ANOVA [9]. The comparative analysis of the treatment averages was realized through the New Multiple-Range Test [3]. For the statistical analysis it was used the SPSS ver. 14.0 (SPSS Incorporation, 1989-2005, Chicago, Illinois, U.S.A.) and the Microsoft Excel (Office 2003).

3. Results
Fig. 1 presents the values of the evolution of the vegetative growth of the plants, according to their height (cm) along the experiment. Plants were higher where no sugarcane residue was applied, followed with the 75% soil – 25% sugarcane mixture.

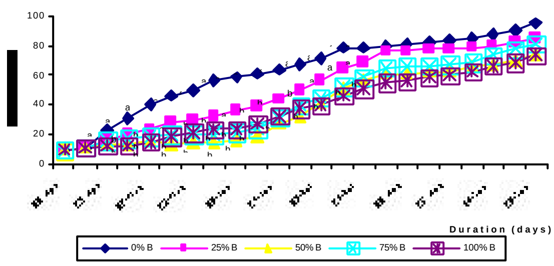

Fig. 1. Plant height (cm) along the experimental period. Averages with the same letter do not present significant differences at 95% (multi average comparison - Duncan test)

Fig.2 shows the values of the green colour chlorosis degree according to the SPAD value of the new leaves, along the experiment. According to SPAD values, plants had darker green colour at 0%, 25 and 50% sugarcane mixtures.

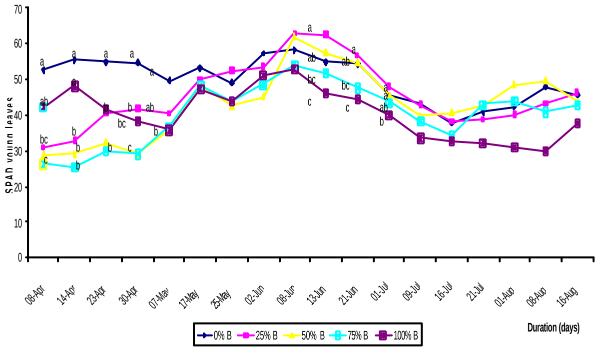

Fig. 2. SPAD values of the new leaves in the different treatments, along the experiment. Averages with the same letter do not present significant differences at 95% (multi average comparison - Duncan test)

Fig. 3 shows the N, P, K Ca contents of pepper leaves, at the end of the experiment.

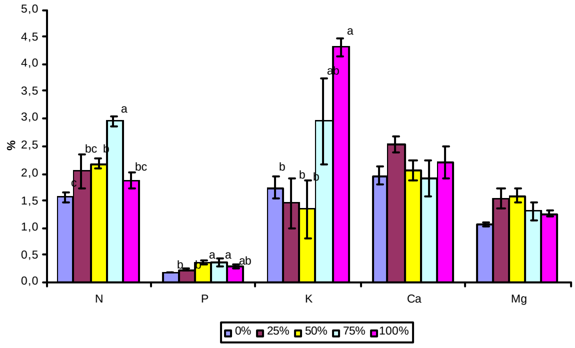

Fig. 3 N, P, K, Ca and Mg contents in pepper leaves, for the different treatments at the end of the experiment. Averages with the same letter do not present significant differences at 95% (multi average comparison - Duncan test)

Fig. 4 shows Fe, Mn, Zn and Cu contents of pepper leaves, at the end of the experiment.

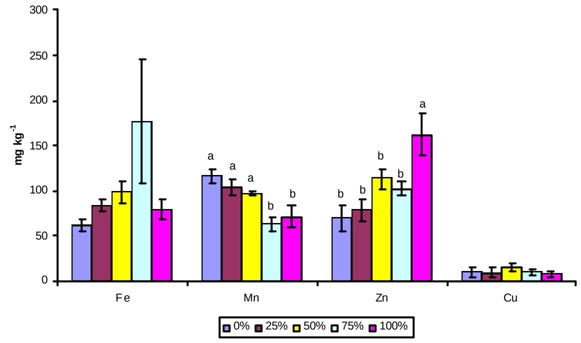

Fig. 4. Fe, Mn, Zn and Cu contents of pepper leaves at the end of the experiment. Averages with the same letter do not present significant differences at 95% (multi average comparison - Duncan test).

Table 1 shows the sugarcane residues chemical analyses at the beginning and at the end of the experiment (pH, electrical conductivity (EC), C/N ratio, organic matter, N, P, K, Ca, Mg, Fe, Cu, Mn, Zn contents).

Table 1. Chemical analysis of the sugarcane residues at the beginning (B) and at the end (E) of the experiment

Parameters	B	E
pH	5.2	7.3
EC (dS m^{-1})	1.0	2.4
Organic matter (%)	96.5	84.0
C/N	147.0	40.2
Nitrogen (%)	0.4	1.2
P (%)	0.1	0.4
K (%)	0.7	0.4
Ca (%)	0.1	0.8
Mg (%)	0.1	0.6
Fe (mg.kg^{-1})	479.3	1821.4
Cu (mg.kg^{-1})	13.8	22.5
Mn (mg.kg^{-1})	33.5	96.5
Zn (mg.kg^{-1})	20.5	91.9

Table 2 shows the values of the chemical parameters (pH, electrical conductivity (EC), C/N ratio, organic matter, N, P, K, Ca, Mg, Fe, Cu, Mn, Zn contents in soil - sugarcane residues mixtures at the end of the experiment for Treatments 1, 2, 3 and 4 (0 %, 25%, 50% and 75 % of sugarcane residues, respectively).

Table 2. Chemical parameters in the soil-sugarcane residues mixtures at the end of the experiment. Averages with the same letter do not present significant differences at 95% (multi average comparison - Duncan test)

Parameters	T1	T2	T3	T4
pH	8.37	8.20	8.23	7.91
CE (dS m^{-1})	0.05 b	0.06 b	0.07 b	0.21 a
Organic matter (%)	1.24 b	1.05 b	1.57 b	2.58 a
C/N	17.98	12.18	15.17	14.97
N%	0.04 b	0.05 b	0.06 b	0.10 a
P_2O_5 ppm	10.95	9.20	6.86	8.25
K_2O ppm	10.16 b	15.70 b	16.88 b	83.69 a

4 Conclusions

Portuguese soils, especially thus on the south, are usually poor in organic matter content, once that the local weather increases mineralization. Hence, this work shows that the use of the sugarcane bagasses has potential to be a reasonable soil organic amendment, increasing soil fertility and improving crop production.

It was observed that the Treatment 2 (75% of sugarcane residue + 25% of soil) had a higher significant organic matter content increase than the Treatments 1, 2, and 3 (0%, 25% and 50% of sugarcane, respectively). It was verified in Treatment 4 (75% of sugarcane) a higher root development. Sugarcane residues might contribute for higher soil porosity and contribute to a better gas exchange at the soil atmosphere. Sugarcane residues as a soil organic amendment have potential to provide lower soil bulk density, higher porosity and also higher water availability [6].

Treatment 5 (100% of sugarcane) presented a satisfactory behaviour, during the vegetative cycle of the crop.

According to sugarcane residues initial C and N contents, and consequently to its C/N ratio, it seems that submitting sugarcane residues to a composting process treatment before its agricultural use it will allow the achievement of an organic product (compost) with a lower C/N ratio, improving its mineralization and nutrients availability, especially on N uptake by plants [1].

References

[1] Badr, M.A., and Badran, N.M., Effect of some composted residues and urea fertilization on wheat yield, *Annals of Agricultural Science,* 39(1), 2001, pp. 707-716.

[2] Caron, B. O.; Pommer, S. F.; Schmidt, D.; Manfron, P. A.; Medeiros, S. L. P., Growth of the lettuce in different substratum, *Magazine of Sciences Agroveterinárias*, 3(2), 2004, pp. 97-104.

[3] Duncan, D.B., Multiple range and multiple F tests. *Biometrika*, vol. 11, 1955, pp. 1-42.

[4] El-Nagdi, W.M.A., and Youssef, M.M.A., Sugarcane residues soil amendments for crop improvement and citrus nematode Tylenchulus semipenetrans management on mandarin under sandy (calcareous) soil conditions, *Egyptian Journal of Agricultural Research*, 82(2(Special Issue)), 2004, pp. 11-25.

[5] FAO, ISRIC and ISSS, *"World Reference Base for Soil Resources"*; Food and Agriculture Organization, International Society of Soil Science and International Soil Reference and Information Centers, 1998.

[6] Fermino, M.H., and Kampf, T.N., Use of the Bom Jesus soil with organic conditioners as horticultural substrates for plants, *Pesquisa Agropecuaria Gaucha*, 9(1/2), 2003, pp. 33-41.

[7] Paiva, J.M.F., Trindade, W.G., Frollini, E., and Pardini, L.C., Carbon fiber reinforced carbon composites from renewable sources, *Polymer-Plastics Technology and Engineering*, 43 (4), 2004, pp. 1187-2004.

[8] Ulloa, J.B., van Weerd, J.H., Huisman, E.A., and Verreth, J.A.J., Tropical agricultural residues and their potential uses in fish feeds: the Costa Rican situation, *Waste Management*, 24 (1), 2004, pp. 87-97.

[9] Zar, J.H., *Biostatistical Analysis*, 3rd Ed. Prentice-Hall International, Inc., New Jersey, U.S.A., 1999.