Supplementary data

Analysis of urban agriculture solid waste in the frame of circular economy: Case study of tomato crop in integrated rooftop greenhouse

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Supplementary information A

Table A1. Generation of residual biomass by crop.

	S1	W	S2	S3 (extended crop)
	Crop period (days)			
	164	169	133	189
	Pruning period throughout the crop (days)			
	134	139	103	159
Pruning waste (kg/day)	0.89	0.72	1.29	1.59
	Generation at the end of the crop (1 day)			
Branches and leaves (kg/day)	90.85	106.80	103.65	71.60
Main stems (kg/day)	72.90	63.80	57.60	**167.99**
***Dry main stems (kg/day)**	14.58	12.76	11.52	**23.99**
% of moisture lost in the stems	80%	80%	80%	**86%**

*Placed on the ground for natural drying for 2 months in a covered area

Supplementary information B. Experimental lettuce crops using tomato stems grown in i-RTG as a substrate.

Objective

As a proposal for the local use of tomato stems as a by-product, it was considered to be used as a substrate for lettuce crops because it is a short-term crop (approximately one month), in addition to being a type of reference crop for other experiments within the research group.

Specific objectives

- Identify the technical feasibility and the procedure to follow, from its obtaining as a waste at the end of the crop, to elaborate substrate with the tomato stems of the i-RTG as a by-product.
- Characterize tomato stems as a substrate.
- Obtain levels of EC, pH and drainage in leachate to identify the viability and behavior of the material as a substrate along two crops.
- Identify from an agronomic approach, deficiencies and possible improvements for use as a substrate with respect to another substrate used as a reference (control).
- Analyze production by comparing it with the control and identify the yield of each crop and its evolution through both.

Materials and methods of the experiment

In addition to the shredded stems for the lettuce crops, a sample of tomato stems was destined to be characterized as a substrate according to the methodology described by Martínez (1992) for granulometry, organic and mineral components; From De Boodt et al. (1974) for apparent density, porosity and water-air relation; Huerta et al. (2010) for total organic matter and carbon; Kjeldahl's method for organic nitrogen, in addition to calculations and estimates to obtain other physical properties such as real density and humidity (the results can be consulted in Table 1).
Half of shredded stems for crop were disinfected in an autoclave for 40’ at 121 °C. This as a recommendation of a specialist to rule out the generation of some fungus from the crop of tomatoes or the drying or storage process.
The distribution of the substrate bags was made in 9 rows alternating rows of control substrate (expanded perlite), UT and TT, as can be seen in Fig. B1. The lettuce stock was purchased in a 4-leaf state. Before transplantation, the substrates were irrigated to achieve good water saturation.
The crop period was, for the first: 07/05/2018 - 04/06/2018; the second: 20/06/2018 - 18/07/2018 (approximately one month each).
Drip irrigation was used with a flow rate of 3 L/h each dropper. Leachates were collected every day in 5-liter pails placed at the end of each row in order to measure the volume in liters of leachate (drainage), pH and EC. The mineral nutrient solution incorporated into the irrigation system was: 8 NO3-, 1 P + 5, 3 SO42-, 3 Cl-, 0 Na +, 8 K +, 4 Ca2 + and 1 Mg2 + (mEq / L).

Chemical and physical substrates characterization

Table B1. Tomato stem chemical characterization.

		Physical Properties
72,75	Dm	Dry matter (%)
27,25	H	Humidity (%)
0,10	Ad	Apparent Density Dry (g/cm^3)
-40,97	Ac	Air capacity (%)
4,36	Wea	Water easily available (%)
2,57	Rw	Reservoir water (%)
6,93	Wa	Water Available (%)
34,04	Wha	Water hardly available (%)
1,58	Drd	Determination of real density (g/cm^3)
93,70	Tps	Total porous space (%v/v)
81,69	Om	Organic matter (%)
18,31	Mm	Mineral matter (%)
0,10	Ad	Apparent density (g/cm^3)
10,74	EC	Electric conductivity (micro S/cm a 25º)
5,52	Ph	ph (sense filtrat a 20º)
5,41	Ph	ph (filtrat a 20 º)
0,46	Dah	Apparent wet density (g/cm^3)

Perlite: The expanded perlite is used as a control since it is an inert and inorganic substrate and free of potential diseases with which you can have greater control of the measurements. The used is 100% v/v expanded perlite with granulometry from 0 to 6 mm, EC of 0.09 dS/m, pH of 7, total effective porosity of >90%, air volume >60%.

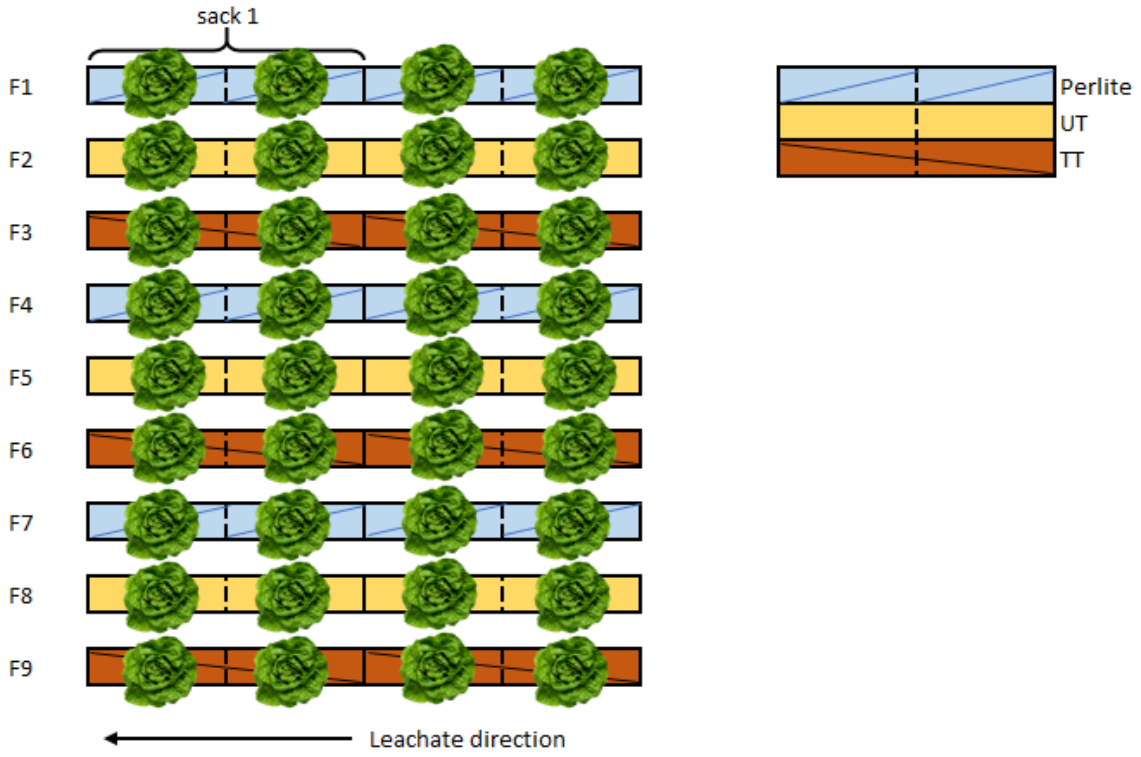

Fig. B1. Distribution of substrate bags for the two lettuce crops.

Description of the experiments

Crop 1

At the beginning of the first crop, the leachates presented a high EC (13 mS/cm avg.) with respect to the control. For 26 days 2.6 L of irrigation was added per row to regulate the level of EC. The crop lasted 29 days periodically adjusting irrigation to maintain drainage between 30% and 40%. At the end, the lettuces were removed along with the root, each sack of substrate was weighed again, and samples of the lettuces were taken separating them in aerial and root part, weighed and dried for analysis. Samples of leachate were also taken regularly throughout the crop for analysis.

Wash treatment

When seeing the high levels of EC at the beginning, it was considered to do substrate wash tests, for which the bags of rows 12 (UT) and 18 (TT) were used. The two sacks of each substrate were removed on day 14 of the culture, weighed without considering the lettuce plant and the TT and UTs were placed separately in containers with 10 liters of water each after making a first wash of the substrate with tap water. The pH and EC values of each of the washes were measured in addition to the tap water every 24 hours for 15 days. The values can be seen in the Table B2.

Table B2. pH and EC values of the substrate wash treatment.

May 2018		Measurement of leachate from substrate wash treatment every 24hrs. (7pm)					
		Tap water		UT6 (LAU2)		TT6 (LAU2)	
Day	#	EC	pH	EC	pH	EC	pH
14	1	.680	7.9	8.10	6.8	3.9	7.2
15	2	.660	8.3	6.3	6.3	3.6	6.4
16	3	.640	8.2	3.5	6.6	1.91	6.4
17	4	.540	8.0	2.0	6.2	1.21	6.1
18	5	.560	8.0	1.43	6.3	0.940	6.1
Weekend							
21	6	.570	6.3	1.680	5.3	1.040	5.3
22	7	.63	6.4	1.120	5.7	.760	5.89
23	8	.530	6.7	.910	5.6	.710	6.0
24	9	.500	6.8	.770	5.4	.590	5.9
25	10	.490	6.6	.630	6.0	.540	6.8
Weekend							
28	11	.480	6.6	.760	5.8	.670	6.0
29	12	.540	8.0	.630	6.3	.620	6.6
30	13	.550	7.4	.790	6.7	.670	7

Crop 2

The second crop was done under the same conditions as the first. It began with levels of EC and pH more stable than the first, so it was not necessary to add water to the irrigation. The crop lasted 29 days, periodically adjusting the irrigation to maintain drainage between 30% and 40%. In the end, the lettuces were removed along with the root, each sack of substrate was weighed again, and samples of the lettuces were taken separating them in the aerial and root part, weighed and dried for analysis. Leachate samples were also taken regularly throughout the crop for analysis.