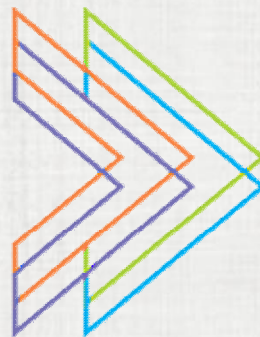


ANALYTICAL PROCEDURES FOR VERIFICATION OF COMPOST QUALITY AND ENVIRONMENTAL ACCEPTANCE

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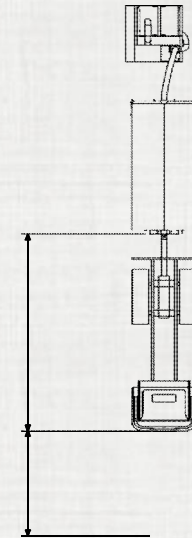
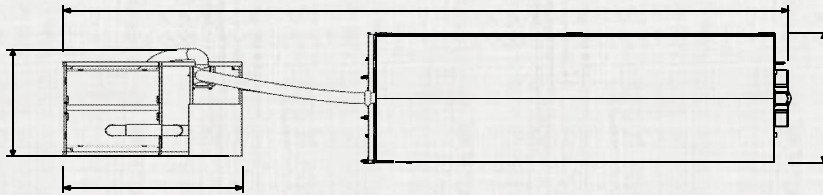
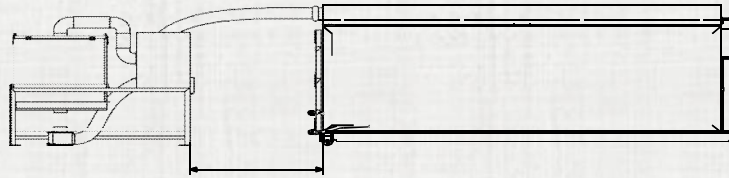
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Introduction

- " This report, after a brief presentation of the composting plant in operation in San Marino, summarizes the activities related to inspections aimed at verifying proper operation and protection of the environment.
- " The composting plant of San Marino is built with modules technology. In this, the particular air system distribution guarantees an efficient composting process and at the same time maximum hygienic safety with particular attention the emission of unpleasant smells.
- " The plant treats approximately 4,000 t/y of bio-waste that is collected by the method of door to door and 1,000 t/y of rejects from the greenspace (pruning and green waste).
- " The organic waste mixed with Woody waste is put in Biocell channels for 20 days then off for more 15 days in a Windrow in open space.
- " To verify the production of compost the management provides a range of chemical, physical and biological protocols through analysis and measurements made during the trial and on samples taken directly from Biocells.
- " The drawing below shows a schematic of a brief vision of Biocell module while the photos from a large vision of the plant.





Checks and inspections

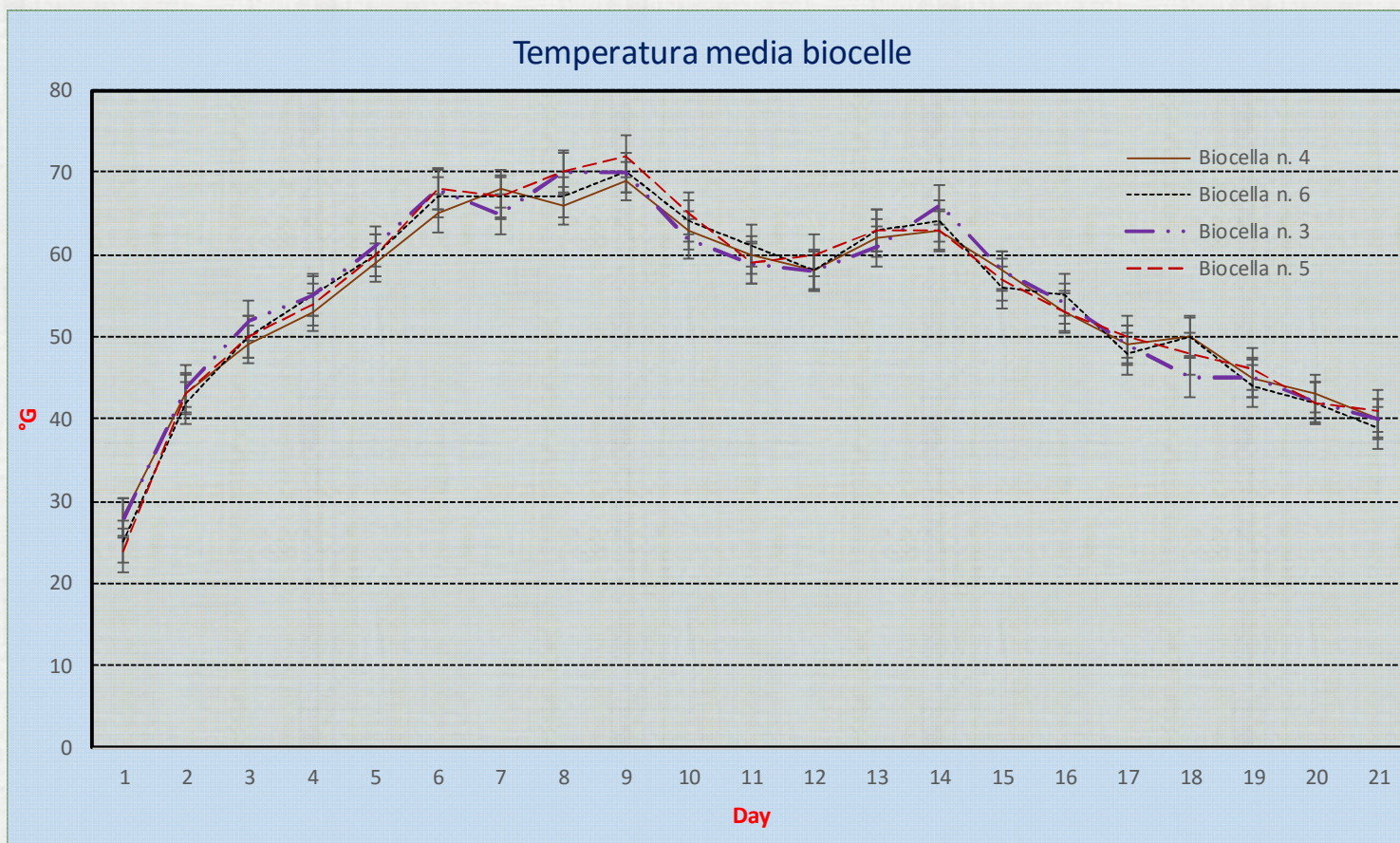
- “ Analytical control to the end of production of compost is distinguished in the following phases: *a)* Checks incoming products *b)* checks during the compost processing *c)* testing the stability of the finished product *d)* Tests on the finished product.
- “ The analyses and measures covered by the Management Protocol and the correlation between certain parameters allow you to get a reliable and transparent way the check in on product quality.
- “ The Protocol of the analysis provides:
 1. **Incoming materials analysis to check suitability for composting process of the substrate (C, N, humidity, Hg, Ni, Cr6 +, Ni, Cd)**
 2. **Measurement of temperatures in significant points of BioCell channels and consequent average value found.**
 3. **Evaluation of temperature gradient.**
 4. **Measurement of the concentration of oxygen within the substrate with hourly sequence value recording.**
 5. **Correlation between temperature value with that of oxygen.**
 6. **Value of dissolved organic Carbon and correlation with oxygen and temperature.**
 7. **Determination of dynamic and static Respiration index in the output from the BioCell channels at the end of the period of maturation.**
 8. **Analytical evaluation on the characteristics of the compost for use (hygienic and agronomic characterization)**
 9. **Phytotoxicity tests: test of lepidium sativum**

Analysis to check suitability for composting process

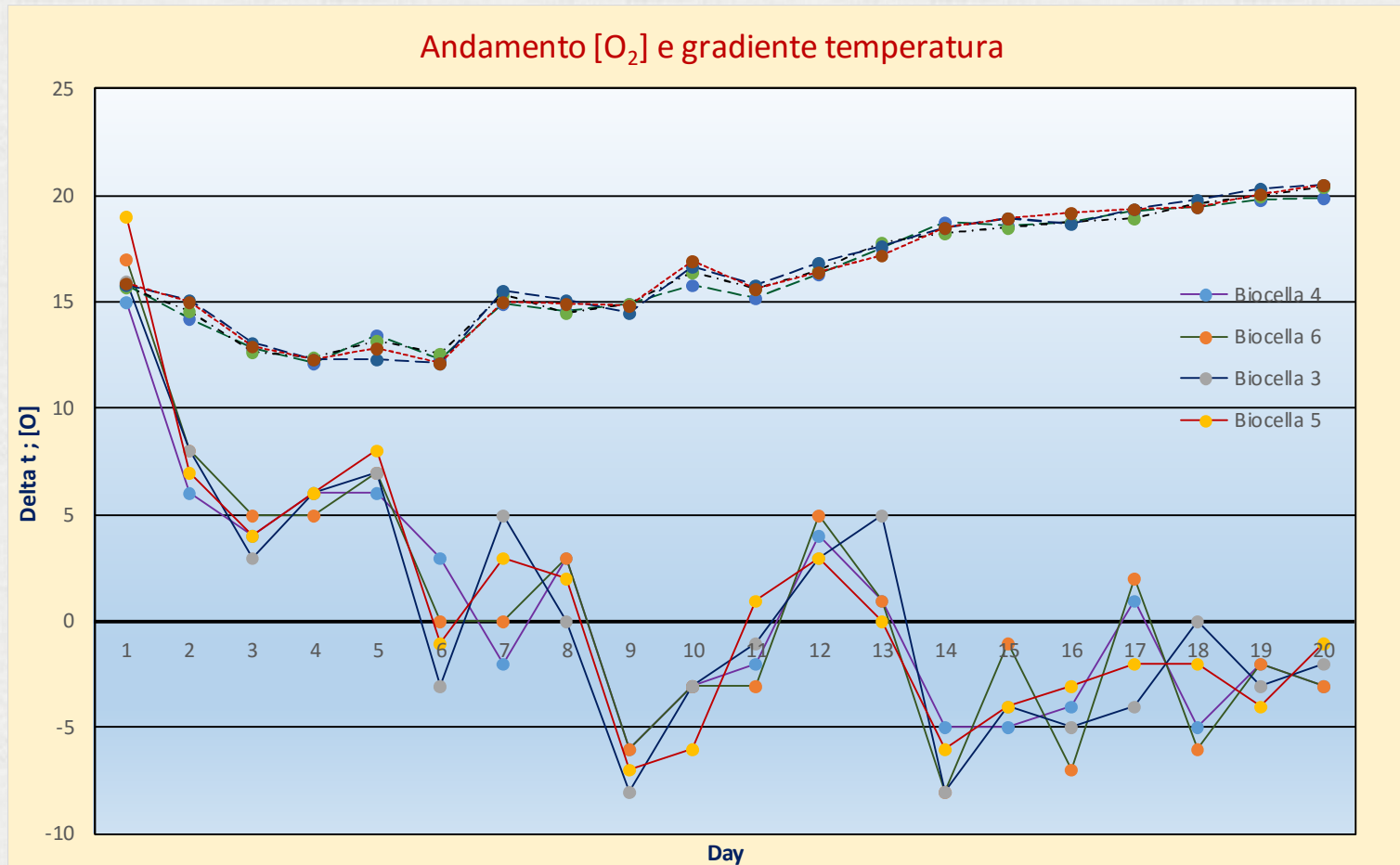
Tipologa Scarti	% C	% N	% H ₂ O	C/N	% S.S.	%	C	N
Kitchen and canteen waste	42,80	4,50	82,00	9,51	18,00	65,00	7,70	0,81
Garden Waste	52,00	1,20	38,50	43,33	61,50	15,00	31,98	0,74
Untreated wood	58,50	0,10	5,80	585,00	94,20	10,00	55,11	0,09
Pruning	55,00	0,15	10,50	366,67	89,50	10,00	49,23	0,13
SUBSTRATE	20,24	0,66	60,71	30,66	39,30	100,00		

	Parameter	Period	Period	Period	Period	Period	Period	
	Hrs process	48	96	192	288	480	672	h
	Days process	2	4	8	12	20	28	day
Normal Value	Temperature	62	65	62	63	58	54	°C
	O ₂ Concentration	14,9	12,8	13,8	13,7	16,8	18,9	[O ₂]
	Average fluid velocity	7 - 8	7 - 8	7 - 8	7 - 8	7 - 8	7 - 8	m/s
	Moisture	62	63	60	59	46	39	%
Abnormal Value	Temperature	< 55 > 75	< 55 > 75	< 53 > 72	< 50 > 65	< 42 > 58	< 25 > 42	°C
	O ₂ Concentration	< 11 > 20	< 11 > 20	< 13 > 20	< 14 > 20	< 16 > 20	< 15	[O ₂]
	Average fluid velocity	< 4 > 12	< 4 > 12	< 4 > 12	< 4 > 12	< 4 > 12	< 4 > 12	m/s
	Moisture	< 50 > 75	< 50 > 75	< 45 > 70	< 40 > 65	< 40 > 60	< 35 > 45	%

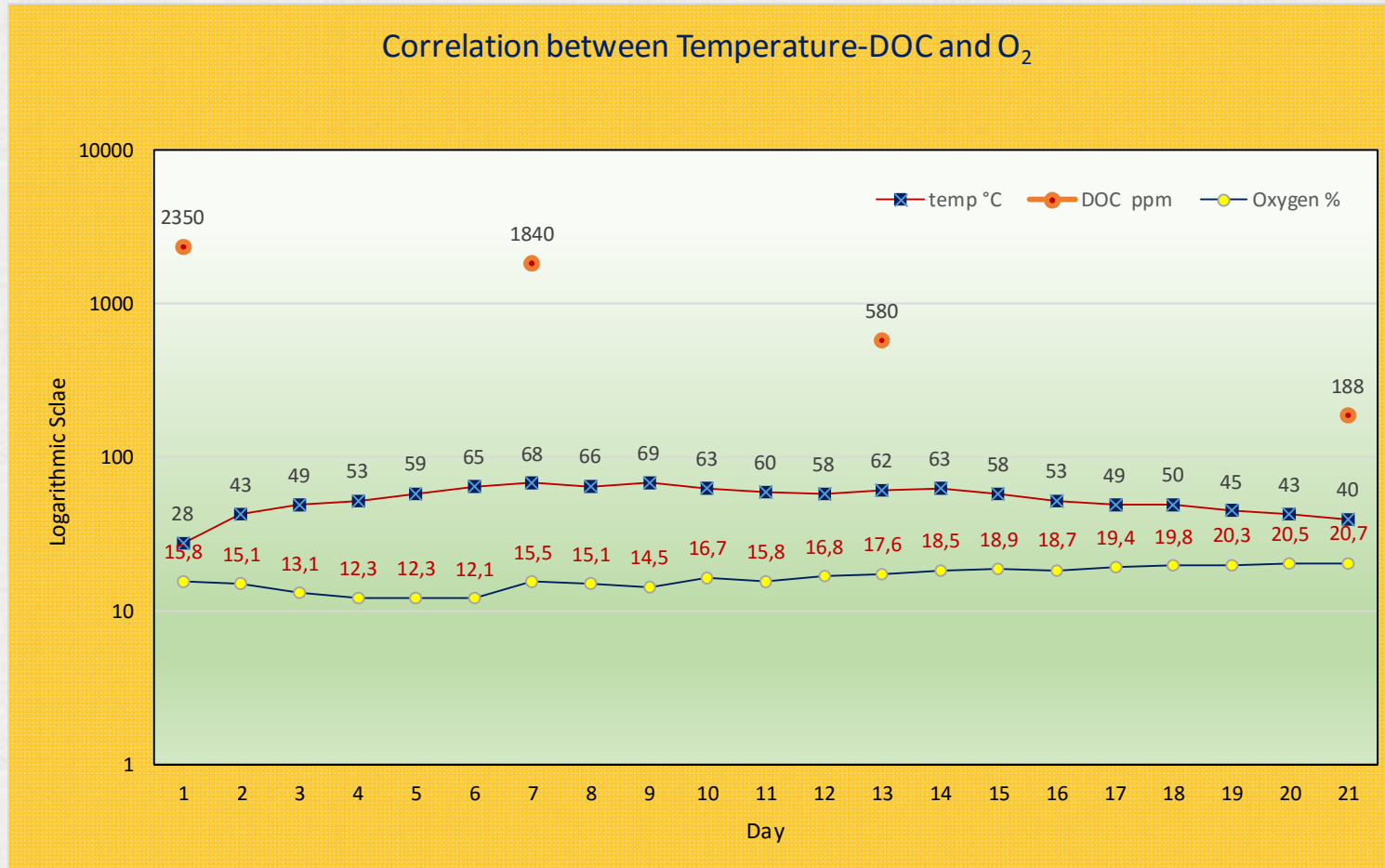
Measurement of temperatures



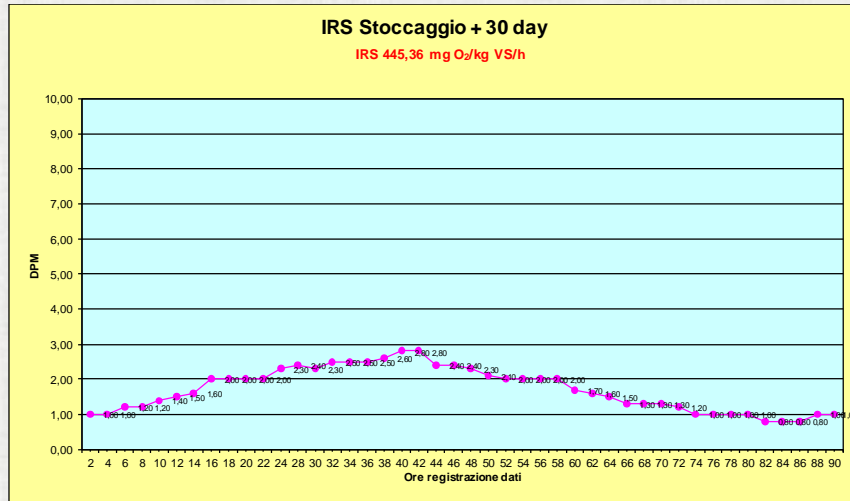
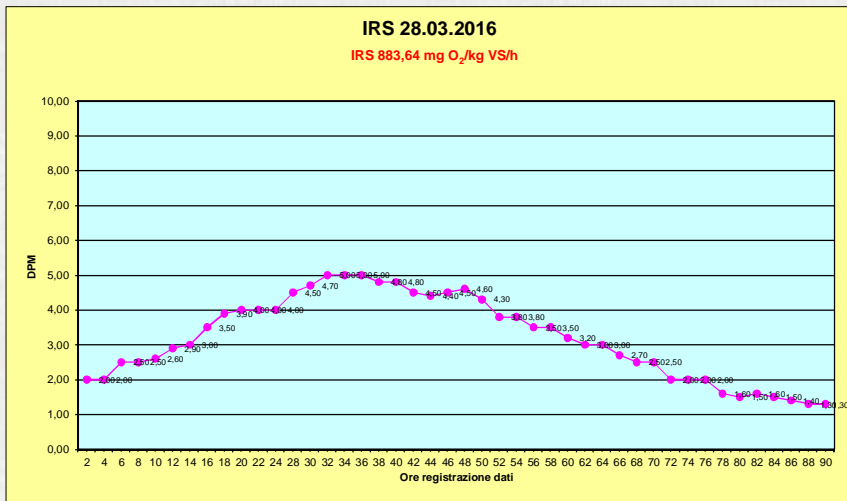
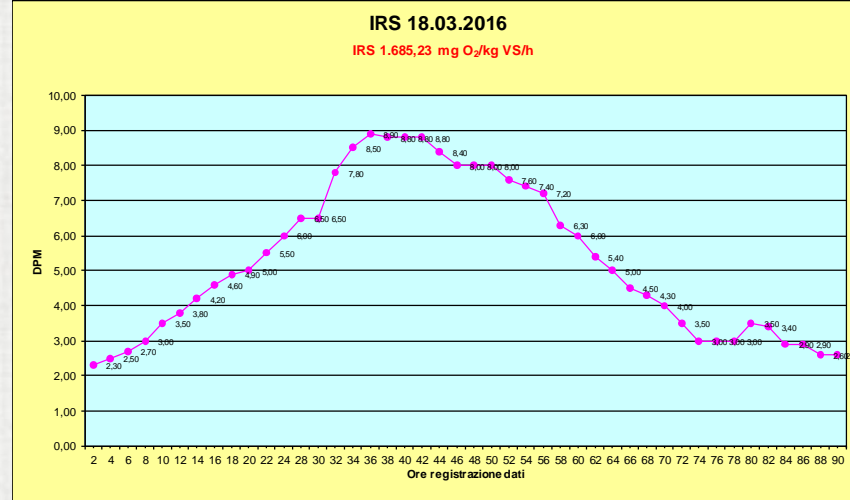
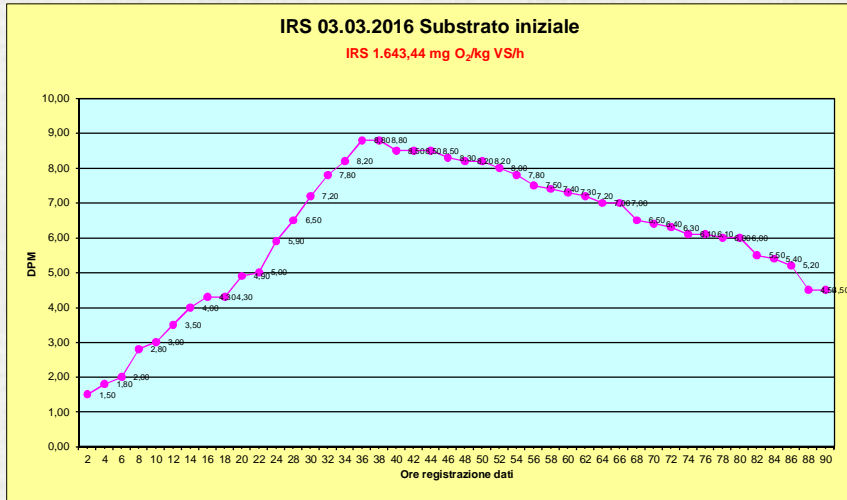
Evaluation of temperature gradient.



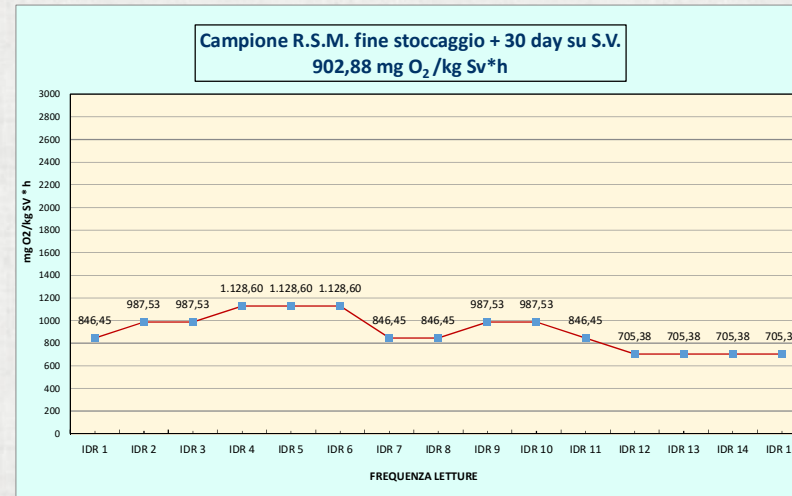
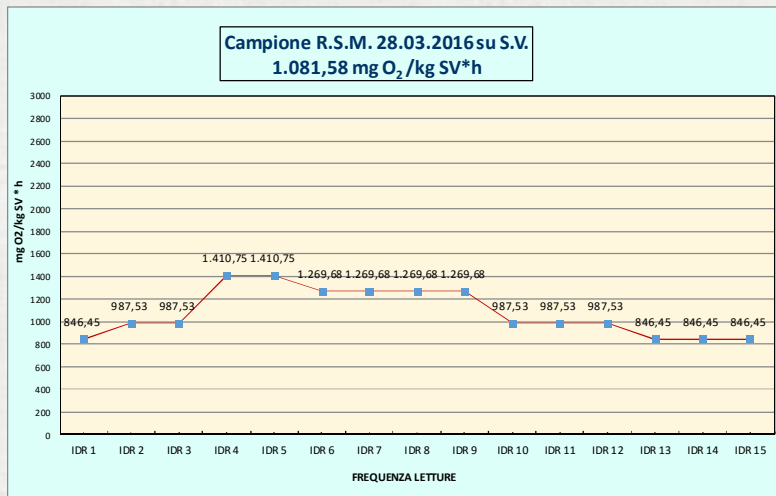
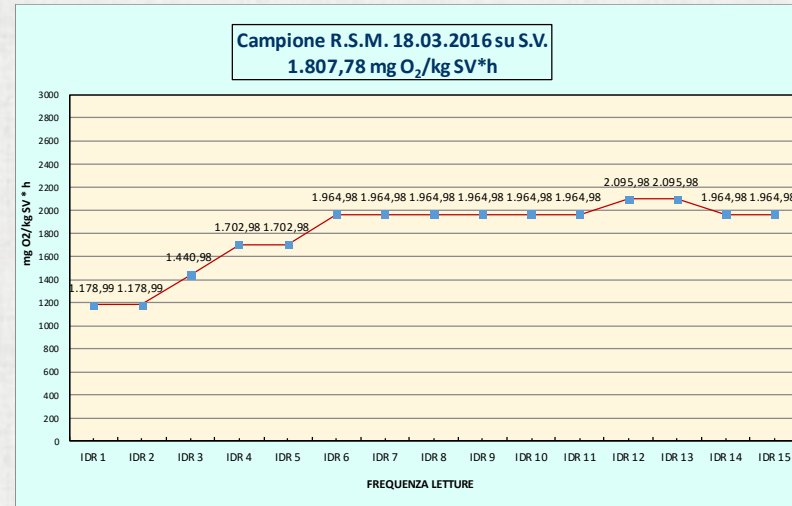
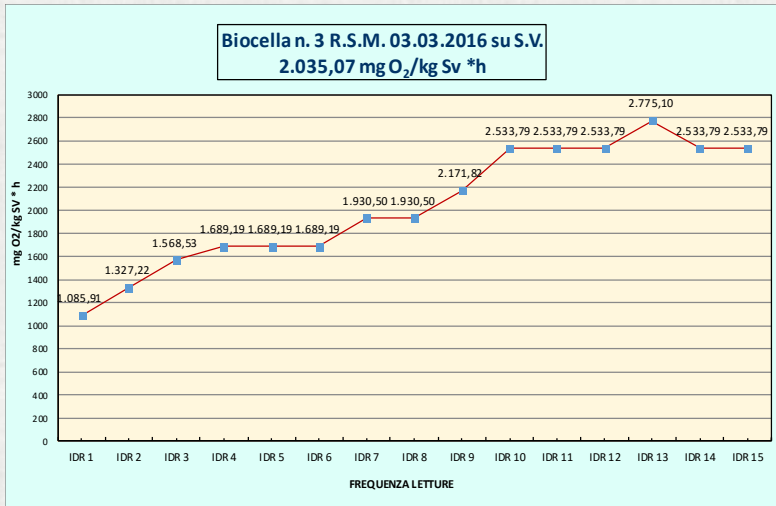
Correlation between Temperature-DOC and O₂



Value of I.R.S. in different time



Value of I.R.D. in different time



Pictures of IRD and IRS instrument



Phytotoxicity tests: test of lepidium sativum

TEST DEL CRESCIMENTO (LEPIDIUM SATIVUM) a 24 ore			
Fango Agrolab n. 2		Data Prelievo	Aprile 2016
TESI	BIANCO	CAMPIONE	
		Dil. 75%	
	Germinazione	Germinazione	
Prima	8	10	n semi germ.
Seconda	7	9	n semi germ.
Terza	9	8	n semi germ.
Quarta	8	7	n semi germ.
Quinta	9	7	n semi germ.
Media	8,20	8,20	media germ,

Calcolo dell Ig % a 24 ore del test	
Diluizione 75 %	108,20%

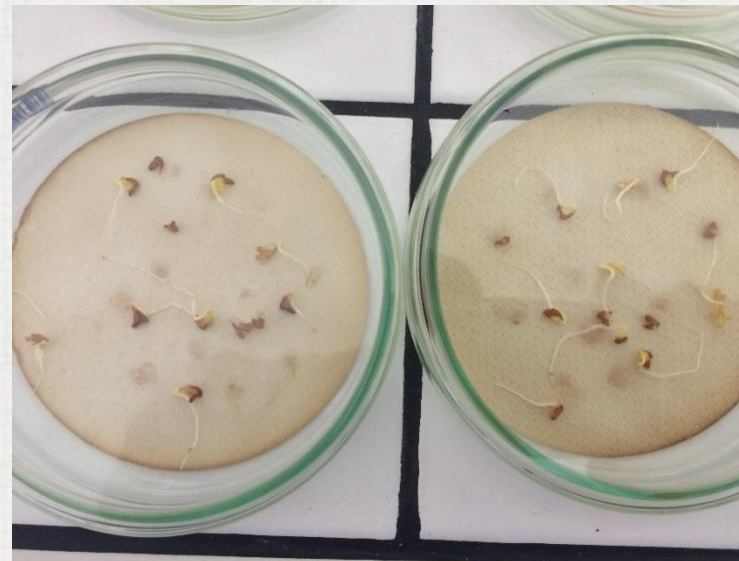
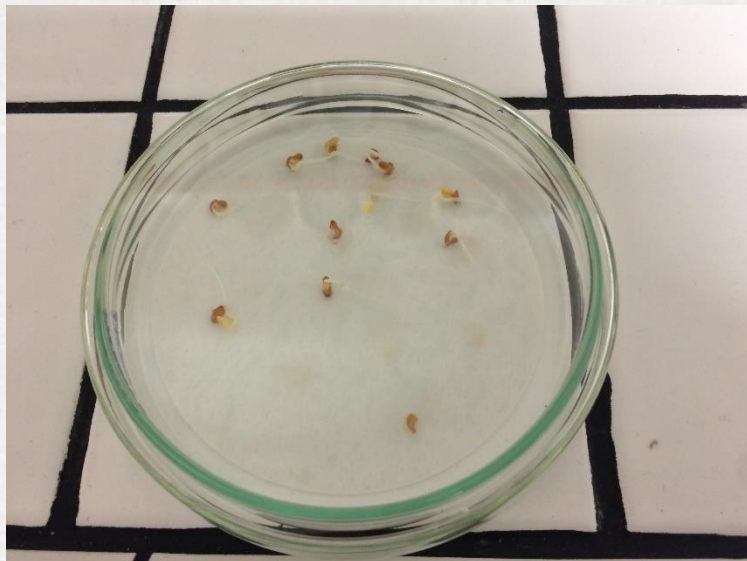
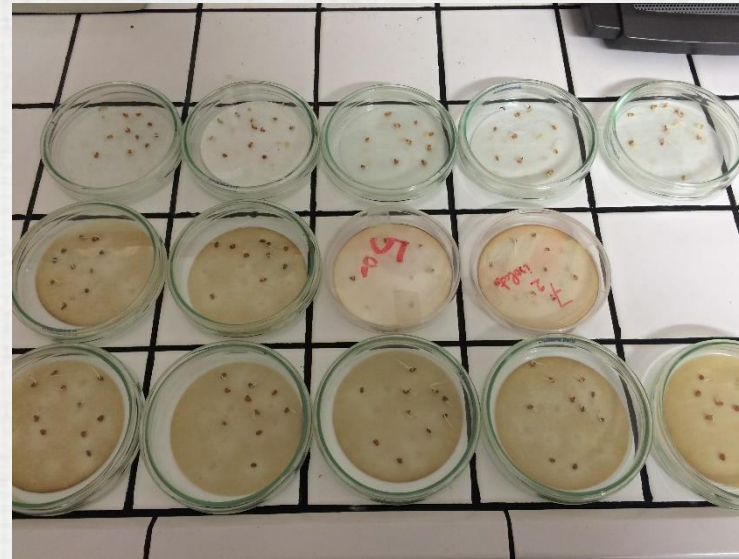
TEST DEL CRESCIMENTO (LEPIDIUM SATIVUM)			
Fango Agrolab n. 2		Data Prelievo	Aprile 2016
TESI	BIANCO	CAMPIONE	
		Dil. 50%	
	Germinazione	Germinazione	
Prima	8	9	n semi germ.
Seconda	7	8	n semi germ.
Terza	9	6	n semi germ.
Quarta	8	8	n semi germ.
Quinta	9	9	n semi germ.
Media	8,20	8,00	media germ,

Calcolo dell Ig % a 24 ore del test	
Diluizione 50 %	89,77%

Allungamento Radicale Test Lepiduum Sativum a 24 ore										Campione	Compost	Prelevato	Gaviano	Data	27.04.2016	
Bianco	1	2	3	4	5	6	7	8	9	10	Valori medi					
Prima	16,8	9,8	5,2	8,3	13,1	17,5	24,7	10,6	0	0	10,60					
Seconda	1,1	5,6	16,2	17,1	19,5	9,8	15,1	0	0	0	8,44					
Terza	0,9	1	2,1	10,8	13,9	13,4	15,8	20,2	22,1	0	10,02					
Quarta	1,9	3,1	18,9	25,9	23,6	20	24,1	20,2	0	0	13,77					
Quinta	0,8	1,8	3,5	12,4	21,3	10,4	14,3	15,6	6,7	0	9,64					
											Valore medio generale					10,49
Campione	Diluizione 75%															
Prima	2,1	1,8	17,2	9,8	19,8	20,9	16,5	14,6	17,1	13,7	13,35					
Seconda	17,1	8,1	15,6	18,7	24,8	13,6	19,5	17,2	16,1	0	15,07					
Terza	7,1	21,2	9,5	9,8	13,1	14,6	18,2	23,7	0	0	11,72					
Quarta	3,1	4,1	10,8	13,9	10,5	12,5	17,8	0	0	0	7,27					
Quinta	4,2	6,3	5,8	12,3	15,6	10,5	16,3	10,45	12,2	0	9,37					
											Valore medio generale					11,36

Allungamento Radicale Test Lepiduum Sativum a 24 ore										Campione	Compost	Prelevato	Gaviano	Data	27.04.2016	
Bianco	1	2	3	4	5	6	7	8	9	10	Valori medi					
Prima	16,8	9,8	5,2	8,3	13,1	17,5	24,7	10,6	0	0	11,78					
Seconda	1,1	5,6	16,2	17,1	19,5	9,8	15,1	0	0	0	8,44					
Terza	0,9	1	2,1	10,8	13,9	13,4	15,8	20,2	22,1	0	11,13					
Quarta	1,9	3,1	18,9	25,9	23,6	20	24,1	20,2	0	0	15,30					
Quinta	0,8	1,8	3,5	12,4	21,3	10,4	14,3	15,6	6,7	0	8,68					
											Valore medio generale					11,07
Campione	Diluizione 50%															
Prima	14,1	14,4	18,5	4,2	13,5	8,2	14,2	10,8	15,7	0	11,36					
Seconda	16,5	16,2	13,8	18,4	20,9	17,6	12,1	14,5	0	0	14,44					
Terza	1,6	8,7	10,3	12,2	10,5	13,2	0	0	0	0	5,65					
Quarta	2,1	17,2	9,5	21,6	16,9	16,5	13,2	15,1	0	0	14,01					
Quinta	1,8	4,8	5,6	5,3	12,4	10,4	2,3	4,6	1,8	0	5,44					
											Valore medio generale					10,18

Test of lepidium sativum pictures



Finished product analysis (agricultural and sanitation)

Parametro	U.M.	Valore	Limiti
Microrganismi indicatori inquinamento fecale	MPN/g	< 3	< 5.000
Salmonella Spp	50 g	Assente	Assente
Streptococchi fecali	MPN/g	8	1.000
pH	Unità pH	8,11	6–8,5
Umidità	%	30,7	< 50 %
Ceneri	%	38,6	n.i
Acidi umici e fulvici	%	15,7	> 7
Salinità	meq/100g	42.100	n.i.
TOC	%	21,3	> 20 %
DOC	mg/kg	168,8	nr
Rapporto C/N	l	7,1	Max 25
Azoto organico	mg/kg	27.450	80 % Ntot
Azoto totale	%	3,0	n.i.
Cadmio	mg/kg	0,1	1,5
Cromo VI	mg/kg	< 0,5	0,5
Fosforo Totale	% s.s.	1,6	n.i
Mercurio	mg/kg	0,1	1,5
Nichel	mg/kg	7,4	100
Piombo	mg/kg	7,2	140
Potassio	%	0,22	n.i
Rame	mg/kg	20,5	230
Zinco	mg/kg	63,7	500

Conclusions

- “ The proper management of a composting plant must include a number of analytical tests to guarantee the smooth progress of the biological process and on the quality of the finished product.
- “ For this reason when handling it is necessary to apply an analysis protocol to ensure the proper functioning of a plant and the best production of compost.
- “ For implantation of San Marino in order to protect the environment are performed a series of analyses and measures with low costs to verify proper operation.
- “ Considering the annual operating cost of the system including the amortization of 78 euros per tons of refuse, the economic impact analysis was 0.08%, virtually no effect on total operating costs.
- “ This paper summarized the main measurements and laboratory tests normally performed when handling the composting plant in Biocells in operation in the Republic of San Marino.

