Study and assessment of compost of different organic mixtures and effects of organic compost tea on plant diseases.

Znaïdi, I.A *; M. Daami;** M. Ben Khedher* and M. Mahjoub**

* Technical Center of Organic Agriculture
P.O.Box 42 Chatt Meriem, Sousse, Tunisia
Tél: +216 73 346 279; Fax: +216 73 346 277
E-mail: akram_znaidi (AT) yahoo.fr

** Agricultural Research and Development Center, Chatt Meriem, Sousse, Tunisia
Tél / Fax: + 216 73 348 543

Abstract

Four compost treatments representing different organic mixtures were studied:

- Treatment T_1: 100% cattle manure
- Treatment T_2: 80% cattle manure and 20% sheep manure
- Treatment T_3: 70% cattle manure, 20% sheep manure and 10% poultry manure.
- Treatment T_4: 50% cattle manure, 20% sheep manure, 20% poultry manure and 10% crushed wheat straw.

The results showed that the temperature was higher for the 4th treatment which was richer in carbon than the other treatments.

The initial alkaline pH decreases for all treatments and approaches neutrality at the end of composting process, essentially for the first treatment. There is also a decrease in the carbon / nitrogen ratio.

At the maturity stage, a compost tea was prepared from different composts after five days extraction period. The four compost teas were tested on different plant pathogens: *Fusarium roseum var sambucinum*, *Fusarium oxysporum, Fusarium oxysporum, Fusarium solani var coeruleum*, *Phytophtora erythroseptica* and *Rhizoctonia solani*. All the treatments were efficient against these pathogens and especially the 4th treatment which considerably reduces also the dry rot of *Fusarium solani* in potato tubers during storage. This is considered an important result since *Fusarium solani* seems to be the most important pathogen in Tunisian soils.

Our studies should be carried out in order to determine the better combination of organic mixtures, the better method of compost tea extraction (aerobic or anaerobic), the optimal period of extraction and doses to be used.

1.Introduction

In recent years, global awareness of health and environmental issues has been growing. The international community increasingly encourages organic and other forms of sustainable agriculture.

Organic farming is based on a holistic viewpoint, the support of biological processes, the equilibrium of the agro-ecosystem, the enhancement of the structure and the fertility of the soil, the implementation of diversified crop rotation, a preventive control of weeds, pests and diseases without recourse to synthetic chemical products (Guet, 1999). Among the key characteristics of organic agriculture are the use of organic material to maintain organic matter and nutrients in the soil, including animal manure, compost, green manure, various cropping systems and soil management techniques such as mulching (ITAB, 2001).

Composting is an efficient way to recycle various organic matter sources. Composting is an aerobic biological process allowing the decomposition and degradation of organic material and is characterized by different parameters such as moisture, aeration, temperature, and carbon / nitrogen ratio (Mustin, 1987). Compost has nutritional and sanitary values. Compost tea is rich in nutrients and micro-organisms and can stimulate growth, protect plants from diseases and help suppress soil born pathogens (Quarles, 2001).

This work aims to study and assess the compost of different organic matters and effects of organic compost tea on plant diseases.

2. Material and methods

2.1. Study of different organic mixtures composting

2.1.1. Organic matters

The used organic matters are those available, in big quantities, in our area at the agricultural farms.

- Cattle manure: brought from intensive livestock husbandry for milk production and mixed with small quantity of wheat straw as a litter.

- Sheep manure: brought from extensive livestock husbandry for meat production.

- Poultry manure: collected from fattening livestock husbandry, on the soil, for meat production and mixed with wheat straw as a litter.

- Wheat straw: brought from an extensive field crop farm and crushed before incorporation in the compost pile.

The various characteristics of used organic matters are presented in Table 1.

Table 1. some characteristics of used organic materials

Composition / Materials	Dry matter content in % of fresh matter	Organic matter in % dry matter	C / N ratio	pH	Salinity Gr / liter
Cattle manure	27	38.08	20	8.13	1.33
Sheep manure	33	49.28	20	8.26	2.1
Poultry manure	63	51.9	14	8.14	1.96
Wheat straw	88.4	91.4	98	6.96	0.84

2.1.2. Experimental design:

A randomised complete block design with 4 treatments and 3 replications was used (12 compost piles).

- Treatment T_1: 100% cattle manure
- Treatment T_2: 80% cattle manure and 20% sheep manure
- Treatment T_3: 70% cattle manure, 20% sheep manure and 10% poultry manure.
- Treatment T_4: 50% cattle manure, 20% sheep manure, 20% poultry manure and 10% crushed wheat straw.

2.1.3. Composting procedure

Each compost pile is made of a convenient size : 2 m large, 1.5 m high and 8 m long. Compost piles are made by alternating layers of mentioned organic materials. The compost piles are watered and turned over as necessary. The compost process lasts about six months.

2.1.4. Measured parameters

- Temperature: the temperature of each pile was measured during all the composting process using an electronic thermometer with stainless steel probe. The temperature retained is the mean of 6 measurements in different parts of pile by introducing thermometer as deep as 50 cm .

- pH: the methodology consists on :

- preparation of suspension of compost to water ration of 1:5
- stirring the suspension for 5 minutes
- measurement of pH after minimum 2 hours with pH meter apparatus.

- Carbon / Nitrogen ratio :

- the total nitrogen is determined by the Kjeldahl method.
- The carbon is determined from organic matter analysis: C = OM / 2

2.2. Study of compost tea effect on plants pathogens

2.2.1. Pathogens agents

The pathogens tested were isolated from local potatoes tubers with symptoms of dry decay or pink rot:

- *Fusarium roseum var sambucinum*
- *Fusarium roseum var graminearum*
- *Fusarium oxysporum*
- *Fusarium solani var coeruleum*
- *Phytophtora erythroseptica*
- *Rhizoctonia solani*

All this pathogens are multiplied at 25°C on PDA (Potato Dextrose Agar)

2.2.2. Compost teas

Extracts of composts were prepared from different compost treatments(T_1, T_2, T_3, and T_4) in the maturity stage of compos based on the extraction method developed by the German researcher Heinrich Weltzein. Compost teas were obtained from a compost to water ratio of 1:5. They were stirred once and allowed to ferment outdoors between 15°C and 20°C . After a soaking period (5days) referred to as "extraction time", the solution was strained through cheesecloth and then stored in bottles in refrigerator at the temperature of 4°C. The solutions of compost tea were kept out of refrigerator half an hour before their use.

2.2.3. Experimental design

A split plot design was used with four replications and the following factors as treatments:

- Factor A: compost teas
- Factor B: pathogen agents

2.2.4. *In vitro* experiment

One ml of each compost tea was mixed with 200 ml of PDA liquid. After stirring, this solution was put in Petri dishes. Following solidification of this medium, inoculation was made with the six pathogen agents and incubation was made at 25°C. The diameter of colonies were recorded take at :

- 48 hours after inoculation for *Phytophtora erythroseptica*
- 6 days after inoculation for *Fusariums* and *Rizoctonia solani*

2.2.5. *In vivo* experiment

Potato tubers of Spunta variety (the most common used cultivar in Tunisia) were disinfected with sodium Hypochlorite diluted at 10% during 5 minutes. Then, tubers were cleaned with sterilised and distilled water. This experiment consists of causing injuries on the tuber (6 mm of depth) and inoculating with pathogens.

For *Phytophtora*, 10 tubers were used with one infection site and for *Fusariums* we used 5 tubers with two infection sites

After inoculation, the potatoes tubers were soaked in water solution with 10% of compost tea during 10 minutes and subjected to incubation. The incubation took place in plastic containers with small quantity of water in order to increase moisture. The containers were covered by aluminium paper and put in glass greenhouse during 48 hours for *Phytophtora* and 21 days for *Fusariums*.

After incubation period the tubers were sliced longitudinally in two parts and the rot depth penetration was measured as follows (Lapwood and al.,1984):

$$\text{Penetration (mm)} = (I/2 + (p-6)) / 2$$

I: maximum width
p: depth

3. Results and discussions

3.2. Compost experiment

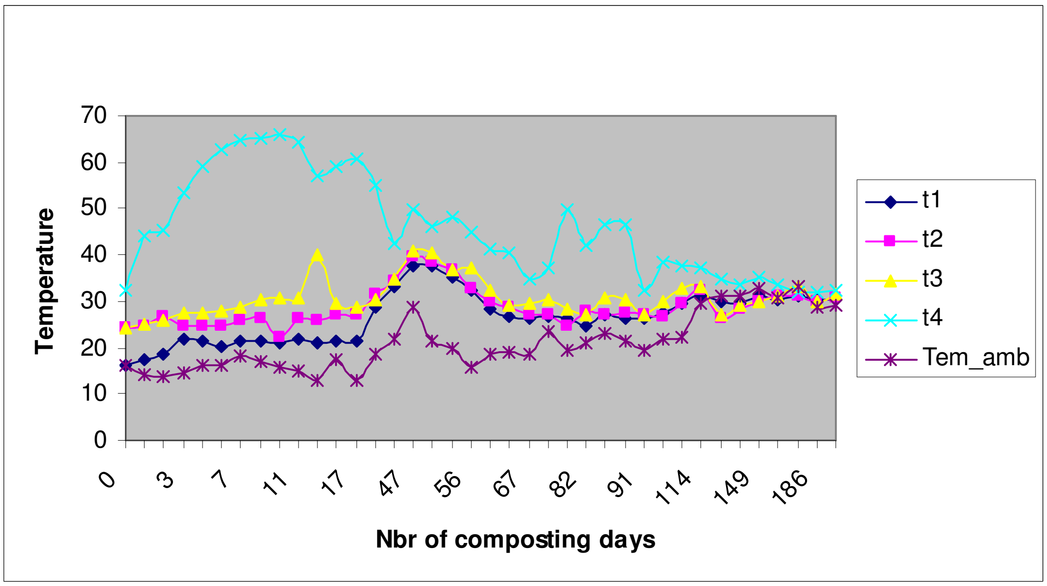
3.2.1. Temperature

Fig.1 shows that the temperature of all compost piles were higher than ambient temperature during the composting process. The temperature of the treatment (T_4) having wheat straw was much higher than that of other treatments and reached 66°C at 10 days after the beginning of the composting process. This was due to the thermophilia micro-organisms (Mustin, 1987) and the fact that this treatment was richer in carbon and was more voluminous than the other treatments.

The highest temperature of the other treatments was about 40°C and indicated that the compost piles did not have a good biological activity.

About six months after the beginning of the composting process, the temperatures of all treatments fell down and were the same as the ambient temperature meaning that the compost was mature.

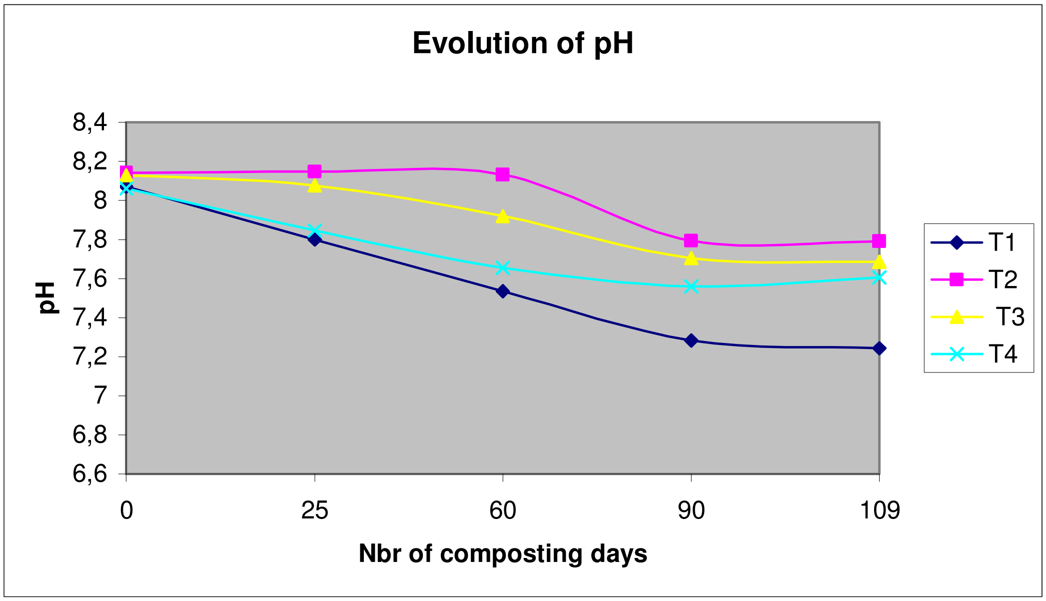
Figure1: Evolution of temperature during composting process



3.2.2. pH

Fig.2 indicates that the initial pH of all treatments was about 8.2. This favours the development of actinomycets and alkaline bacteria (Mustin, 1987). The pH of all treatments decreased until 7.8 to 7.4 due to the release of organic acids following the decomposition of organic substances. The lowest pH was obtained by the treatment (T_1) having only cattle manure.

Figure 2: Evolution of pH during composting process

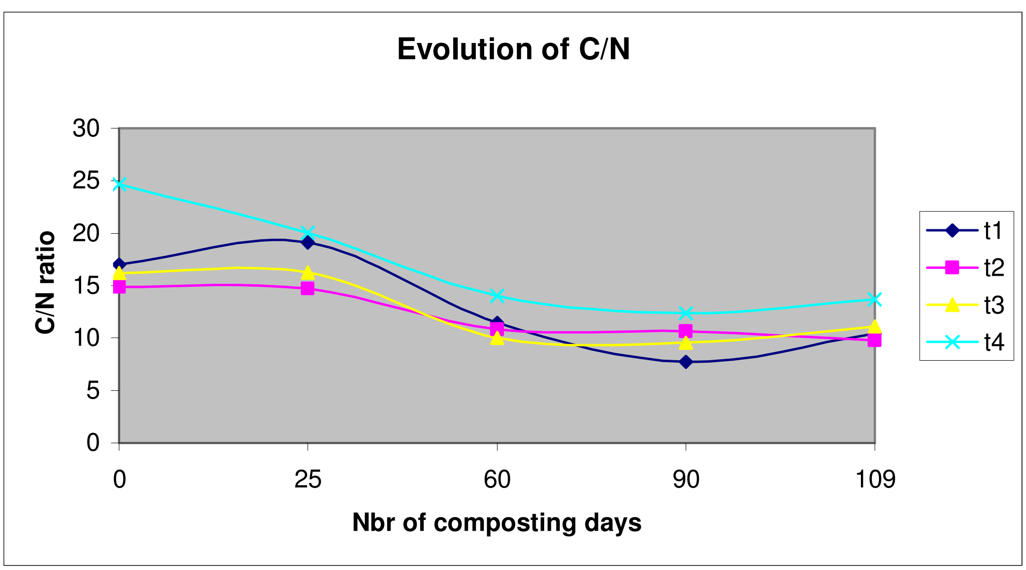


3.2.3. Carbon / Nitrogen ratio

The starting C/N ratio of the treatment T_4 was higher than that of the other treatments because of wheat straw (Fig.3). All the three other treatments had a C/N ratio as low as 15 and consequently were not favourable for biological activity as it is shown by temperature results shown by Fig.1.

The final C/N ratio varies from 9 to 14 depending on the organic matters mixtures.

Figure 3: Evolution of C/N during composting process



3.2. Compost tea experiment
3.2.1. *In vitro* tests

- *Phytophtora erythroseptica*

The compost teas of all the treatments led to an inhibition of the mycelium growth of *Phytophtora erythroseptica* . However, there was difficulty to estimate the diameter of colonies. So, the comparison of the different treatments was not easy.

- *Rizoctonia solani*

Table 2 shows a significant difference between the control and the compost tea treatments. Moreover, the treatment T_4 was more efficient in inhibiting *Rizoctonia solani*. Photo 1 shows clearly that after six days of incubation, the invasion of Petri dish by the fungus in the control treatment and the inhibitory effect under the compost treatment T_2.

Table 2 : Diameter of colonies of *Rhizoctonia solani*

Treatments	Control	T_1	T_2	T_3	T_4	significance
Diameter of colonies(cm)	8.5_a	7.1_b	5.5_c	7.4_b	4.5_d	**

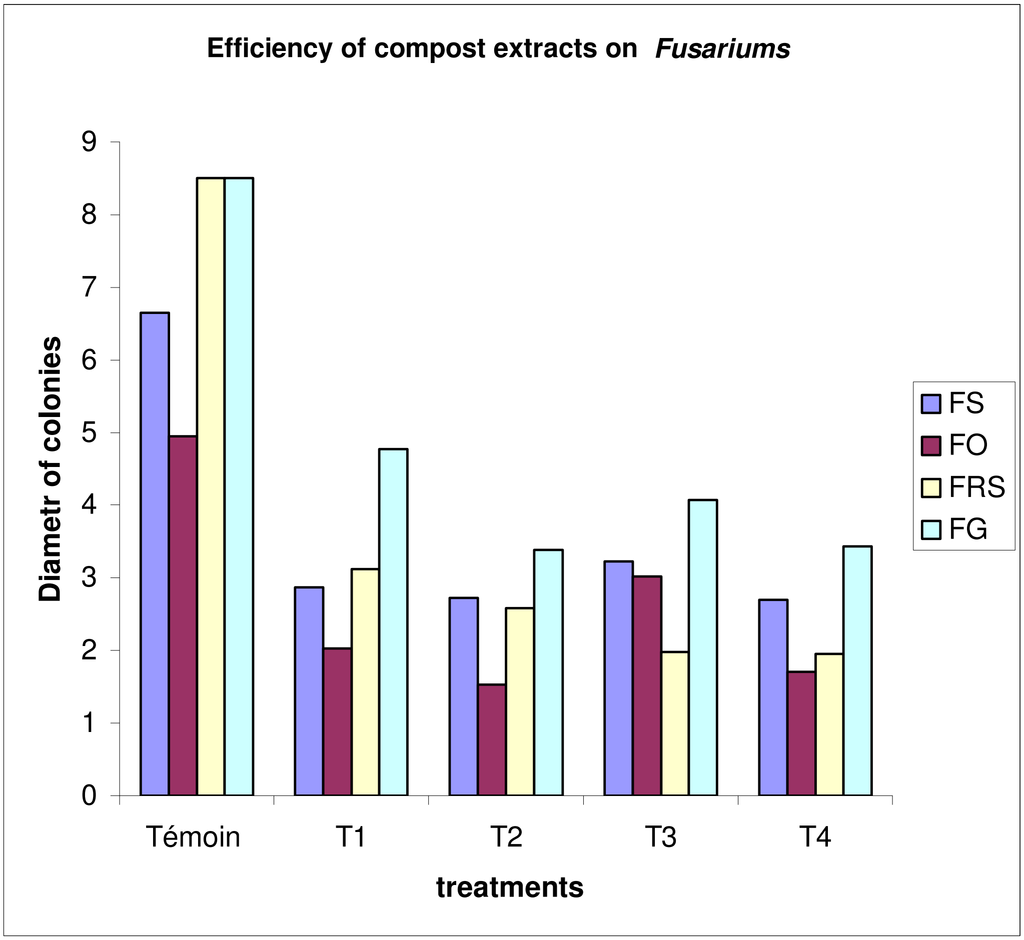
Photo 1: Effect of treatment 4 on medium of *Rhizoctonia solani*

- *Fusariums*

Fig. 4 indicates that there is a significant interaction between the compost tea treatments ant the pathogens. All compost teas had inhibitory effects on all the *Fusariums* . The degrees of these effects depended upon both factors, compost teas and pathogens. In general, the treatment T_4 gave better results than the other treatments. Photos 2 and 3 show the differences between the control and the inhibitory effects of treatments T_4 and T_2 on *Fusarium roseum var graminearum.*

These results confirm those reported by Kai et al. (1990) in relation to *Fusarium oxysporum*. Weltzen (1990) obtained an inhibitory effect on Botrytis by using compost tea made from cattle and poultry manure.

Figure 4: Efficiency of compost extracts on different kinds of *Fusarium*



FS : *Fusarium solani*

FO : *Fusarium oxysporum*

FRS: *Fusarium roseum*

FG: *Fusarium graninearum*

Photo 2 : Effect of treatment 4 on medium of *Fusarium graninearum*.

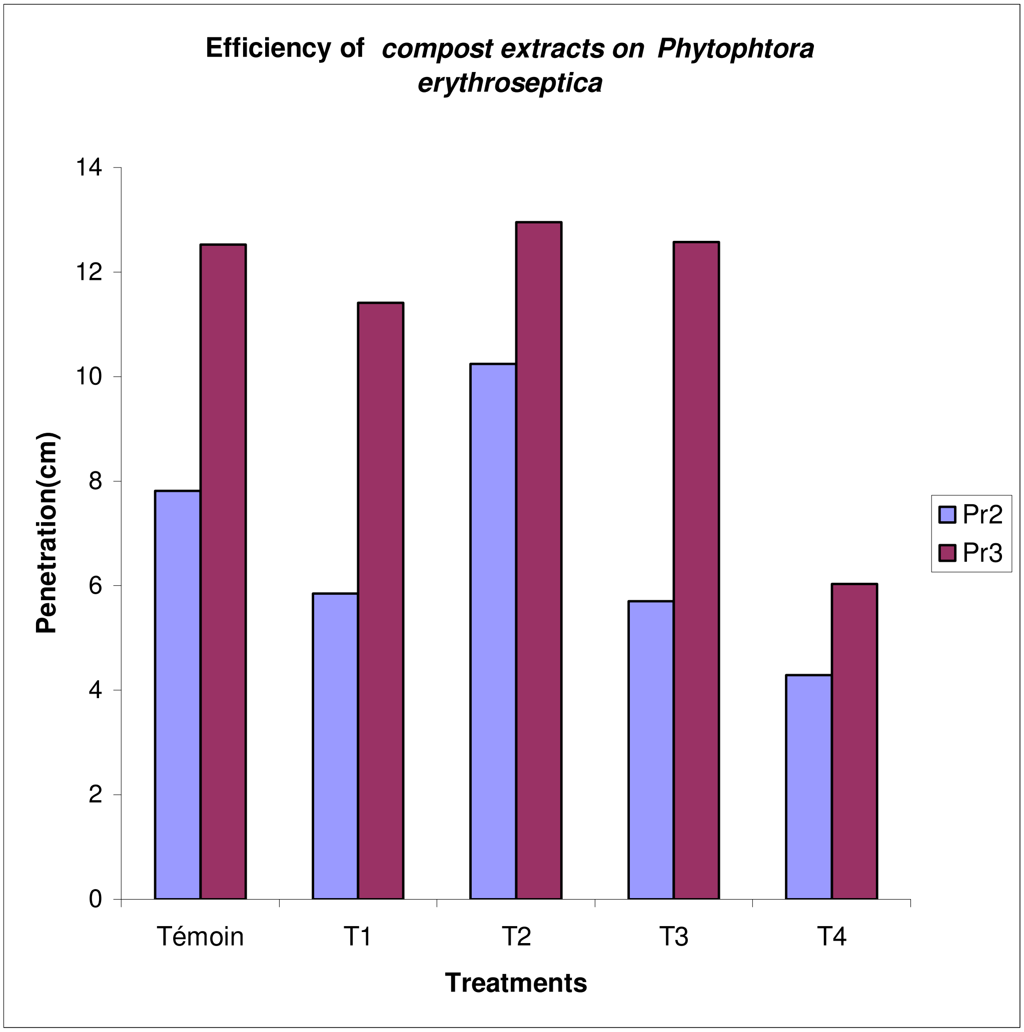
Photo 3 : Effect of treatment 2 on medium of *Fusarium graninearum*.

3.2.2. *In vivo* tests

- *Phytophtora erythroseptica*

The effects of the different treatments on two races of *Phytophtora erythroseptica* are shown on Fig.5. On may notice that the treatments T_2 and T_3 did not have any effect. However, the treatments T_1 and T_4 had slight and big effects respectively.

Figure 5: Efficiency of compost extracts on two races of *Phytophtora erythroseptica*



- *Fusariums*

The tests made on potato tubers indicated that the compost tea treatments inhibited only *Fusarium solani var coeruleum* (Fig. 6). Photo 4 shows this inhibitory effect with treatment T_4.

Figure 6: Efficiency of compost extracts on different kinds of *Fusariums*

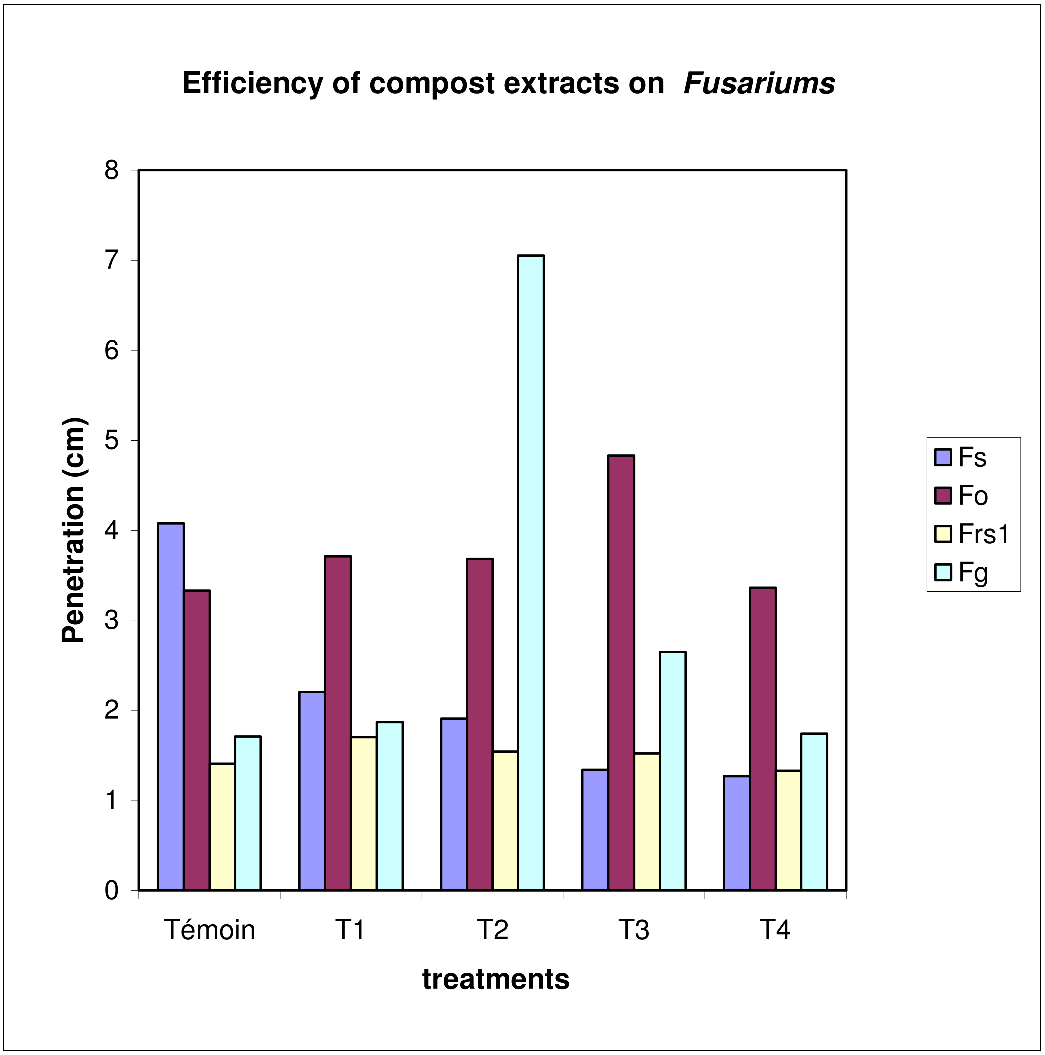
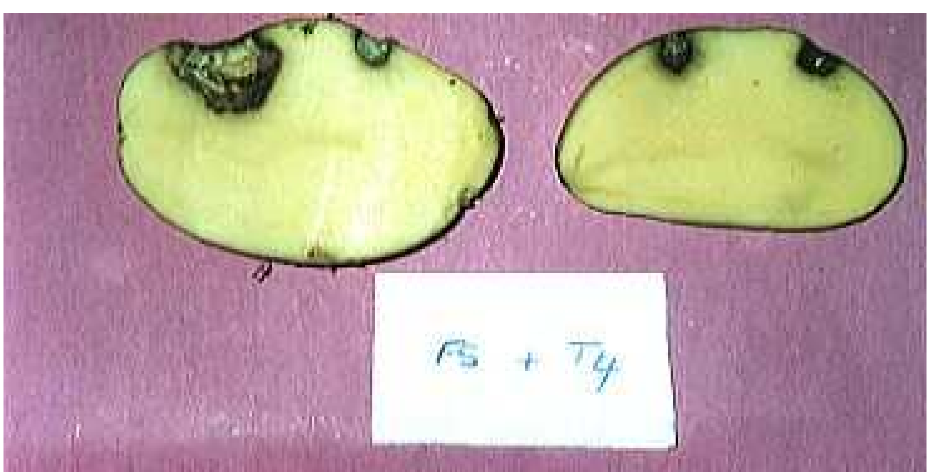


Photo 4: Inhibitory effect of T_4 on *Fusarium solani*



Compost teas are easy to produce and apply an can be used for a wide range of crops. Compost tea contains millions of bacteria, fungi and other micro-organisms that work to keep crops free of diseases (Quarles, 2001).

4. Conclusion

All the available organic matters can be composted. However, the presence of a carbon source is very important to ensure a good composting process. The highest temperature during composting was obtained by the compost including wheat straw. The decrease of the pH and C/N ratio during the composting depended on the nature of the used organic matters.

The *in vitro* tests showed that all compost teas had inhibitory effects on all tested pathogens: *Fusarium roseum var sambucinum*, *Fusarium oxysporum, Fusarium oxysporum, Fusarium solani var coeruleum*, *Phytophtora erythroseptica* and *Rhizoctonia solani*, The compost tea extracted from a compost made cattle manure, sheep manure, poultry manure and wheat straw was the most efficient.

The *in vivo* tests made on potato tubers showed some inhibitory effects on *Phytophtora erythroseptica* and *Fusarium solani var coeruleum.* This is considered an important result since *Fusarium solani* seems to be the most important pathogen in Tunisian soils.

Our studies should be carried out in order to determine the better combination of organic mixtures, the better method of compost tea extraction (aerobic or anaerobic), the optimal period of extraction and doses to be used.

References

Guet, G. 1999. Memento d'agriculture biologique. Editions Agridécisions. Paris. 349p.

ITAB. 2001. Guide des matières organiques. Tome 1. Deuxième édition. Institut Technique de l'Agriculture Biologique. Paris. 238 p.

Kai, H., Uedia, T and M. Masaguchi. 1990. Antimicrobial activity of bark compost extracts. Soil. Biol. Biochem. 22 (7) : 983-986

Lapwood, D.H., Read, P.J and Spokes, J. 1984. Methods for assessing the susceptibility of potato tubers of different cultivars to rotting by Erwinia carotovora subsp. atroseptica and carotovora. Plant Pathology 33: 13-20.

Mustin, M. 1987. Le compost – gestion de la matière organique. Editions François Dubusc – Paris. 954 p.

Quarles, W. 2001. Compost tea for organic farming and gardening. The IPM Practitoner. XXIII (9) – September 2001. p:1-8

Weltsen,H.C. 1990. The use of composted materials for leaf disease suppression in field crops. P-115-120 in. Crop protection in organic and low input agriculture, R.Unwin, ed.BCPC Monographs N°.45, British Crop Protection Council, Farnham, Surrey, UK. 254 pp.