Development of a pot bioassay to screen organic matter or mycorrhiza input

ML. Brachet[1], M. Millan[2], A. Garcin[2]

Abstract

The addition of exogenous organic matter or mycorrhiza in orchard (natural soil) can contribute/promote some biological, physical or chemical processes such as microorganism activity, water management or mineral element availability. Assessment of a range of organic matter in situ is often difficult because of response time and space available in orchard. The development of a pot essay (ex-situ), with natural soil or growing mix, will help to evaluate large number of organic matter. Two experiments were made in 2013 in greenhouse with peach plant (GF305). We compared several organic matter or endomycorrhize additions, four types of soils (natural sandy, silty clay and clay soil, artificial soil) and we measured different variables such as stem length, number of internodes, nitrogen status of plant or fresh and dry matter and mycorhization on trees roots. Three main results were highlight. First, our experimental set-up allows differentiating modalities after 6 weeks of culture. Second, some indictors are useful such as stem length while some are useless (internode). Finally, the origin of soil has an impact on results. This kind of experiment should be a preliminary step before evaluation in orchard condition.

Keywords: peach, organic matter, pot bioessay

Introduction

In literature, many experiments were made to evaluate the impact of adding exogenous organic matter in orchard conditions because exogenous organic matter can contribute/promote biological, physical or chemical processes; but results are sometimes difficult to explain because of the complexity of soil dynamic. Furthermore, it takes two or three years to have positive or negative results. The development of a pot bioassay could reduce the response time and could be used as the first step to screen a wide range of organic matter. The study conducted aimed to develop a pot bioassay, which could be used in routine.

Material and Methods

Two experiments were carried out in a greenhouse during spring 2013 (2-month-period) in two different locations: the first in the south-east of France (Ctifl de Balandran, Bellegarde) and the second in the south-west (Ctifl de Lanxade, Prigonrieux). A common protocol has been defined previously.

Plant material: peach seedlings of GF305 were used. Cold stratification was applied to seed during two months. Then, seeds were germinated and transplanted in pots of 1.5 litres when they reached seven centimetres tall. No fertilizer was applied.

Experimental design: randomise design with five replications was used; each replication contain three peach plants.

Treatments: in each experiment, we test different treatments to cover a wider range, and one treatment was common.

[1] Technical Institut for Fruits and Vegetables (Ctifl), Centre de Lanxade, 28 route des Nébouts, 24130 Prigonrieux, France. e-mail: brachet@ctifl.fr

[2] Technical Institut for Fruits and Vegetables (Ctifl), Centre de Balandran, 751 chemin de Balandran, 30127 Bellegarde, France. e-mail: millan@ctifl.fr; garcin@ctifl.fr

Table 1: Treatments evaluate in each location (SW = South-west; SE = South-east).

Treatment	Location	Type of soil	Organic matter	Mycorrhization	Proportion soil/organic matter
1	SW	Sandy	/	No	100 - 0
2	SW	Sandy	Biochar	No	95 - 5
3	SW	Sandy	Biochar + Compost	No	67 - 33
4	SW	Sandy	Compost	No	71.5 - 28.5
5	SW	Clay	/	No	100 - 0
6	SW	Clay	Biochar	No	95 - 5
7	SW	Clay	Biochar + Compost	No	67 - 33
8	SW	Clay	Compost	No	71.5 - 28.5
9	SW, SE	Artificial	/	No	100 - 0
10	SE	Silty-clay	/	No	100 - 0
11	SE	Silty-clay	/	Yes	100 - 0
12	SE	Silty-clay	Biochar	No	95 - 5
13	SE	Silty-clay	Biochar	Yes	95 - 5
14	SE	Silty-clay	Terra Preta	No	67 - 33
15	SE	Silty-clay	Terra Preta	Yes	

- Variables measured: a notation was made every 15 days till the transplantation.
  - Stem length: 2 variables were used
    - Total length of branches (SE experiment)
    - Length of the main axe (SW experiment)
  - Number of internodes
  - Nitrogen status using N-Testeur
  - Fresh matter and dry matter of below- and above-ground biomass.
  - Mycorrhization of roots using 4 variables:
    - F%: frequency of mycorrhiza
    - M%: overall intensity of mycorrhizal
    - m%: mycorrhizal intensity of mycorrhiza fragments
    - a%: arbuscular intensity of mycorrhiza part
    - A%: arbuscular intensity in the root system

Results

- Stem length:

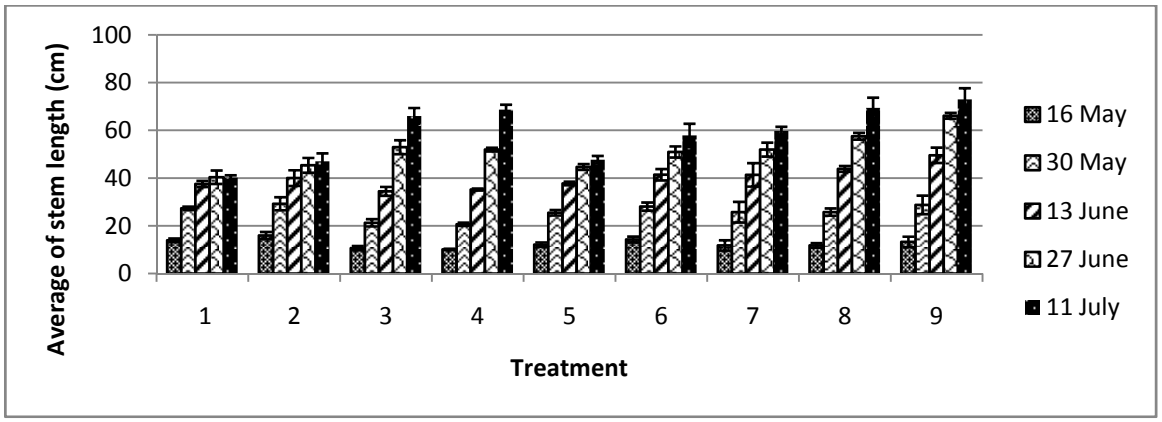

Figure 1: Stem length of each treatments at different date - South-west experiment.

After six weeks of culture (13 of June), first treatment differences appear; then, the differences are growing at eight and ten weeks. The same result is obtained with the data of South-east experiment.

- Number of internodes:

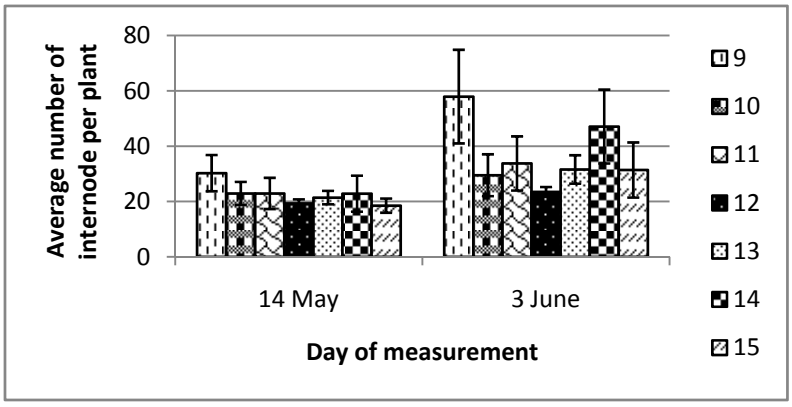

Figure 2: Number of internode of each treatment at different date - South-east experiment.

At the first notation (14 May), few differences were made between treatments; at the second notation, there are more differences but standard deviations are large and it's difficult to conclude.

- Nitrogen status using N-Testeur:

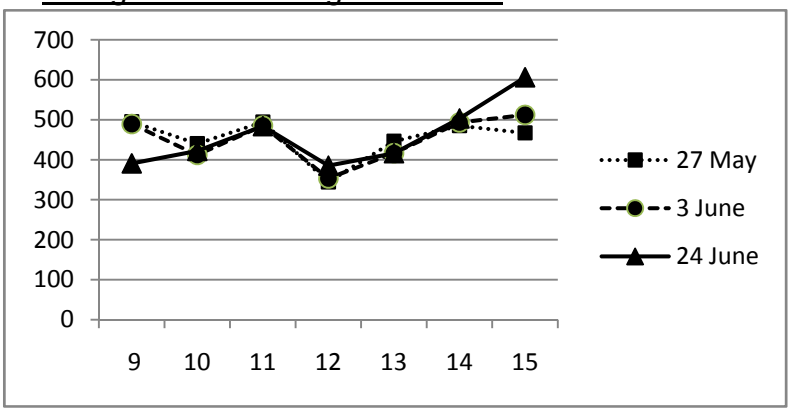

Figure 3: Results of nitrogen status on leaves using N-Testeur - South-east experiment.

With the measurment of nitrogen status, differences were made only for two treatments: number 9 (Artificial soil) and 15 (Terra Preta + Mycorhization). It seems that this parameter should not be used with all types of treatment (e.g. Organic matter).

- Fresh matter and dry matter of below- and above-ground biomass:

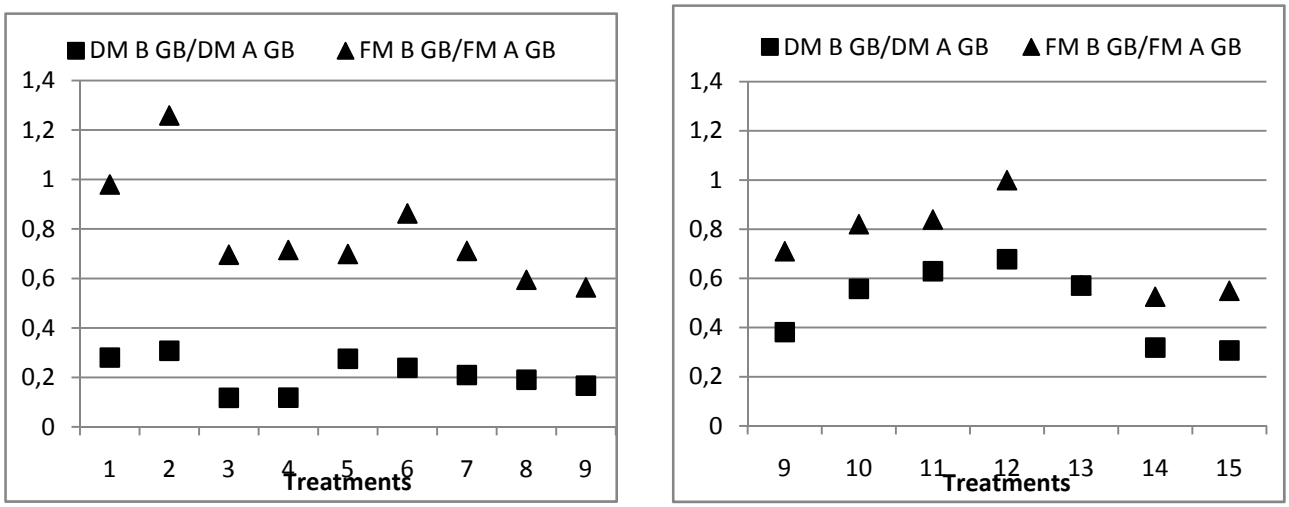

Figure 4: Ration of fresh matter and dry matter of the root system on the air system (DM B GB/DM A GB = Dry matter below ground biomass/Dry matter above ground biomass; FM B GB/FM A GB = Fresh matter below ground biomass/Fresh matter above ground biomass).

Dry matter and fresh matter show the same kind of results (same trend), even if results with fresh matter are more discriminating.

- Mycorrhization:

Table 2: Results of mycorrhization variables.

Treatment	F%	M%	m%	a%	A%
9	0	0	0	0	0
10	100	73,6	73,6	27,3	20,5
11	98,7	62,7	63,4	17,8	11,7
12	100	66,6	66,6	44,5	31
13	100	68,3	68,3	24,4	16,2
14	92,3	57	61,7	31,5	18
15	96,2	55	57,4	29	17,8

Shaded box in the table correspond to the mycorhizal treatments. As we can see in the table 2, no differences were made between treatments; it seems that all treatments are mycorrhized enough and the adjunction of mycorrhizae made nothing.

Discussion

Our objective was to develop a standardized method to pre-assessment inputs (organic matter or mycorrhizae) in soil. Several parameters have been defined:

- Plant material: we use peach seedlings of GF305 because this plant material is readily available in our technical center. Our experiments have confirmed the value of this vegetable material because it is homogeneous and rapidly reactive to treatment.

- Experiment duration: experiments were conducted for two months; but, some differences were made after six weeks of culture (stem length). For the next experiments, it would be interesting to continue measures for one month more, to see if it brings something.

- Selection of variables measured: stem length and fresh and dry matters are discriminant and could be used. The number of internode does not provide any additional information; it is not necessary to maintain this observation. For the variables “nitrogen status” and “mycorrhization”, results are less clear-cut. Results of “nitrogen status” using N-Testeur showed differences after 6 weeks of culture; it will be interesting to continue measurement during one month to see if differences are confirmed or not. For “mycorrhization” variable, it is necessary to first assess the mycorrhizal soil only to see his level of mycorrhizal before evaluating the different inputs.

2013 was the first year of development of this method; results are encouraging and need to be confirmed.