Agroecosystem sensitivity under temperature variation in Eastern region of Madagascar

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Table

1. Introduction

Climate change became one of the most important problems of our time because it increases the pressures considerably weighing on the society and the environment. (UNEP 2007). It affects the physical and biological environment of the earth ecosystem owing to human activities. Indeed, As the rest of the world, Madagascar lost half of its forest cover during 50 last years. According to the Department of the Environment, Forests and Malagasy Tourism, there remains today approximately 9.3 million hectares (93 000 km^2) of natural forests. The essence of the forest was destroyed by the practice of slash and burn cultivation, the creation of pastures or the firewood collection. The cleared forests are then converted into herbaceous carpets and lose its forest values. As a result, increase of greenhouse gases (GES) such as carbon dioxide occurs, leading to average temperature increase on the atmosphere and acts on soil microbial activity. According to the protocol of Kyoto, an agreement signed between the countries industrialize and aiming at reducing the emissions of GES. CO_2 is the most one which is emitted following the combustion of fossil energies (coal, oil and natural gas), with deforestation and also the cattle breeding. CO_2 concentration represent approximately 70% of the GES emitted in the atmosphere, but its time of residence is also longest. Thus the urgency is currently turned to the policies of GES emissions reduction and the increase in the ways of carbon sequestration, but also in finding strategies of adaptation and attenuation to the climate change. Research showed that the change of the temperature currently touches the soil (EEC, 2008), and that the agricultural domain is, consequently, most vulnerable (Lal and al., 1998). The soil represents a very large carbon store (Feller and Bernoux, 2008), so it plays a major part of sources and carbon store in relation to other greenhouse gases. The concern reconsiders the temperature change effect on the stock of carbon soil, the axis in which resides the present study. Indeed, it will try to study the agro ecosystem sensitivity of the eastern of Madagascar towards climatic variability. The problems reside on the made that with estimation that an increase of temperature will being for next years, what would be the soil behavior as regards CO_2-C? How is going to occur the mineralization of the soil organic matter?. It has main object of determining the effect of the climatic variability on soil organic matter mineralization in two different systems, through modeling which will translate carbon soil mineralization. Three hypotheses are emitted to make the study: ***h1***: modification of the temperature involves an increase in carbon mineralization, whatever the considered system; ***h2***: carbon mineralization is higher in agroforestry system with a high content of Carbon, than in conventional system with weak content of Carbon; ***h3***: organic manure addition modifies the dynamics of Carbon mineralization, it is more important in not resilient systems with temperature variation. With regard to these hypotheses, the global objective of the study is to determine the effect of the climatic variability on the mineralization of the carbon in two different systems. Indeed, to follow the evolution of the soil behavior regarding mineralization of the organic matter according to temperature conditions, and thus to determine the level of soil sensibility in two defined agro ecological systems among which the agroforestry and the conventional system of the Malagasy East coast.

2. Material and Method

2.1. Site description and sampling

Soil samples were taken from Ferrallitic soils of Malagasy East coast and from agroforestry (AGF) and conventional system (CV), which Belong to the rural district of Ambodimanga II of the Region Analanjirofo , with geographical coordinates : 49°20 " - 49°28 " of eastern Longitude and 17°20 " - 17°30 " of Southern Latitude. The soil samples were taken from the upper layer (0-10cm). Then they were dried up under greenhouse during 15 days, then crushed and sieved under stitch of 2mm. For the experimentation, the requirement of soil was 640g, which 320g per system. That is to say 16 soil samples of 20g per system.

2.2. Laboratory incubation and measurements

An experiment of incubation which simulates the climate change, through the two systems was carried out. The mineralization of carbon was followed during the experimentation. The amouts of soil organic carbon mineralized were measured at predetermined points during the pre-incubation and incubation periods (days 1, 2, 7, 10, 15 and 1,3,7, 10,15, 21, 24, 28, 36, 42, 50, 56,59 respectively) Handling in laboratory consists of the incubation of soil samples and then measurement of CO_2 emission with microgas Chomatograph at different time of incubation. There are two incubation times: at first, soil samples are preincubated during 15 days in 25ºC, to stabilize the microorganisms activities of the soil, before being incubated in 25ºC and 35ºC, which are temperatures chosen according to the current temperature of the region (25ºC) and overestimation of the future change (35ºC). All Soil samples were placed in incubators in 25ºC in the first time (preincubation), then in incubators of 25ºC and of 35ºC during the incubation .

2.3. Substrate and temperature addition

At the beginning of the incubation period, *organic manure* was added to half of the soil samples. 0.2g added per 20 g of soil for 16 soil samples. At the same time, temperature was *rising for 10ºC for samples (* 35ºC*)*. Soil moisture was maintained constant *(75%)* throughout the incubation periods by weighing and addition of distilled-water when required, *a*fter each measurement.

2.4. Calculations and statistical analyses

The value of C-CO2 given by CPG is expressed in pixels and represents the surface area occupied by CO2 in each jar with resulting from a time T of incubation, this surface area was then converted into volume expressed in vpm, value usable in the statistical analysis: All the stages of calculation were integrated in several worksheets Excel then the ANOVA with one factor according to treatment and of the dates of incubation was carried out in order to determine the effect of the temperature, the land use, the organic contribution on carbon mineralization, by using the Honestly Significant Difference test of Tukey-Kramer. The difference were considered to be significant for p less than 0,05.

3. <u>Results</u>

3.1. Carbon mineralization during the pre-incubation and incubation periods

The curves (fig.1) show the cumulated CO2-C emissions. During the pre incubation period, subjected to the same temperature (25°C), the two systems are distinguished one well from the other. In 15 days, the CO2-C mineralization for the two systems rose, both for the agroforestry system and system CV. From J_3 the CO2-C emitted by AgFS having a high carbon content (41,26g/kg soil) becomes higher than the CO2-C emitted by system CV having a weaker Carbon content (36,35g/kg soil). From the 15th day of pre incubation, curves's shape changed following the organic manure contribution and with the introduction of the second condition of temperature (increase of 10°C). At the end of incubation, the curves which showed the highest cumulative emissions belong to samples subjected to 35ºC of temperature.

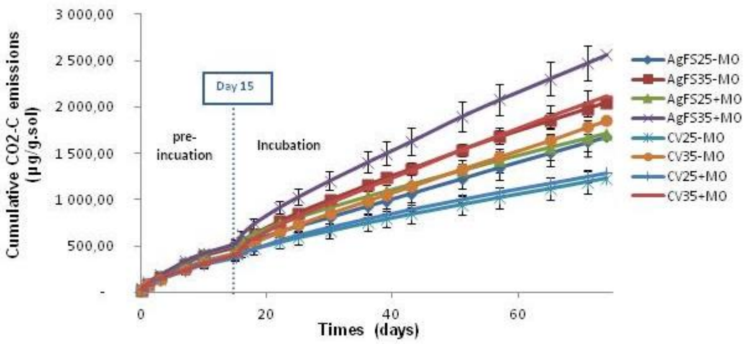

Fig.1: Cumulative CO2-C emissions during preincubation and incubation periods

3.2. *Effect of temperatures, land use and organic manure addition on CO2-C mineralization(days 16-60)*

The temperature has a significant effect on the treatments in the agroforestry and conventional system. It is much stronger for AgFS having subjected organic matter contribution (+MO) that for AgFS without organic matter contribution (- MO) and system CV for towards the end of incubation, especially for CV-MO. On all the data and for the two systems, the mineralization of CO2-C increases with the temperature. For the two systems, the values of emissions CO2-C to 35°C are higher and are different significantly with those with 25°C. (fig.2a). By considering the factor land use, the values of the emissions of CO2-C in AgFS are higher than that of the values of the emissions of CO2-C in CV system.In general, lad use affects the mineralization of CO2-C for the both systems. *P* values are lower than the α=0,05
In incubation period, the AgFS system is significantly different from system CV;
The AgFS system emits more CO2-C by report system CV. Apparently, the two systems are different significantly(fig.2b). As for organic manure addition, its contribution had an effect on AgFS subjected to 35°C of temperature, but it did not have an influence very marked on carbon mineralization for the remains of the samples. For the latter case, the results of the statistical tests didn't show a significant difference between the samples with contribution of organic matters and those without organic matter contribution. With organic matter contribution, CO2-C mineralisation is high compared to the mode without MO contribution. On the other hand, the emission of CO2-C is concentrated much in the mode without MO contribution. The difference between +MO (with organic matter contribution) and – MO (without organic matter contribution) is significant (fig2c)

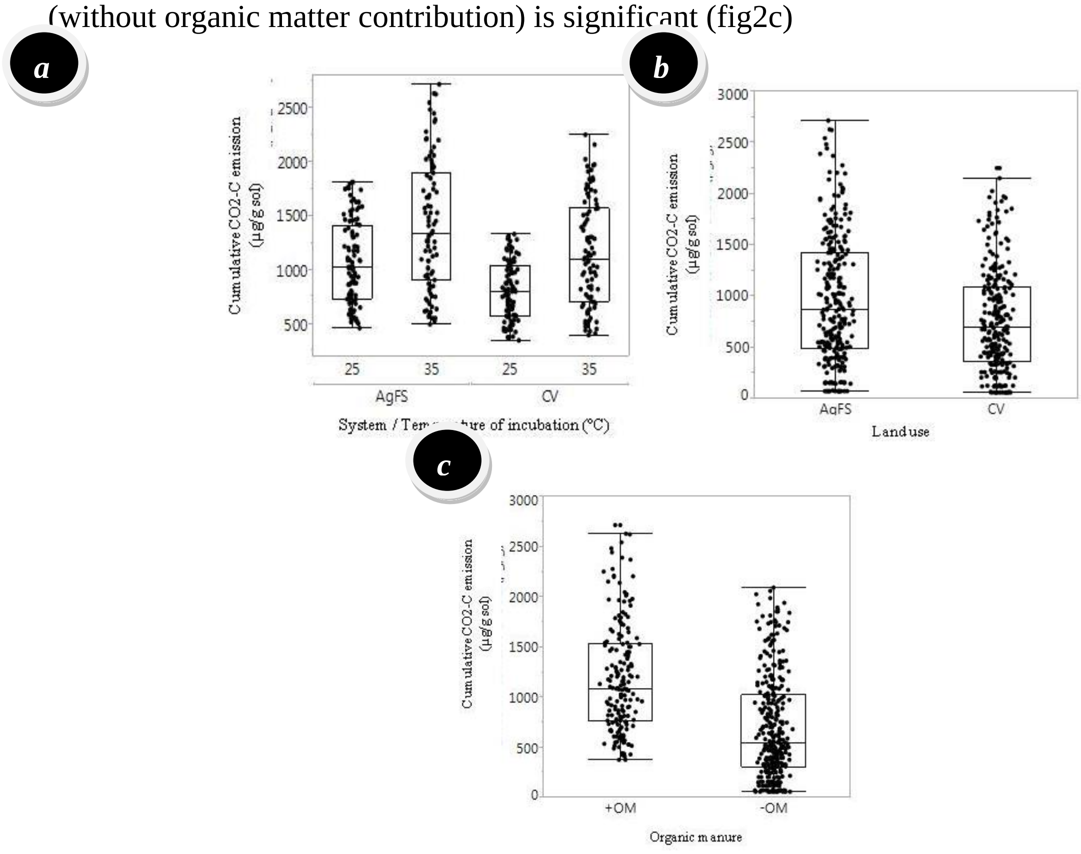

Fig.2: (a) temperature effec on CO2-C mineralization t; (b) land use effect on CO2-C mineralization Cumulative CO2-C; (c) organic manure addition effect on CO2-C mineralization.

3.3. Soil resilience

The variation in the temperature (Δ T) was taken into account to see the sensitivity of the soil from the agro ecosystems considered. The curve 3(fig.3) shows the variation of the emissions of CO2-C for the Agroforestry and the system conventional compared to the temperature variation (ΔT), with and without organic manure contribution. Indeed, in incubation period, without OM contribution, the AgFS system mineralizes less carbon compared to the system CV which mineralizes some more. This is checked by the position of the curves with – MO, which, from J_{10}, AgFS curve is in bottom of that of CV. At the end of incubation, the difference between the two curves of the trends between the two systems is significant. With organic matter contribution, mineralization increased for the two systems, putting system CV below AgFS, but the difference is not significant. The emission of CO_2-C in system CV remains increasing with respect to AgFS.

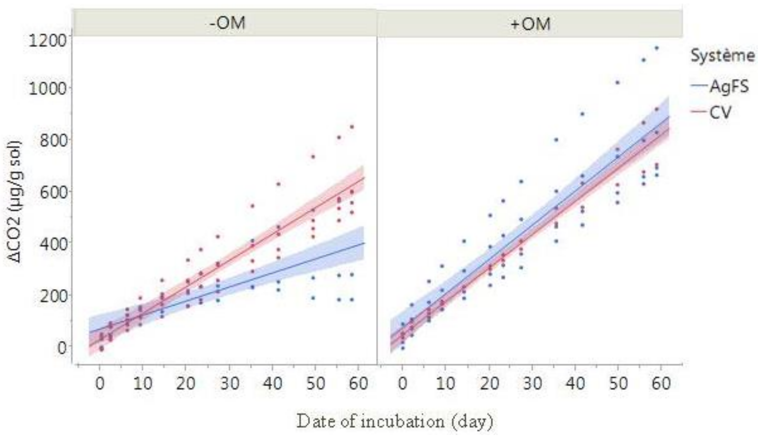

Fig.3 : Curves of tendancy of CO2-C minéralization for the two systems : AgFS et CV

4. <u>Conclusion</u>

The factor temperature has a significant effect on the emission of soil CO2-C. For a given moisture, carbon mineralization of the soil samples is generally function linear of the temperature, it tends to increase the carbon mineralization (G.BACHELIER, 1968). The agroforestry is an association of annual culture with trees which are perennial cultures. There are thus more restitution of organic matters on soil. In conventional system, which is primarily made up of system of slash and burn , soil is thus rather naked and contains very few organic matters, so that it is rather low in carbon. However the richer is soil in carbon, the more it mineralizes Carbon. This trend was already observed often in the literature (Razafimbelo and al., 2008). It is thus perfectly logical that mineralization in system agroforestry is high compared to system CV. The organic contribution has a significant effect on mineralisation of Carbon, especially at the AgFS system. This can be explained by the phenomenon of the "Priming effect". A fresh organic matter contribution can generate a carbon clearance coming from the mineralization of the advanced organic matter of soil. (Cheng, 2009). The variation in the temperature at the two agro systems ecological showed that, without MO contribution the agroforestry is more resilient compared to system CV. In conclusion, the agroecological system such as Agroforestry could be identified as sustainable system in climate variability mitigation which is more marked under organic input system in the Malagasy context.

5. References

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