BIOLOGICAL PROFILE FROM SOIL USING MAIN COMPONENTS ANALYSES

MARIA SOL ROSSI[1], RODOLFO MON[1]

[1]*De los Reseros y Nicolás Repetto S/N, Hurlingham, Instituto de Suelos / INTA*

rossi.maria@inta.gob.ar

ABSTRACT

It is known that principal components analysis is used as a mathematical procedure that transforms a set of correlated response variables into a new set of non-correlated variables known as main components. The sensitivity of the variables in response to the changes in the soil environment under different health conditions of trees. In order to clarify the structure of interdependence between all properties, principal components analysis was applied to the data corresponding to all the soil properties studied. We analyzed this dataset and we found that the metabolic quotient (qCO_2) and micC are the two parameters that differed most in the studied soil. The metabolic quotient (RES:micC) was higher in the presence of pathogens, while the biological quotient (micC:orgC) was lower. The score plots indicated that the samples can be divided into two groups (LRs-BAs and LRc, LRh, BAc, BAh), which suggests that the two different states of plant health conditions had a strong effect on soil properties. In PCA biochemical parameters explained 84 % of the system variability. Strong association between LRs with DH and b-Glu was observed. The score plot indicated that the samples can be defined into two groups: LRc, LRh, BAc, BAh and LRs, BAs which suggests that the presence of the patoghen had an effect on soil properties. The parameters studied showed the same variability within LR as BA soils. Our results empathize the importance of determining soil quality indicators and rizopherical bacterial communities in the presence of root pathogens. Bacterial communities from soil played a differential role in the presence of root pathogens. Microbiological activity correlated with biochemical properties from soil in locations with trees with fungal symptoms. We hypothesized that changes in the health state of trees could be related to changes in rhizospheric soil quality indicators.

Key Words: *main components analysis, soil biological indicators*

INTRODUCTION

It is known that principal components analysis is used as a mathematical procedure that transforms a set of correlated response variables into a new set of non-correlated variables known as main components. The sensitivity of the variables in response to the changes in the soil environment under different health conditions of trees.

METHODS

We use biological and chemical tools to characterize the rhizosphere environment of diseased olive plants, symptomatic (s), asymptomatic (a) and uncultivated soils, control (c). These treatments were evaluated in two contrasting soils and at depth intervals of 0-5 cm, 5-20 cm and 20-40 cm.The sampling sites are located in Aimogasta (La Rioja-LR) and Castelar (Buenos Aires-BA).The soil of La Rioja is classified as Torripsament while the soil of Buenos Aires corresponds to a typical Natracualf according to Rossi (2008).

The biological indicators evaluated were: basal soil respiration (RES), by means of NaOH titration according to Alef and Nannipieri (1995), microbial biomass carbon (Cmic) by means of the direct extraction method with chloroform according to Vance (1987), with a kEC factor of 0.45 according to Wu (1990).The metabolic coefficient (qCO2) was determined according to Anderson and Domsch (1993) and the global biological quotient (qBiol) was calculated as micC:orgC.

In order to clarify the structure of interdependence between all properties, principal components analysis was applied to the data corresponding to all the soil properties studied using the R program (R 2015).

RESULTS

We analyzed this dataset and we found that the metabolic quotient (qCO_2) and micC are the two parameters that differed most in the studied soil. The metabolic quotient (RES:micC) was higher in the presence of pathogens, while the biological quotient (micC:orgC) was lower.

The score plots indicated that the samples can be divided into two groups (LRs-BAs and LRc, LRh, BAc, BAh), which suggests that the two different states of plant health conditions had a strong effect on soil properties.

In PCA biochemical parameters explained 84 % of the system variability. Strong association between LRs with DH and b-Glu was observed.

The score plot indicated that the samples can be defined into two groups: LRc, LRh, BAc, BAh and LRs, BAs which suggests that the presence of the patoghen had an effect on soil properties. The parameters studied showed the same variability within LR as BA soils.

Basal soil respiration was significantly higher ($p<0.05$) at 0-5 cm (LRs=421±0.2, BAc=398±0.2).

Cmic was significantly higher ($p<0.05$) in the undisturbed soil (LRc=233±0.2, BAc=239±0.2) regardless of climate and soil type in the first 0-5 cm of depth.

On the other hand, the metabolic coefficient was significantly higher ($p<0.05$) in LRs (2.14) than in LRc (2.05) and LRa (2.04) ($p<0.05$).

While the biological coefficient data showed significant differences ($p<0.05$) between depths from 0 to 5 cm and from 5 to 20 cm.

The sensitivity of the variables in response to changes in the soil under different crop health conditions was described using a hierarchical cluster analysis based on a set of methods and dissimilarities.

The hierarchical cluster analysis Hartigan (1975) using the minimum distance variance method provided compact and spherical clusters, classifying as a result the two contrasting soils against the two conditions of plant health states.

Subsequently, a principal component analysis was performed to evaluate the results of the clustering. As a result, biological variables explain only 60% of the total variance of the system. Therefore, the principal components analysis of the biological variables did not show differentiation between the treatments in the control and soil sites with root pathogens as allowed to differentiate the biochemical variables.

The characterization of the soil of the rhizosphere of healthy and diseased olive groves found important differences in the biological variables (RES, Cmic, qBiol, qCO_2) and in the biochemical and molecular variables there was an important effect of sampling depth. The microbial activity measured as Cmic was not a sensitive variable to discriminate between the two health conditions studied, as was observed in the microbial activity based on biochemical variables.

CONCLUSION

Our results empathize the importance of determining soil quality indicators and rizopherical bacterial communities in the presence of root pathogens. Bacterial communities from soil played a differential role in the presence of root pathogens. Microbiological activity correlated with biochemical properties from soil in locations with trees with fungal symptoms. We hypothesized that changes in the health state of trees could be related to changes in rhizospheric soil quality indicators.

This work was support by PE AEAI-271171. Diagnóstico de la compactación del suelo en siembra directa y técnicas para la descompactación y su control. INTA-Instituto de Suelos.

REFERENCES

Alef, K. y P. Nannipieri. 1995 .Methods in applied soil microbiology and biochemistry. *Academic Press Harcourt Brace and Company Publishers Great Britain.* *https://www.elsevier.com/books/methods-in-applied-soil-microbiology-and-biochemistry/alef/978-0-12-513840-6*

Anderson, T.H. y K. H. Domsch. 1993. The metabolic quotient for CO_2 (qCO_2) as a specific activity parameter to assess the effects of environmental conditions, such as pH, on the microbial biomass of forest soils. *Soil Biol. Biochem.*, 25:393-395. https://www.sciencedirect.com/science/article/abs/pii/0038071793901407

Hartigan, J.A. 1975. Clustering Algorithms, New York: Wiley. https://www.scirp.org/(S(vtj3fa45qm1ean45vvffcz55))/reference/referencespapers.aspx?referenceid=1947216

R Development Core Team. 2015. R: A language and environment for statistical computing. *R Foundation for Statistical Computing*, Vienna, Austria. ISBN 3-900051-07-0. https://www.r-project.org/

Rossi, M.S. 2008. Aspectos bioquímicos y microbiológicos como indicadores del estado de salud del suelo. pp 1-156. Ed UNSAM

Vance, E.D., P.C. Brookes y D.J. Jenkinson. 1987. An extraction method for measuring soil microbial biomass carbon. *Soil Biol. Biochem.,* 19: 703-707. https://doi.org/10.1016/0038-0717(87)90052-6

Wu, J., R.G, Joergensen, B., Pommerening, R. Chausson y P.C. Brookes. 1990. Measurement of soil microbial biomass by fumigation-extraction:an automated procedure. *Soil Biol. Biochem.*, 22:1167-1169. https://repository.rothamsted.ac.uk/item/8660w/measurement-of-soil-microbial-biomass-c-by-fumigation-extraction-an-automated-procedure