Towards Precision Microbiology

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Abstract.

In the recent years, the use of organic matter (OM) and microorganisms is increasing beyond organic agriculture, into conventional horticultural systems, in order to achieve high yields and quality through a more sustainable soil management. Thus, Integrated Nutrient Management (INM), that includes the use of diagnostic tools, high quality OM, microbial inoculants, highly-efficient fertilizer, and site-specific management in gaining space in intensive production systems.

Precision microbiology (PM) is a key concept to properly implement and evaluate INM programs. There are several reasons for PM to be used, among them: 1) once corrected the soil chemical and physical limiting factors, the biological properties are usually the ones that determine yield and quality; 2) there is a high variability of soil microorganisms and their activity; 3) responses to the application of organic and bioproducts are site-specific; 4) since the effects of the application of bioproducts are usually modest, compared to conventional crop inputs, they require more complex statistical analysis based on Precision Agriculture tools.

Keywords. *Integrated Nutrient Management; Precision Microbiology; bioproducts; organic matter.*

Integrated Nutrient Management

Microorganisms in agriculture are now receiving a great deal of attention in both, developed and developing countries, as important components of organic amendments and compost, as inoculants for growth promotion to improve crop quality and yield, and for reduction of labors (Higa & Parr, 1994). Although the use of these products has been evaluated to demonstrate which microorganisms are responsible for the effects, how they interact with indigenous species, and how these new associations affect soil quality and plant nutrition, their roles and effects have not been well-defined (Kahn et al. 2009).

Microorganisms by themselves are not enough to produce high yields and quality in intensive horticultural systems, thus they must be integrated into fertilization programs. Integrated Nutrition Management (INM) is considered the new paradigm to reach high yields and quality, in a sustainable way, under intensive horticultural systems. It is based on the use of high-quality organic matter and microbial inoculant, along with proper fertilizer rates to maintain soil fertility and plant nutrient supply at an optimum level for production; it also includes the use of available tools for diagnostic and follow up for soil, plant tissue, and biological products, the use of highly-efficient fertilizers, and site-specific management (Ortega, 2014).

Precision Microbiology

Precision microbiology (PM) is a key concept to properly implement and evaluate INM programs. There are several reasons for PM to be used, among them: 1) once corrected the soil chemical and physical limiting factors, the biological properties are usually the ones that determine yield and quality; 2) there is a high variability of soil organic matter and microorganisms and their activity; 3) responses to the application of organic and bioproducts are site-specific; 4) since the effects of the application of bioproducts are usually modest, compared to conventional crop inputs, they require more complex statistical analysis based on Precision Agriculture tools (Ortega, 2013).

In a recent study performed in table grapes, differences in plant vigor measured by NDVI were explained by biological properties, in particular enzymatic activity, while phyisical and chemical properties did not have any effect (Figure 1).

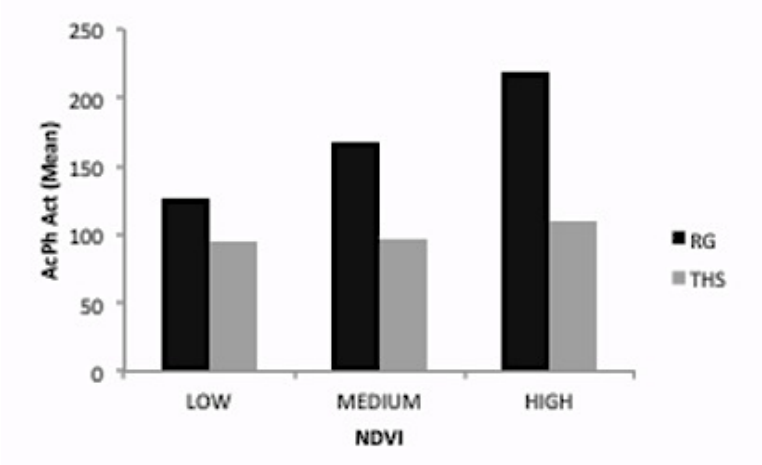

Fig 1. Phosphatase activity in two table grape varieties as explained by plant vigor estimated by NDVI.

The elevated spatial variabilty of microorganisms and their activity causes serious limitations to evaluating their effects in soil. Coefficient of Variation (CV) of some biological properties can reach values between 50 to 200 %; variables as soil fungi and yeast and microorganisms that degrade starch (amilollytic) presented the highest values (Figure 2). Understanding variability in agricultural soils, have two important advantages: 1) improved quantification of the property under study and 2)

improved identification of driving variables; these are good reasons to implement PM as tool to assess variability and understand the effects of organic matter and microorganism in soil and plant nutrition (Parkin, 1993).

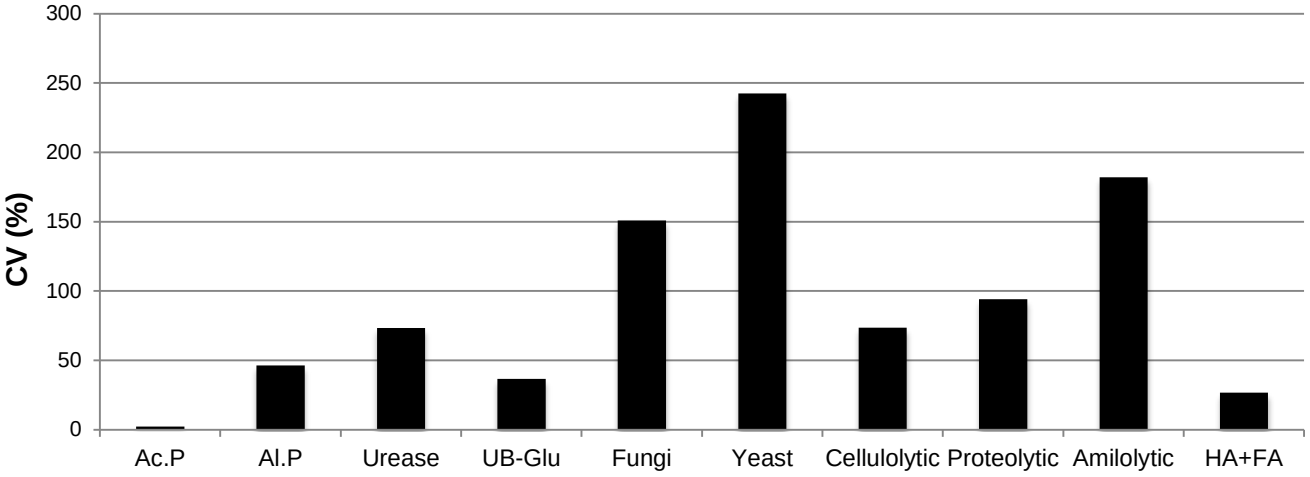

Fig 2. Coefficient of variation of soil biological properties as quality indicators (AcP:Acid Phosphatase activity; AlP: Alkaline Phosphatase Activity; UB-Glu: Glucosidase Activity; HA+FA: Humic and Fulvic acids; Cellulolytic, Proteolytic and Amilolytic. (Referred to microbial counts).

When organic matter is applied on field, responses are site-specific and so are the needs. Thus it is important to use new technology to allow closer, more site-specific management of the factors affecting crop production. Precision agriculture can measure their output more precisely by matching yield variables with the location in the field. Special computer-driven equipment can change the rate at which organic materials, inoculants, fertilizers, seed, plant pest control products, and other inputs are used, based on the needs of the soil and crop in a particular portion of a field.

This perspective allows Precision MIcrobiology to emerge as new tool to evaluate the effects of the application of organic matter and microorganisms, supported on Precision Agriculture tools, such us ground sensors, and more complex analysis techniques and specific statistical models. For example, autoregressive models (eq. 1) based on spatial data, present better adjustments to evaluate the true effect on organic matter and biological inputs (Ortega, 2013).

$$Y = X\beta + \varepsilon \qquad \text{[eq.1]}$$
$$\varepsilon = \lambda W\varepsilon + u$$

Final Comments

As the use of organic matter and bioproducts increases in today's agriculture, it is necessary to move towards Precision Microbiology, to properly apply them, and measure their effects on soil, plant growth, yield and quality.

References

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