Soil and fertility management

Post Graduate Specialization Programme
In Mediterranean Organic Agriculture

Bari – ITALIE

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Karim RIMAN
Consultant in Ecological Farming

Activities

- **Global diagnosis of soil fertility** - Soil Cartography
- **Technical follow-up** For certified organic farmers and reasoned agriculture certified farmers.
- **Audit of transition projects towards organic agriculture** on temperate and tropical crops : technical, economical feasibility and technical follow-up.
- **Setting up of field experiments** for companies trading in natural products
- **Training :** Help in setting up and realization of training programmes

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Areas of intervention

- Vine growing
- Fruit growing : Stone and Top fruit; Olive trees
- **Tropical fruits :** citrus, mangoes, bananas, pineapples
- **Market garden products**
- **General crops and rice**

Places of intervention

- **Europe : Southern France , Corsica, Italy , Portugal**
- **Oceania : Australia, New Zealand**
- **Africa : Morocco, Ivory Coast, Togo**
- **Asia : India, Lebanon, Palestine**

A new approach to global soil diagnosis

Aims at optimal improvement of soil fertility, measuring together :

- Physical quality
- Organic and biological quality
- Quality of its organo-mineral complex
- Chemical content
- Evolution status

There are different levels to define soil fertility

- **Aptitude to produce regularly good crops ; soil fertility is not fertilization, which is enrichment of soil in fertilizers. (See tables of Gabriel GUET)**

- **Soil fecundity is its capacity to produce all food chain, going from micro-organisms to man, passing through plant and animal, and this during generations (H.P. Rusch).**

European regulation n° 2092/91 of the Council of 24th June 1991 modified, precise : « fertility and biological activity of soil must be maintained or increased first by : a) legumes culture, green manure, cover crops, deep rooted plants within an appropriate several years' rotation. b) incorporation of animal waste of organic origin ; c) incorporation of other organic materials, composted or not, whose production comes from farms comforming to the present regulation. Other supplementary inputs of organic or mineral fertilizers mentioned in Annex 2 can be made exceptionally.»

***So,** organic agriculture will prefer supplementary inputs of natural origin, used either raw or after processing by physical means (crushing) or by fermentation (composting) ; it also aims at maintaining long term soil fertility.*

METHODOLOGY OF APPROACH AND TOOLS USED FOR DIAGNOSIS

IN THE FIELD

- **Collect farmer's usual practices and agronomic results.**

Objective : to understand farmer's logic and define with him the problem to be treated.

- **Observe farm environment ; and crop state.**
- **Identify the different soil types in a field or on the farm.**
- **Prepare and observe soil profiles by type of soil.**

Observations of soil profile

- horizons, depth, stone content, geological subsoil. Two big families: alkaline soils and soils born from acid materials
- soil structure, pedological phenomenon going on
- rooting of crop and cover crop : density, depth, state
- biological activity (earthworms, ants…)
- presence of raw crop residues

General comments on soil and limiting factors

Work in field ends with flora inventory in order to determine its bio-indicator character .

And of course, observation of crops' aerial parts development

Examples of soil profiles

So, soil profile observation conditions the decision on soil preparation type before planting :

- work in depth or not, de-compaction, ploughing etc
- drainage, levelling
- reflection on soil resting and the planting of a cover crop. *Avoid leaving soil bare for a long time.*
- Choice of irrigation system and its management
- Choice of rootstock and density of plantation
- Choice of cover crop for future orchard, vineyard, citrus grove etc.

Soil analyses

Indispensable complement to field diagnosis

Samples are taken by type of soil in the different profile parts. Interpretation is made part by part and by comparing data from one part to the other and between different points of field. Example: field top and bottom in case of slope.

Major criteria used:

Soil fixation capacity, measured from the quantity and quality of ultra-fine particles ("real" clay and fine silt).

This parameter determines level of inputs not to be exceeded and necessity or not to fraction them. CEC Cobaltihéxamine

Links of organo-mineral complex, measurement of :

Exchangeable calcium and magnesium
Iron Mehra-Jackson
total and active limestone and index of chlorosis capacity (In French IPC).
Water pH and KCl pH.
"Exchangeable" aluminium with KCl.

These parameters determine the decision to bring calcareous amendments or not (nature, quantity, fractioning), give an evaluation of blockage risk, and correction needed.

Organic matter: Measurement of total carbon and total nitrogen ; Link C/N. This is not enough in order to characterize the organic soil functioning.

Then we measure two fractions of organic matter :

- **stable humus, complex polymers linked to ultra-fine particles,**
- **free organic matters, easily accessible to microbial biomass soil, then to the plant ; they are measured on the coarse part of fine earth.**
  The level and balance between those two fractions determine the type of product to bring to the soil.

The quantity of inputs depends on crop, soil fixation capacity o and on biological activity.

Microbial Mass and mineralization activities

An important part of soil fertility is linked to its biological components. Microbial Mass constitutes the most active fraction of this component.

The analysis is made on surface earth (5 to 30cm).

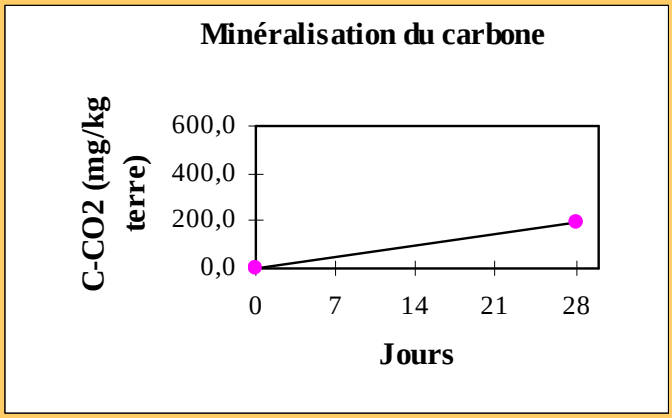
The chosen parameters are :

Microbial biomass : expressed in milligrams carbon per kilo of earth : this is the quantity of microscopic organisms in soil (mainly fungi and bacteria

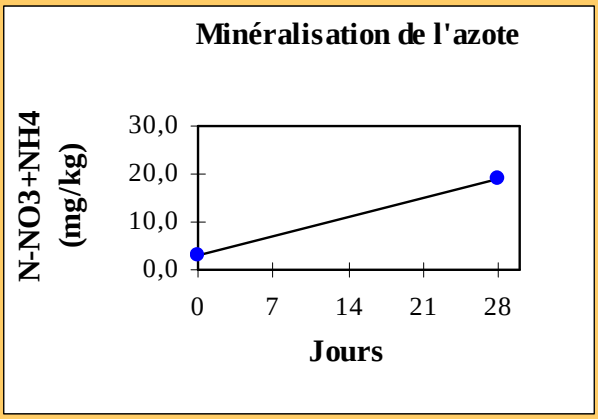
Example :

Biomass mg C/kg of soil	Interpretation
100-150	**LOW**
200-300	**Correct**
300-400	**High**

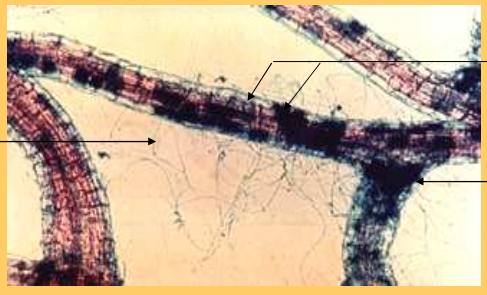
Carbon Mineralization Activity expressed in mg C-CO2/kg/28 days. Calculation of carbon mineralization index.



Nitrogen Mineralization Activity: expressed in mg N-mineral (NO_3^- et NH_4^+)/kg/28 days.
Calculation of nitrogen mineralization index



Analysis of roots mycorrhization rate : qualitative indicator of soil and plant functioning



(Photo INRA)

Mineral content : easily exchangeable elements and trace elements.

Total elements measured on the mineral substratum : P, K, Ca, Mg. *Determines inputs balance and eventual corrections*

Soil Evolution : *balance between free iron and total iron. Balance between free aluminium and total aluminium.*

Soil Hydromorphy : *manganese easily "reduced" /total manganese*

So, soil is not considered any longer as a support for crops, but as a component with a major impact on quantity and quality of crop

Objectives of this diagnosis

Soil profile ; agro-pedological and organo-biological analyses

- to understand the soil
- to define its state of fertility, organo-biological, physical and nutritional
- to show its limiting factors
- to decide its technical improvements : maintenance ; crop rotation ; choice of species, rootstock and variety ; choice and supply of mineral and organic amendments ; choice and supply of mineral fertilizers

Soil Cartography :

Management of the technical itinerary depending on the types of soils and selection of appropriate crops

TECHNICAL FOLLOW-UP

Methodology

- Work carried out on, one or several reference fields, on which a complete follow-up is realized in order to :
- verify working hypothesis deduced from soil diagnosis
- reply to a question
- solve a production problem
- etc.

We validate the new technique by comparison to the control field

- Follow-up of water supply both in soil and plant during the growing season :
  - –Measurement of the water supply evolution in the soil using probes put in the ground at different depths
  - –registering plant reaction and identifying the periods of water rationing or stress, with PEPISTA® and pressure chamber.

Management of cover crops, modification if needed of the water supply and change in the techniques of plant management.

Nutritional follow-up by : soil solution analysis and plant analyses (leaves, fruits, branches).

Study by «sensitive *crystallisation processes*» for global and qualitative information

Technical and economical assessment : conclusions and path to be followed

Method efficiency depends on an active implication of grower and employees