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Plant protection by restoration of antagonistics microorganisms population in agro-ecosystems.

Sol-Actif® as natural agent of bio-stimulation.

Biodiversity as an alternative to pesticides.

Soil organisms contribute to a wide range of essential services to the sustainable function of all agro-ecosystems, by acting as the primary driving agents of nutrient cycling, regulating the dynamics of soil organic matter, degrading organic matters, modifying soil physical structure and water regimes, enhancing the amount and efficiency of nutrient acquisition by the vegetation, enhancing plant health, neutralisation of pesticides. These services are not only essential to the functioning of natural agro-ecosystems but constitute an important resource for the sustainable management of agricultural systems. Soil biodiversity is a key to sustainable development.

Sol-Actif (*3) is a soil organic amendment, it causes a very strong increase of bacterial faune. Antagonist micro-organism in greater number will colonise plants roots and enter in conflict with phytopathogen responsible for verticillioses, sclerotinoses, fusarioses and other diseases. Those micro-organisms will réduce capacity of pathogens to colonise roots of germinating seeds, plantlets and cuttings but also of adult plant after transplantation. **Sol-Actif** favour roots development, plant growth and production.

Systematic recourse to pesticides has been a short-term response to damages caused to plants by phytopathogens, but this recourse has strongly reduced soil biodiversity. If sustainable development goes through reduction of pesticide usage, it is also obvious that this reduction cannot take place without optimisation of alternatives strategies to control plant pathogens like stimulation of biodiversity and restoration of beneficial organisms that attack, repel or otherwise antagonize diseases causing pathogens.

Micro-organismes and plant control disease.

Numerous soil microorganisms are capable of controlling plant diseases, they belong to various groups of symbiotics bacterias and arbuscular myccorrhizal fungi. Those symbiotics micro-organisms, bacterias PGPR (Plant Growth Promoting Rhizobacteria) (*1) and AMF (Arbuscular Mycorrhizal Fungi) (*2) fungis are ubiquitous in nature and constitute an integral component of terrestrial ecosystems, forming symbiotic associations with plant root systems of over 80% of all terrestrial plant species, including many agronomically important species. AM fungi are particularly important in sustainable farming systems that rely on biological processes rather than agrochemicals to control plant diseases. They can promote growth either directly by production of phytohormons, improvement of absorption of nutriments or by indirect means by elimination of pathogens. Of particular importance is the bioprotection conferred to plants against many soil-borne pathogens such as species of *Aphanomyces*, *Cylindrocladium*, *Fusarium*, *Macrophomina*, *Phytophthora*, *Pythium*, *Rhizoctonia*, *Sclerotinium*, *Verticillium* and *Thielaviopsis* and various nematodes by AM fungal colonisation of the plant root. Rhyzosphere colonisation by a few non pathogens micro-organisms can protect plants

The rhizosphere and spermosphere are zones in soil immediately surrounding plant roots and seeds. The functioning of organisms in these zones can have a profound effect on both plant growth and nutrient cycling. The spermosphere is a critical area because seed colonization is the first step in root colonization. Microorganisms established on the germinating seed can multiply and colonize the length of the root as it emerges and grows through the soil. Thus, colonization of the imbibing seed may predispose future colonization of the root and greatly impact crop growth. The growth of a root through an area of soil increases the population of some microorganisms and influences the microbial interactions that benefit plant growth. Because of the greater activity of soil biota in the microenvironment of the rhizosphere, it is a very different environment from that of the bulk soil and needs to be managed as such.

against a large variety of disease. The earliest an antagonistic micro-organisms colonise roots, the more efficient it is.

If introduction of antagonistics micro-organisms is a biological way of controlling soil born disease, another way consists in stimulation of the existing micro-organisms population from rhizosphere and spermosphere in favor of same micro-organisms already present but not numerous enough to be sufficiently active. This method stimulates all species and what is important those known for their activity but as well known for their lack of cultivability. First avantage of this method is that bioremediation will be undertaken by existing micro-organisms well adapted and distributed in soil.

Electrons donors and soil biodiversity.

Majority of antagonistics bacterias capable of disease reduction are chimioorganotrophes, it means that their source of energy to survive and multiply are organic matters. They utilise chemical energy, the one « contained » in chemical liaisons made free during oxydation reactions as source of energy. An oxydation reaction allways lead to electrons liberation, this is why those supports are called electron donnors.

Chimioorganotrophes bacterias degrade substrates in smaller molecules to give intermediate metabolites who themselves are degraded with production of CO_2, H_2O and of energy. These energy producing reactions are reactions of oxidation of hydrogenated substrates, with release of electrons thanks to Déshydrogénase S. The transfer of electrons to a final acceptor is carried out by a whole series of enzymes which form a chain of electronic transport. Energy thus produced is released by small stages with an aim of being transferred in chemical bonds rich in energy (ATP, NADH, NADPH). In all the cases, the final acceptor of electrons must be an oxidized molecule (O_2, NO − , SO −). The organic compound is the energy source or the donor of electrons while an other made up organics is the accentor of electron.

Biodiversity restoration in favour of antagonistics micro-organisms can be achieved by bringing various types of electrons donors like oxygen, nitrogen, phosphorus, malic acid, lactic acid, fatty acid, amino acid or glucide as soil input. Those electron donors are brought using specific biological amendment such as molasses, soybean oil, peanuts oil, palm oil, chitin or chitosan…Those biological amendments can be utilised on their own or as a mixture of several one.

Sol-Actif (*3) is the most performing electron donor on the market, it causes a very strong increase of bacterial population, up to 19 logs in 24 h, 30 logs in 21 days and 5 logs in 54 days. All bacterias present in soil beneficiate from Sol-Actif addition, on top proportion of same bacteria colonising roots increases significantly.

*(1) PGPR given name to bacterias from rhyzhosphere who by colonising roots stimulate plant growth. Those PGPR can have several effects on a plant, including nitrogen fixation, effect on root nodulation, hormon production, nutriment uptake, growth and production increase.

*(2) AMF Arbuscular mycorrhizal (AM) fungis are ubiquitous and are a very important part of earth ecosystems, forming symbiotic associations with majority of roots systems of plants. Those AMF fungis create a biological protection against species such as *Aphanomyces, Cylindrocladium, Fusarium, Macrophomina, Phytophthora, Pythium, Rhizoctonia, Sclerotinium, Verticillium* and *Thielaviopsis* and various nematodes through plant colonisation, even if mechanisms through which this colonisation brings a protection to plants are not fully known.

*(3) OM mini 87% out of which Organic Nitrogen 7,1%, C/N ratio 6.56%.