The theory of trophobiosis in pest and disease control

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In agriculture, as in nature, a healthy system is most easily achieved in environments which have the greatest variety of species. A diversified agricultural system is more able to maintain its equilibrium through the multiple relationships which exist between the biotic and abiotic components. It takes some time for an agro-ecosystem to become capable of regulating pest and disease problems through the biological control performed by parasites and predators. This ideal equilibrium is still not the reality in many agro-ecological production systems. Small scale monocropping can still be found even in ecological or organic agriculture, due to access to markets or market demand. Reducing these monocultures will depend, among other things, on changes in markets and customers' habits. In addition, situations of environmental stress, such as droughts, excessive rainfall, heat or cold, can encourage incidence of pests and diseases, putting ecological production at risk.

It has long been known that plants which are fertilized with organic material present few pest and disease problems. It is also well known that with the modernisation of agriculture, the number of species which are now regarded as pests and diseases has increased. Studies done by the French researcher Francis Chaboussou provide the basis for the theory of trophobiosis, which allows for a significant link to be established between these two observable facts verified in practice by farmers.

The theory of trophobiosis

The theory states that the susceptibility of a crop plant to pests and diseases depends on its nutritional state. Pests and diseases will not attack a healthy plant. The health of a plant is directly associated with its internal balance, which is constantly changing. According to Chaboussou, it is not just any plant which is attacked by pests and diseases, but only those which could serve as food for the insect or pathogen. In other words, the cultivated plant will only be attacked when the food these pests need is available in the sap. If a plant has sufficient quantity of the substances which are food for the pests and diseases, it is because it has not been cultivated in an optimal way. So, for a plant to be resistant, it is important to manage its growth in the correct manner. All factors which affect a plant's internal balance and functioning can lessen or increase its susceptibility to pest and disease attacks. These could be factors related to the plant (such as adaptation to the local climate, plant age, grafting) or the environment (climate, light, temperature, humidity, wind), or be associated with management practices (such as soil fertility, time of planting, spacing, tilling, pruning, type of fertilizers used).

Table 1. Indicator plants

Indicator	Scientific name	What it indicates
Sorrel	*Oxalis oxyptera*	Clay soil, low pH, lack of calcium and/or molybdenum.
Purslane	*Portulaca oleracea*	Well structured soil, with organic matter.
Barnyard grass	*Echinochloa crusgallii*	Soil lacking aeration, with nutrients that can be toxic.
Sedge	*Carex* spp.	Poor soil, with very low levels of calcium.
Amaranth	*Amaranthus* spp.	Available nitrogen (organic material).
Bracken	*Pteridium aquilinum*	Excess toxic aluminium.

Source: Adapted from Primavesi, 1989.

Photo: Centro Ecológico

Farmers meet often to exchange information and experiences with bio-fertilizers.

In the 1980s, the technical team of Centro Ecológico/Ipê, an NGO in Rio Grande do Sul, Brazil, along with farmers and other technicians, were looking for ways to overcome some of the technical difficulties in ecological production. They were specifically testing out Chaboussou's ideas that the nutritional state of a plant is a result of interaction between its genetics, the local environment and management practices. In this way, cultivation practices were aimed at understanding the causes of the problem, rather than only treating the consequences, such as pests, diseases and low productivity.

Application of the theory in practice

This region of Brazil was mainly occupied by Italian immigrants, who developed a form of subsistence agriculture and then introduced the grape for commercial purposes. With the modernisation of agriculture there was a huge increase in vegetables and fruits, grown with intensive use of inorganic fertilizer and pesticides. This brought an increased incidence of pests and diseases, as well as environmental and health problems.

Eroded soils, low fertility, and the use of modern varieties of vegetables (mostly tomatoes and onions) and fruits (apple, peach and grape), which were less adapted to the local climate and suffering intense attacks of insects and diseases, were challenges to be overcome by ecological farmers. The changes began by removing the main cause of disequilibrium of the soil and plant – inorganic and soluble fertilizers. Instead, manure and green manures were introduced, even in the orchards which were planted under conventional systems. Next, farmers looked for ways of complementing plant nutrition. With these changes, the level of attack of most pests and diseases was tolerable.

One way of finding out more about the existing ecological situation is to look at some local biological indicators – such as weeds and the development of cultivated plants. Weeds provide good information about soils. For example, a soil dominated by *Digitaria sanguinalis* (also known as crabgrass) tells us that the soil structure is poor (Table 1). So, a cultivated plant grown here would probably use a lot of energy to establish itself, and may show nutrient deficiencies. In the same way, pests and diseases indicate the origin of the difficulties that the plants were having, such as lack of nutrients (see Table 2). These nutrients could be present in the soil, but are not being taken up by the plant. For example, blossom end rot in tomatoes happens due to lack of calcium in periods when the soil is very dry, and not necessarily due to lack of the mineral.

Table 2. Insects and diseases as indicators

Crop	Indicator	Indicates deficiency of ...
Tomato	Blossom end rot	Calcium
Beans	Tomato Spotted Wilt Tospovirus Whitefly (*Bemisa tabaci*) Bean Golden Mosaic Virus	Calcium
Cauliflower	Grey mould (*Botrytis* sp.)	Boron
Maize	Army worm (*Spodoptera* sp.)	Boron
Maize	Cornstalk borer (*Elasmopalpus lignosellus*)	Zinc

Source: Adapted from Primavesi, 1989.

In time we realised that even if we did not know the technical details of what was happening, we still could look for ways of improving plant metabolism, and therefore its health. This can be done by selecting the best plants each year and collecting their seeds, in order to have the plants best adapted to the area; by changing the soil management practices, using more green manure; or by letting weeds grow and using them as green manure.

Farmers also intervened directly in the plant's nutrition in order to improve its resistance – this is known as physiological control. They were interested in demonstrating that a healthy, well-fed plant will seldom be attacked by pests and disease, which will die of hunger on a healthy plant. Insects, nematodes, viruses and bacteria are the consequences of problems the plant is having, not the cause.

There are many cheap and simple products which can be used in farming systems to improve plant nutrition. Examples include ash, powdered rock or bio-fertilizers. Generally, such inputs are abundant, locally available and easily incorporated into farmers' management practices. A good example is a very common product: "enriched liquid bio-fertilizer". This is a cheap technology, which the farmers really do use, and which today can be found in nearly all ecological agriculture systems in Latin America. As an example, thrips disappear from onions when they are sprayed with it. Élio Chilanti, from Antonio Prado, in Rio Grande do Sul told us: "When we started more foliar nutritional treatments, the vines did not die so often, became more vigorous and the grapes were bigger. The nutritional treatments thickened the leaves and reduced the mildew."

Enriched liquid bio-fertilizers

Enriched liquid bio-fertilizers can be made with any fresh organic material. Usually, they are made with animal manure, but can also be made from just plant material. To enrich the mixture, minerals can be added, such as ashes or powdered rock. The minerals help the fermentation process and improve the quality of the final product. Adding milk, whey or molasses also helps the fermentation. When fermented they are used on the soil as well as in foliar sprays. In this case, they are very efficient at controlling various plant problems, because they help the plants' physiological functions to become more harmonious and balanced. It is also possible to make bio-fertilizer with materials the farmer has at home, which means he or she can improve the health of their plants independently. Home-made formulas of bio-fertilizers are easily owned, used and reproduced by farmers.

Enriched bio-fertilizers feed the plant, but it has also been discovered that bio-fertilizers protect the plant, acting as a defence mechanism. This defence could be due to different factors, such as a plant which is better fed has better resistance, as explained by the trophobiosis theory. If a plant has everything it needs at its disposition, in the right quantities and at the right time, it has all the conditions to defend itself from insect attack, mites, nematodes, fungi or bacteria. Also, because bio-fertilizers are a living product, the micro-organisms present in them can also help in the fight against harmful micro-organisms which are attacking the plant.

Conclusions

For the farmers Centro Ecológico works with, understanding and applying the theory of trophobiosis has been an invaluable experience. It has been a tool which has allowed an innovative and facilitative approach to try and understand and manage, with success, some of the technical problems which ecological farmers face. This is especially the case when seeking to do more than just substitute agrochemicals, but rather looking at the system as a whole and improving plant health and resistance.

As well as being based on solid and pioneering scientific knowledge, most of the accumulated knowledge has come about through participatory experimentation, and is intended to stimulate new initiatives by the farmers. If we can understand that for every difficult situation there will always be a reaction in nature, we can look for ways to improve imbalances in our farming systems. According to this theory, the correct way to protect plants is to prevent the attack of pests and diseases, by providing a healthy and balanced environment and food supply. This can be reinforced further if we stimulate physiological control, for example with the use of enriched liquid bio-fertilisers.

Our practical experiences, based on the theory of trophobiosis, have shown us that we can manage an isolated productive unit ecologically, or even just a part of it. Above all, an understanding of trophobiosis has been very useful during the process of transition to agro-ecological production systems, especially in times of environmental stress. ■

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References

- Chaboussou, F., 2004. **Healthy crops: A new agricultural revolution.** Jon Carpenter Publishing, Alder House, Market Street, Charlbury, U.K.
- Primavesi, A., 1989. **Manejo ecológico de solo.** Nobel, São Paulo, Brazil.