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Proposals for Integrated and Biological Pest Control Advances in the Tropics (**)

Crop protection methods based on ecological knowledge, such as IPC and B.C., require very wide knowledge, thorough investigations and broad experimental research.

The work carried out in temperate countries with respect to crops and pests that are also present in the tropical regions can offer these areas either good indications for crop protection or an example and a guidance for further research.

Great attention is given to the vegetal improvement strategies aiming at providing agricultural plants with hereditary pest resistance.

In an interesting paper contained in the book published by D. Pimentel "Handbook of Pest Management in Agriculture", W. Cromartie writes: "In tropical areas, the value of diversification for pest reduction in traditional cropping systems is beginning to be more fully appreciated. Where agriculture is more labor-intensive, the potential of intercropping may be more easily realized since the complexity of fields is less of a problem in manual than in mechanical sowing, cultivation, and harvesting".

Beyond the plant biochemical and physiological hereditary properties, on which geneticists have worked very hard, the nature, thickness and surface of the cuticle as well as other morphological characteristics under genetic control are available for setting up new resistant varieties.

Mainly mechanical resistance has been obtained in maize poly-hybrids with stems highly resistant to more burrows of some borers (Ostrinia, Sesamia, and so on). Maize also shows a resistance degree to the attacks of 1st generation larvae of *Ostrinia nubilalis* correlated to the amount of a glycoside, the Dimboa

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(2,4-dihydroxy-7-melhoxy-2H-1,4-benzoxazin-3(4H)-one) contained in the leaves. It is an antibiotic process, responsible for high mortality-rate in the first two larval stages, known as "leaf feeding resistance".

Some observations made on fruit-trees and vegetables show that some morphological characters, findable in different species or varieties, can be used in order to increase the plant defence factors and to decrease the pest aggressive power. The trichome covering is able to keep a sufficient distance between the tissues and the foreign bodies, e.g., insects which are not allowed to reach the epithelia to get their food (figures 7, 8).

For instance, the expansion of nectarine-growing has brought to evidence their Achille shell, that is, the lack of hairy covering, which protects them against some insects (figure 9).

The ovary and the young fruit, which are usually covered with hair able to prevent the arthropod mouth-appendices from reaching the epidermis in the nectarines, lack hair and can be easily reached and affected by the saliva injected by some arthropods, such as Mites, Aphids and Coccides.

In different apple cultivars, for instance, the leaf lower blade can be tomentose to a different extent (figure 10). The adult female of a miner microlepidopter, i.e., *Leucoptera malifoliella*, prefers laying eggs on glabrous leaves or on leaves with thin hair, so its eggs and mines as well as the number of leaves attacked decrease as pubescence increases.

In some species of *Lycopersicon* the surface of the epigeous parts is covered with glandular and non-glandular hair with varying length and thickness according to different species (figures 1, 2, 11, 12).

If a foreign body rubs a glandular hair, it breaks and liberates its viscous content. Some insects, such as aphids, young larvae of coleoptera and other olometabolous insects are smeared with the secretion, which hardens in the air and blocks above all the appendices (figure 3).

Worthy of remark is the size of many parasitoids of phytophagous species that makes them able to escape from the tangle of glandular hair, improving protection against pests. For instance, some *Encarsia* spp., parasites of white-flies (figure 4) and *Praon* spp., parasites of Aphids (figure 5), can carry on their activity without being damaged by *Lycopersicon* hair.

Figure 6 shows that the more tomentose the various *Lycopersicon* are, the more the mortality rate of Aphids and Colorado beetle increases. Investigations by various authors show that the glandular hair secretions can be highly repellent and even lethal and that this characteristic does not exclude other physiological defences.

At the level of scientific Organizations for Environmental Strategy, the tropics can take great advantage from the results of the experimental work carried out in Europe by continuous synoptic monitoring of aerial insect populations, the purpose of this work being to foresee the extent of aphid migrations and seasonal disseminations.

The Euraphid Organization, founded upon Taylor's proposal in 1981 and supported by the Commission of the European Communities, has a large net of

Fig. 1

Fig. 4

Fig. 2

Fig. 5

Fig. 3

Fig. 6

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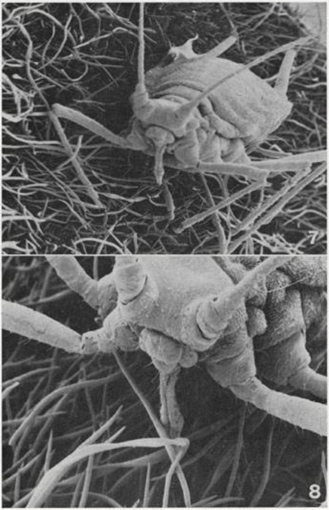

Fig. 7, 8 - Morphological characters as plant defence factors.

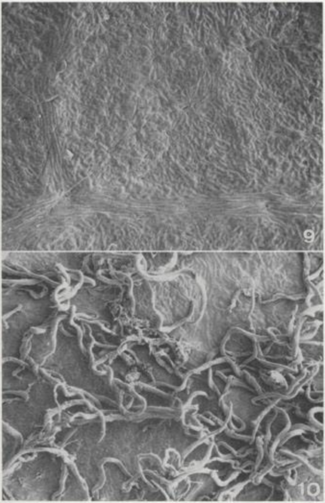

Fig. 9, 10 (see text pag. 432).

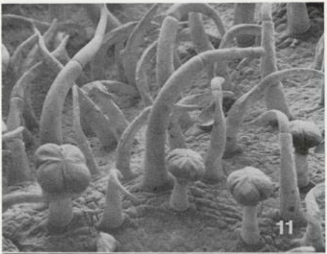

Fig. 11, 12 (see text pag. 432).

suction traps at its disposal. Such traps, placed 12 m from the soil level, are set every week by Institutes and Centers for entomological research in several countries and the captured specimens are thus identified. The data bank of daily distribution of aphids and other insects is analyzed in correlation with geographic position, date, weather and previous population change (figures 13, 14).

The information is collected by Rothamsted Experimental Station data bank and used for accurate short-term warnings of aphid infestation and virus infection.

These data give elements for pest population models, virus movements and the causing distribution of predators and parasites, which are also monitored.

Such monitoring might turn out to be useful for the tropical or subtropical areas where aphids, for instance in cereal-growing, offer very heavy problems. The growing circulation of people, means of transport, plants and agricultural products has favoured the diffusion of a large number of infesting agents, so that the ecosystems in the countries they have been brought into have been upset.

Insidious species of Diptera Tripetidae, Aleurodidae Coleoptera Curculionidae and Cerambicidae have overcome the barriers set by the quarantine services of the industrial countries.

Efficacious natural enemies of some of them, found in the countries of origin of the pests, have brought to their rearing and utilization.

This activity is giving very favourable results, so that we can only regret that it cannot profit by further means and research. The traditional forms of B.C. are used as the main defence activity in the crops where no nuisance treatments able to upset the agro-biocenosis are carried out, and most phytophagous arthropods are under natural control.

The recourse to pathogens in the struggle against pests is not so deeply conditioned by the pesticide treatments. For years *Bacillus thuringiensis* preparations have given appreciable results in many countries, including the tropical ones. At present, viruses are in the limelight thanks to their high specialization rate (NPV Nuclear Polyhedrosis and GV granulosis). In the U.S.A., U.S.S.R. and China, various Nuclear Polyhedrosis preparations are available and used in the control of cotton and forest pests. In the U.S.A. two NPV recently essayed against *Ostrinia nubilalis* caused significant reduction in the number of larvae per plant and in the plant damage.

The granulosis virus of Codling moth, *Cydia pomonella*, which was discovered in Mexico and then recently tested in the fields in about ten countries, has shown adequate efficacity and is now manufactured in small quantities.

Tropical countries might take advantage of the utilization of G.V. of Noctuids tested with good results in the U.S. against some species of cutworm.

Some environments and some crops are more suitable than others for an integral biological control. This method has given good results in tropical and subtropical areas, mainly for some crops where a higher threshold of damage and/or slight morphological defects of the product can be tolerated.

For glasshouses, the Glasshouse Crops Research Institute of Littlehampton has pointed out the management of the key pest populations. *Tetranichus urticae* is fought by means of the predator *Phytoseiulus persimilis*, while *Trialeurodes*

Fig. 13 - RIS suction trap (12.2 m) sampling sites now operate throughout W. Europe in EURAPHID, a collaborative scheme established with C.E.C. support.

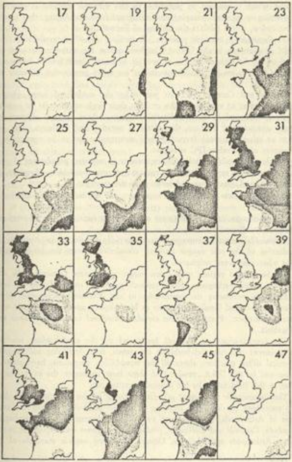

Fig. 14 - The changing distribution of *Aphis fabae* at bi-weekly intervals throughout; organized with C.E.C. support (Taylor, 1981).

vaporariorum, previously inoculated in the crops, is fought by the parasite *Encarsia formosa*, which is released on purpose. In this way the withefly is prevented from setting up on crops, escaping monitoring and from multiplying, thus producing honeydew, which inhibits the activity of Encarsia.

Furthermore, a microbic pesticide, *Verticillium lecanii*, is available in commercial preparations in the United Kingdom against the withefly. Its use has turned out to be efficacious if it is possible to cover plants for 24 hours with a plastic film to ensure suitable conditions for spore germination (Hussey and Scopes, 1985).

Aphids and Coccides are also put under the control of entomophagous arthropods, so as to avoid pesticides or limit their application as far as possible.

In Europe and in other industrial countries where the use of pesticides is quite common and frequent, the release of parasites and predators, their protection or other operations favouring their maintenance has to be compatible in the context of the other IPC strategies.

A relevant possible cunning device consists in releasing populations of predators and parasites more tolerant or resistant to some pesticides. However, the biological control gets better and better into the strategic IPC.

Beneficial insects also play an important role in reducing the density of certain weeds.

Besides insects, other biotic agents such as plant pathogens can be employed to control weed species.

Chondrilla juncea (Compositae) is successfully controlled in Australia by introduction of the rust fungus *Puccinia chondrillinae* from the Mediterranean region where the weed originated.

In the tropical regions only a few target weeds were selected to be controlled by fungal pathogens. Some research programs are conducted in India and Indonesia evaluating the possibilities to use *Alternaria eichlorniae*, *Myrothecium roridum* and *Uredo eichhorniae* as biotic agents against the aquatic weed *Eichornia crassipes*. Plant pathogens are also considered to control *Salvinia* spp. in Rhodesia.

The investigations on the soil fauna and on the modifications resulting from recurrent pesticide and herbicide treatments, from fertilizing and frequent mechanical tilling practices, above all the weed-killing operations, have given in Europe and in the U.S.A. results that show how important the expansion of studies in this field might be for tropical countries too.

The innumerable Arthropod populations living in the soil directly or indirectly contribute to the quick recycling of vegetal residues. Among the main groups of Arthropods, it is frequent to find micophagous and bacteriophagous Collembola, Carabids and Stafilinids, predators of epigeous and hypogeous phytophagous Arthropods and Molluscs, Diptera consuming organic materials of vegetal origin.

Mechanical, physical or chemical cultural practices often cause the extinction or the removal of many organisms, or can affect the soil microfauna and microflora to a different extent.

The relationship soil/plant/biocenosis is relevant to the problem of the interventions on the soil too, from fertilizers, in particular the nitrogenous ones, to other practices, such as irrigations or the use of fumigants against nematodes, which may all modify the cultural environment.

Out of a subject where a great deal of contributions are scattered, only a few have been mentioned as an example, to recall the opportunity to gather experiences from different countries in a more organic way.

The tropical countries, helped by the industrial ones, can develop a less intensive agriculture, less deeply depending upon chemicals and not aiming at such an aesthetically perfect product.

Brader, for many years responsible for developing F.A.O. IPC programs writes: "The possibility of beginning with an empirical approach for the immediate application of I.P.C., followed by verification and modification through experiments, permits the gradual development of sound and permanent I.P.C. programs suitable for small farmers".

On the threshold of the year 2000 the *modus operandi* of vegetal production is still empirical everywhere. This is not astonishing since agriculture depends on many different doctrines, the dictates of which are widely lacking in co-ordination, although their effects cross and may contradict one another.

If the helps to the Developing Country privilege the many millions of small growers with extension services aiming at improving the cultural practices within the limits of an I.P.C. adequate for the local conditions, it will be possible to increase the agricultural production with less energy consumption and more respect for the environment.

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