PESTICIDES

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1. INTRODUCTION

The loss of a major portion of the harvest due to all kinds of pests and parasites has been a problem facing mankind ever since the establishment of systematic farming. From as early as the second half of the 18th century, attempts have been made to protect crop harvests with creosote, lead arsenate, different varieties of paraffin, hydrogen cyanide, Paris Green (arsenite complex) and plant extracts, but these have met with only very limited success.

Even at the beginning of the 20th century, it was still necessary for farmers to accept damage to their harvests just as they were powerless to influence the wind or the weather.

Increasing developments in the structure of farming towards large estates and in favour of a large-scale monoculture economy have aggravated the situation even further. Apart from financial losses which at times assumed dramatic proportions, this has frequently led to bottlenecks in supplies to the rapidly growing population of the earth. There are estimates showing that a third of the world's harvest is lost, largely due to insects, plant diseases such as fungi or bacteria and rodents.

Against this background, the possibilities to combat plant pests and parasites arising from the successful results of research in the field of agricultural chemistry have primarily been seen as a universal blessing for mankind.

2. DEFINITION

The term "pesticides" (plant protection products) refers to a group of natural and synthetic substances which, on account of their special reactivity, are particularly suited to protecting plants from harmful organisms, either parasitic or not. The word "harmful organisms" - according to the philosophy of chemical plant protection - is used to refer to living organisms whose actions are detrimental to human interests and who are thus regarded as pests or parasites, such as insects, fungi and bacteria.

Other substances are targeted against lice and maggots, mites or red spiders, nematodes or microscopic worms, viruses, rodents, molluscs, small vertebrates and even fish; some other (the pheromones) act as attractants of insects, other repel also rodents or birds. Some act on vegetals themselves as growth inhibitors, defoliants, desiccants, antitranspirants. The term "herbicide" seems dedicated to weeds' control.

Finally, the action of these substances can be strengthened by synergists.
For their application, the active substances in pesticides are generally mixed with carriers or correctives, e.g. solvents, emulgators, wetting agents, adhesives and odoriferants (so-called pesticide formulations).

3. SCOPE OF THE PESTICIDE PROBLEM

Over the past few decades, there has been a total change in the public understanding of such terms as "DDT" and "pesticide". For many years the word DDT was regarded as a symbol of progress and of a forward-looking approach to farming, particularly in the years of reconstruction following the Second World War. The successful agricultural exploitation of the soil without having recourse to the many possibilities of chemical plant protection is practically unthinkable anywhere in the world today.
Today they have negative connotations, and for many people are the epitome of noxious substances and of the poisoning of the environment. In 1990, for example, 80 % of all US citizens of purchasing age stated that they saw a considerable danger in pesticides.

Sensationalised half-truths and a clear taste for exaggeration of facts presented in the media have contributed and continue to contribute today to the feelings of insecurity and uncertainty among consumers. It is common knowledge today that all substances employed as pesticides generally have a main focus for their chemical action and are thus particularly suited to their purpose, but that their biocidic action cannot be restricted to the target group alone.

The progress made in chemical analysis has made it further apparent that the natural disappearance of the substances used by oxidative or microbial degradation, does not in fact take place as expected. Thus residual quantities of pesticides have been detected in many sectors of the so-called food chain: DDT was proved to have a half-life of 10 years in water and of 40 years in exposed soil. In the case of dieldrin, the half-lives are considerably higher. Substances of this type have even been detected in concentrations of 2 ppm (mg/kg) in the fat of Arctic animals, and practically every human being in Europe has concentrated traces of this chlorinated substance in his/her body fat. This indicates the extent to which the world-wide production of 3 million tonnes of DDT (the amount produced until 1991) has permeated and been retained in life forms as a result of its enormous persistency.

Taken in isolation, this phenomenon alone would merely seem remarkable and undesirable as a matter of principle. It became a problem when at the same time it was discovered what severe effects the absorption of substances used as pesticides can have on health and how serious the deferred consequences, even in small quantities, are for advanced creatures. All pesticides are more or less harmful in certain concentrations for animals and human beings. Their use is also increasing at a rate of approx. 5 % per year. But due to "Good Agricultural Practices" as well as the mentality, the legislation and the cost of pesticides, their relative use (expressed per km^2) is often globally decreasing.

Because it is impossible to restrict this use either geographically or temporarily, the burning question world-wide is how to prevent residues of pesticides from entering foodstuffs on the one hand, while satisfying the justifiable demands of agriculture on the other. The popular catchwords are "risk-benefit analysis" and "environmental impact testing".

The calculations vary considerably, depending on the focus of interest. Seen by themselves, both sides are right - even the "green" lobby - when they appeal to an apparent sense of reason. It is a frequently ignored fact that every form of organised agriculture represents a priori a serious interference in the ecological balance of nature. The solution to the problem can only be a compromise in which proper consideration is given to both ecological and health factors.

In Germany alone, some 35,000 t of pesticides are used every year to keep agricultural production at a level which renders it economical. One estimate made in 1986 concluded that only 0.1 % of this volume reaches its objective, i.e. the harmful organism it aims to combat. The huge surplus is unavoidable even when "good agricultural practices" are employed, but it makes the overall procedure more vulnerable to attack. For many, the inexpert and/or negligent approach to handling pesticides frequently observed among farmers is a criterion in itself, quite apart from the danger to which they are subjecting themselves. On the other hand it may be argued that the use of dangerous substances such as DDT has in the meantime been prohibited in practically every country in the world (51 countries), and that in addition there are newly developed synthetic substances which afford less of a health hazard and have the same biocidic effect when spread over the fields in markedly lower concentrations. An important development is the ability of the so-called "systemic pesticides" to enter the plant itself, instead of remaining on its surface.

4. SUBSTANCES USED IN THE PROTECTION OF CROP

Of the more than 1000 known biocidic substances, some 600 are used to any great extent for the protection of crops in the extremely chemistry-oriented agriculture sector (in 1990, the total turnover came to approx. 36 billion DM). The number of those permitted is generally considerably lower in individual countries.

4.1 Organochlorine compounds

The substances in this group were the first to be developed and comprise such universally well-known insecticides as DDT, dieldrin, aldrin (HHDN) and HCH (lindane). The history of pesticides commenced with these substances in the 1940's, particularly with DDT, a substance which permitted the practical eradication of malaria in many tropical countries. After the prohibition of DDT (from 1970), toxaphene - the mixture resulting from the polychlorination of a monoterpene - became the most-used pesticide in this group (400,000 t between 1946 and 1974).

All organochlorine compounds are extraordinarily persistent and due to their pronounced solubility in fat accumulate particularly in body fats. For this reason, it is largely ingested in human foodstuffs through dairy produce and meat.

Their use is gradually coming to an end as a result of their prohibition in many countries. Nevertheless, due to their extremely long half-life and continued illegal use, it will still be possible for traces to be detected in the food-chain for many years to come.

4.2 Organophosphorus compounds

As the criticism on chlorine compounds raised, this group of substances was developed. Some examples are parathion, malathion, diazinon and dichlorphos, all of which are widely used today as insecticides, fungicides and herbicides. This group of substances is less persistent than chlorinated hydrocarbons, thus not causing any such high concentration and accumulation in body fats. The process of degradation to less reactive substances is more rapid. As a result, they lose their effectiveness more quickly on the fields through the influence of the sun and rain. Equally, they do not accumulate in body fats in high concentrations.

4.3 Carbamates and thiocarbamates

Development of this group of substances did not take place to any great extent until after the two groups named above had come into being. Well-known broad-spectrum pesticides in this group are aldicarb and methomyl, which are used as insecticides, acaricides and nematicides. Aldicarb occupied the headlines of newspapers when it caused the contamination of drinking water in the USA in 1970.

4.4 Pyrethrins and pyrethroids

It has long been known that extracts from various types of chrysanthemum plant have a strong insecticide effect. Once their chemical structure had been clarified, similar substances to pyrethrins but possessing such improved features as greater resistance to oxygen and light were produced synthetically.

These substances are referred to as pyrethroids, and are widely produced and used around the world. They are preferred ecologically as highly effective insecticides on account of their low persistence and particularly for their lower toxicity to warm-blooded animals. They do not accumulate in the body.

The pyrethroid deltamethrin has recently (since 1977) also become widely used, in particular to combat insects when storing stocks of grain and coffee.

4.5 Triazines

The herbicides atrazine and metribuzin inhibit the photosynthesis of grasses and other "weeds", and are thus widely used against excess herbage among maize cultures and the like in an effort to achieve "clean fields". They tend to persist on account of their low levels of solubility, and have frequently found their way into ground water and drinking water - probably as the result of negligent use.

4.6 Fumigants (poisonous mist sprays)

This group comprises the gaseous insecticides, which - unlike other substances are toxic on account of their state at all stages of insect development. They are used in closed systems, e.g. to fumigate grain and cocoa beans. The main representatives in this group are methyl bromide and phosphine (phosphorus hydride). The degradation products of methyl bromide are probably harmless, but methyl bromide itself can react with the protein content of the fumigated foodstuffs. Their use is thus strictly regulated by law also for ecological reasons (ozone depletion potential).

A promising method of providing protection against storage pests on a purely physical basis is the process of high-pressure disinfection using natural carbon dioxide. This method has already reached an advanced stage of development.

5. TOXICOLOGICAL EFFECTS

All chemical compounds used as pesticides are toxic for warm-blooded animals above certain maximum levels when ingested orally. However, only in extremely rare cases do residual traces of such substances in foodstuffs lead to acute symptoms of poisoning or even to lasting health damage. Only if they are ingested on a repeated basis is it conceivable that they could lead to the wide variety of diffuse clinical syndromes ascribed to pesticides in general: metabolic disturbance, irritation, disfunction symptoms, fatigue, depression, giddiness, itching, exhaustion, spasms or more serious cases, such as nervous lesion and leukaemia. There are reports in which cases of carcinolytic degeneration are not ruled out.

Such symptoms are more probable for the pesticide user (even in the house) than for the consumer. They can certainly only very rarely be diagnosed as having been caused by residual traces of pesticides.

6. EVALUATION CRITERIA AND LEGAL REGULATIONS

The authorisation of a pesticide requires a dossier including conditions for use, residual activities, level of application and efficiency after a field testing. For the reasons outlined above, recommendations have been in existence since 1963 for the protection of consumers: these were issued by the FAO/WHO (Joint Expert Committee on Food Additives - JECFA), and consisted of limits for the maximum acceptable intake quantities, either as ADI (acceptable daily intake) or PTWI (provisional tolerable weekly intake) values.

Some 120 substances had been investigated by 1984, and in the meantime the number has grown. Countries have produced their legal regulations for the maximum levels of each pesticide on the basis of investigations conducted by the Codex Committee for Pesticide Residues (CCPR) as the generally accepted central body responsible. The directives issued by the European Union for plant and animal foodstuffs which prescribe maximum residue levels (MRLS) were also formulated on the basis of these international data. Regulations generally only contain the permissible maximum levels for raw materials, not for the finished products made from these raw materials.
Finished goods practically always have lower concentrations of pesticides after processing.

7. ACTUAL CONCENTRATIONS OF PESTICIDES PRESENT

The many investigations conducted around the world have almost always revealed that if individual foodstuffs reveal any pesticides at all, they only display residual quantities lying below the ADI and/or PTWI.

The food basket survey is considered to be particularly significant because it can take account of the respective consumption habits in individual countries. The so-called FDA food basket comprises 234 different foodstuffs which, for example, were analysed in 1990 for traces of 200 individual pesticides. Residual traces were detected in 51 of them. In terms of frequency, the two pesticides malathion and DDT (still !) together made up one third of the traces found. Only 2-3 % of the samples displayed readings in excess of the ADI limits.

Since then, further checks have been run at regular intervals within the scope of the monitoring system inaugurated by the FAO/WHO. As was to be expected, the highest readings in relative terms were always found among vegetables and fruit, because these are the products most heavily subjected to pesticide.

The conclusion to be drawn from the results of all these investigations is that the danger of excess concentrations of pesticides in foodstuffs is only a very small one, provided the substances are applied taking into account Good Agricultural Practice.

Contrary to a large number of articles in the press, the situation with regard to lindane is also by no means precarious. Apart from the fact that the acceptable limits are only very seldom reached in raw materials, an additional reduction factor arises from the special technology applied to the production of chocolate.

The research conducted over recent years, however, has produced completely new, surprising findings. It has long been known that certain plants contain extremely poisonous substances. However, it had not been known before what "weapons" the individual species used to protect themselves. An extremely large number of substances contained in plants have now become known - over 100,000 - which are just as poisonous as the synthetic substances in pesticides. As early as 1989, renowned scientists in the USA judged the overall danger to human health arising from such natural "pesticides" to be higher than that from the chemically produced substances spread on the fields.

8. THE SITUATION IN RAW MATERIALS FOR CONFECTIONERY AND BISCUITS

The world-wide dissemination of all kinds of pesticides makes it inevitable that raw materials for the confectionery and biscuits industry cannot be kept free of residues. According to the results of the monitoring system, however, no serious danger exists. Nevertheless, it cannot be precluded that in individual cases raw materials are available on the market which exceed either ADI limits or the maximum national residue levels (MRLs). The principles of good manufacturing practice (GMP) oblige firms to establish a sampling system for regular monitoring of raw materials.

9. THE IOCCC POSITION

The IOCCC accepts the necessity for the use of pesticides in agriculture, because this is unavoidable at this point in time in order to guarantee supplies to the world markets.

Every company can exert pressure on its suppliers and thus make its contribution to improving the situation by insisting on deliveries with low residue contents and by giving preference to those raw materials which are free or particularly low in residual concentrations as a result of implementing integrated crop protection measures.

The reduction of residual quantities in raw materials resulting from the technologies used in the confectionery industry fortunately reduces the already extremely low health risk assumed to be present for the consumer who uses them.

The IOCCC appeals to all confectionery manufactory to keep a permanent watch on the problem and to support the GEMS monitoring system of the FAO/WHO as a logical means of control by forwarding the results of their own internal investigations.

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