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Integrated pest-management approaches in orchard, cereal and potato protection in Poland[1]

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With its total area of 312,683 km^2 and a population of about 39 million people, the area of agricultural land per person in Poland is about 0.47 ha. The yields of basic crops are rather low and the losses due to pathogens, animal pests and weeds are high. The use of pesticides is about 1.0–1.3 kg a.i. per ha and this gives a good starting point for integrated pest management (IPM) in the production system of various crops. IPM in glasshouse crops reached the level of 500 ha per year. An IPM approach against codling moth (*Cydia pomonella*) in orchards allowed a reduction by 70% in the number of insecticide treatments. In the case of apple scab (*Venturia inaequalis*), the IPM approach allowed a reduction in the number of fungicide treatments by 30% on an area of 100,000 ha. In respect to small grains, the IPM approach concerns rational use of fungicides and herbicides in winter wheat and barley. In potato protection, the IPM approach mainly concerns Colorado beetle (*Leptinotarsa decemlineata*), which at present is controlled by chemical insecticides on 77% of the potato area. Special research and demonstration IPM programmes sponsored by USDA/AID in Central and Eastern Europe will be operational during 1992/1995 and will concern orchards (apple, pear), small grains (wheat, barley) and potatoes.

Introduction

With its total area of 312,683 km^2 and a population of about 39 million people, the area of agricultural land per capita in Poland is about 0.47 ha. One would expect that it could fully satisfy society's demand for a sufficient amount of low-priced agricultural food products, if compared with 0.14 ha per person in The Netherlands or Belgium. Unfortunately, this is not the case, due to soil, climatic, economic and social reasons. It is sufficient to say that the average yield of wheat is 3.8 t ha^{-1}, of barley 3.3 t ha^{-1}, and of potatoes 18.9 t ha^{-1}. In addition, the general losses due to pathogens, animal pests and weeds during pre-harvest and post-harvest periods are relatively high, e.g. in potato they are estimated at 30% of total yield. In spite of that, Poland is now, due to its present market economy system, an actual and potential exporter of agricultural commodities (meat, livestock, fruits, potatoes) to Western Europe and especially to the countries of the former USSR, although some years ago under the communist system Poland was a heavy importer of grain, meat, etc.

However, some plant protection problems remain the same and years are needed for a change to a better situation. Before 1989, i.e. in a communist centrally planned economy, the situation was such that, although pesticide prices were relatively low, the limited supply of chemical and microbial products did not allow farmers to buy pesticides and to treat according to good agricultural practice (GAP). Unfortunately, the switch to a free market economy has not improved the situation with respect to GAP, due to the dramatic economic situation of farmers.

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Table 1. Pesticides supplied to the Polish market in 1989
Pesticides commercialisés en Pologne en 1989

Type	Amount (t)	% of total
Herbicides	32,853	65.8
Fungicides	11,994	23.9
Insecticides	3,877	7.7
Rodenticides	391	0.8
Other	883	1.8
Total	50,003	100.0

A sharp increase in pesticide prices, uncompensated by price increases for agricultural products, has meant that farmers cannot afford to buy or use pesticides or fertilizers. As the result of the former and present situation, the average use of pesticides in Poland is now estimated at the level of 1.0–1.3 kg a.i.per ha (Table 1).

Of course, one can consider that this is very good starting point for the development and implementation of integrated pest management (IPM) programmes in the production systems of various crops, as there is no necessity to make an effort to convince farmers to reduce pesticide use by 25–50%, as has been observed in some Western European countries, where pesticide use is very high. Furthermore, one could even announce that the total farming system in Poland is of 'organic type', since the amount of pesticides used is negligible by western standards. Unfortunately, the amounts used are much below the levels considered as necessary by GAP standards. There is therefore a need to construct IPM programmes for various crops, to fit the present economic situation of farmers and consumers.

IPM in glasshouse crops

The status of IPM in glasshouse crops in Poland is quite satisfactory. The area of tomato, cucumber and ornamentals grown in glasshouses and protected according to IPM principles, using a parasitoid (*Encarsia formosa*) against *Trialeurodes vaporariorum*, and the predatory mites *Phytoseiulus persimilis* against *Tetranychus urticae* and *Neoseiulus cucumeris* against *Frankliniella occidentalis*, combined with selective pesticides, has reached the level of about 500 ha per year (Pruszynski *et al.*, 1991). Use of biotic agents supplied by a domestic private company (Erna Co.) and a foreign company (Koppert B.V.) is well established among glasshouse owners. The full satisfaction of glasshouse owners with biological and IPM programmes has created a very good attitude, among growers of other crops and among all agricultural societies, towards the enforced efforts for developing and implementing IPM programmes in orchards, potato and cereal crops.

IPM in orchards

In 1989 about 60 million fruit trees (about 300,000 ha) were grown in Poland, among them 34.2 million apple trees and 4.2 million pear trees. It may be mentioned that in 1980 the number of trees was over 97 million, but the terrible winter of 1986/87 killed millions of trees and ruined a number of growers. Polish fruit production is a large and very profitable business and has a high rank in world fruit production (Table 2). Orchards in Poland, as in other countries, provide the

Table 2. Fruit production in Poland in 1990
Production fruitière en Pologne en 1990

Fruit type	Annual production (thousands of t)	% of world production	Position on world ranking list
Apples	1,400	3.4	8
Strawberries	249	11.2	2
Currants	165	28.2	1
Sweet cherries	100	–	–
Raspberries	43	12.1	3

best opportunities for implementation of IPM principles. The Institute of Pomology and Floriculture in Skierniewice has developed and implemented in practice effective and reliable IPM programmes based on established economic thresholds and good forecasting systems in respect to key animal pests and pathogens (Niemczyk, 1989).

In the case of *Cydia pomonella*, IPM programmes are practised on 80% of the orchard area. This has allowed a reduction in the number of insecticide treatments by 70%; in 20% of orchards the insecticide treatments are skipped and in 80% only one treatment is recommended. Insecticides such as pirimicarb, phosalone and diflubenzuron are widely used as they are selective and safe for beneficial arthropods. The date of insecticide treatments against other tortricids is determined by pheromone traps, but not yet on a satisfactory area of orchards.

In the case of *Venturia inaequalis*, implementation of a good forecasting system, based on Mills' tables, has allowed a reduction in the number of fungicide treatments by 30% on the area of 100,000 ha (Nowacka, 1989; Nowacka & Cimanowski, 1983). Cutting out branches with leaves during the phase of primary infection of *Podosphaera leucotricha* led to a reduction in the number of fungicide treatments by 30–70% on an area of 30,000 ha (Cimanowski *et al.*, 1980). Spraying of apple orchards with systemic fungicides (e.g. benomyl or triazoles) just before leaf fall suppresses development of the sexual stages of *V. inaequalis*.

Introduction of new apple cultivars such as Lodel or Pulaski, which are resistant to the main diseases, and cutting out infected shoots and fruits, has reduced the intensity of chemical protection by 20–50%, depending on cultivar (Nowacka, 1989). Use of Polagrocyna, applied by dipping roots of stone fruit and other trees before planting, limits the importance and spread of *Agrobacterium tumefaciens*.

However, the recent increased use of pyrethroids by growers, as less expensive treatments, has created some problems with mites (*Panonychus ulmi* and *Bryobia redicorzevi*) as well as with former 'minor' pests, e.g. various leaf-rollers and leaf-miners. This situation is expected to be improved by advocated use of diflubenzuron and other insect growth regulators and by sale of *Typhlodromus* spp. resistant to insecticides. It is expected that these constraints in the present IPM programmes will soon be resolved.

IPM in cereals

The total area of cereal crops in Poland in 1990 was 7.78 million ha (Table 3), compared with 8.4 million ha in 1989. This decrease is due to lower demands for human cereal food products as well as reduced and more rational use of cereals for animal husbandry purposes. Until recently, the IPM approach in grain protection was a rather neglected area of research in Poland since it was

Table 3. Area and yield of cereals in Poland in 1990
Surface et rendement céréaliers en Pologne en 1990

Crop	Area (mln ha)	Mean yield (t ha^{-1})
Wheat	2.28	3.8
Rye	2.31	2.6
Barley	1.17	3.0
Triticale	0.75	3.4
Oat	0.75	2.7
Other	0.52	—

traditionally considered that seed treatments solve all phytopathological problems and that formerly recognized pests such as *Mayetiola destructor* or *Cephus pygmaeus* do not offer a good chance for attempts at IPM.

However, widespread application of fungicides during the growing season (in 1988 1.2 million ha was treated with fungicides) and increased use of herbicides created serious problems with aphids (mainly *Rhopalosiphum* spp.), leaf beetles (*Oulema* spp.), leaf-miners (Agromyzidae) and others. The Institute of Plant Protection in Poznan has therefore started a broad IPM-oriented research programme on insect pests, which covers natural enemies (pathogens, predators, parasites) of key insect pests, resistant cultivars, impact of herbicide and fungicide treatments on insect pest occurrence, etc.

Just recently, 2 new parasitic protozoans were discovered in *Oulema melanopus* and *O. cyanella*, and a polyhedrosis virus in the cutworm *Cerapteryx graminis*. Since the area under triticale is rapidly increasing in Poland (Table 3), the pathogen and pest complex of that crop is now being studied, together with wheat, barley and other cereals.

The IPM studies conducted so far clearly indicate that there is a good possibility of reducing the number of treatments in cereal crops by combined control of 2 or more pests, or use of fungicides + herbicides (Golebiowska & Zlotkowski, 1988; Janczak *et al.*, 1989). With respect to herbicides, the IPM approach aims to prepare the principles of their sequential use, doses and timing, to prevent the phenomenon of weed compensation and make weed control more effective and cheaper. With respect to pathogen control in cereals, the IPM approach aims to prevent or slow down the occurrence of strains of fungi such as *Erysiphe graminis* (powdery mildew) and *Tapesia yallundae* (*Pseudocercosporella herpotrichoides*) (eyespot), resistant to the fungicides used in wheat and barley crops.

Recent developments and implementations of biological and IPM programmes in the USSR (Samersov, 1988; Voronin *et al.*, 1988) indicate that there is great potential for IPM approaches in cereal crops.

IPM in potatoes

Potato is grown on an area of 1.87 million ha (in 1980 — 2.3 million ha) with an average yield of 18.9 t ha^{-1}. It is a very important crop because of its use as animal fodder, in industry (starch and alcohol) and in human consumption (about 140 kg per capita).

For several years, Colorado beetle (*Leptinotarsa decemlineata*) control has determined not only the intensity of potato protection but the intensity of the whole plant protection programme in Poland (Piekarczyk & Lipa, 1985; Pruszynski & Wegorek, 1991). Even now, chemical control

of *L. decemlineata* is performed on over 77% of the potato area, as compared with control of potato late blight (*Phytophthora infestans*) on 19.2% and weeds on 10.8% of the area (Pietkiewicz, 1991).

Attempts to develop biological and integrated control of *L. decemlineata* by introduction of predatory bugs (*Perillus bioculatus* and *Podisus maculiventris*) and the parasitic fly *Myiopharus doryphorae* were unsuccessful (Lipa, 1985; Pruszynski & Wegorek, 1991). For the last 2 years, *Bacillus thuringiensis* var. *tenebrionis* has been registered as the microbial insecticide Novodor and used on a limited scale (Korol *et al.*,1990).

The Potato Research Institute in Bonin developed an IPM programme for control of potato viruses (mainly potato Y potyvirus and potato leaf roll luteovirus) by growing seed potatoes in so-called 'closed regions'. These regions are located in a heavily afforested part of northern Poland, which provides good isolation of the crops; combined with insecticide applications, this allows control of aphid vectors and prevents the spread of virus infection. Control of potato cyst nematode (*Globodera rostochiensis*) is achieved by internal quarantine measures and use of resistant cultivars (Kornobis & Stefan, 1991).

For the IPM programme, a minimum number of fungicide treatments against *P. infestans* was established depending on level of potato cultivar resistance. In the case of susceptible cultivars (degree 2–4), at least 3 treatments are recommended, medium susceptible (degree 5) 2 treatments, resistant cultivars (degree 6–8) 1 treatment is considered as the minimum. In the case of resistant cultivars (degree 7–8) and at low infection pressure, chemical control of *P. infestans* is not necessary.

Studies showed that fungicide doses can be reduced by 50% when used in mixture with foliar fertilizers. Of special benefit is use of Bonga, which is a contact fungicide with fertilizing effect. As pointed out by Pietkiewicz (1991), due to overuse of systemic fungicides during the last few years against *P. infestans*, a high phenylamide resistance level was recorded in some regions of southern Poland. This resulted in a drop in the use of these fungicides. For this reason, an IPM approach for *P. infestans* control is greatly needed, based on the sequential use of fungicides: systemic-contact-contact.

Conclusions

The Institute of Plant Protection and other research institutes of the Polish Ministry of Agriculture and Food Economy are intensifying their research efforts to develop, and to offer to farm and orchard owners, IPM programmes for various crops suitable for the present economic situation of producers and consumers in Poland. It is expected that the various constraints in the present IPM programmes will be resolved during the research programme scheduled for 1992/1995 planned between Central and Eastern Europe (Czechoslovakia, Hungary, Poland, Romania, Yugoslavia) and the United States Department of Agriculture.

Approches vers la lutte intégrée en arboriculture, céréaliculture et culture de la pomme de terre en Pologne

Avec une surface totale de 312.683 km^2 et une population d'environ 39 millions, la part de surface agricole par personne en Pologne est d'environ 0.47 ha. Les rendements des cultures de première nécessité sont relativement faibles et les pertes dues aux maladies, ravageurs et adventices sont importantes. L'utilisation de pesticides est d'environ 1.0–1.3 kg de m.a. par ha, ce qui constitue un bon point de départ pour l'introduction de la lutte intégrée dans divers systèmes de production. En serre, la lutte intégrée touche 500 ha par année. En verger, elle permet de réduire de 70% le nombre de traitements insecticides contre *Cydia pomonella*. Dans le cas de la tavelure (*Venturia inaequalis*), elle a réduit le nombre de traitements fongicides de 30% sur une surface de 100.000 ha. Pour les céréales à paille, la lutte intégrée concerne essentiellement

le raisonnement des traitements fongicides et herbicides sur blé d'hiver et orge. Pour la pomme de terre, c'est la lutte contre le doryphore (*Leptinotarsa decemlineata*) qui est principalement concernée; actuellement, la lutte chimique est utilisée sur 77% des surfaces de cette culture. L'USDA/AID patronne des programmes spéciaux de recherche et de démonstration de lutte intégrée en Europe du Centre et de l'Est; ils deviendront opérationnels en 1992/1995 et concerneront l'arboriculture (poirier, pommier), les céréales à paille (blé, orge) et la pomme de terre.

Подход к защите плодовых питомников, посевов зерновых и картофеля в Польше с позиции интегрированной борьбы

При общей площади 312 683 кв.км и населении 39 млн. человек на душу населения в Польше приходится 0,47 га земли, отведенной под сельскохозяйственное производство. Урожай основных культур довольно низок, а потери от патогенов, животных-вредителей и сорных растений высоки. Пестицидная нагрузка составляет 1,0 –1,3 кг действующего вещества на 1 га, что служит хорошей отправной точкой для освоения программы интегрированной борьбы при производстве различных культур. В условиях теплиц интегрированный метод борьбы проводится на площади до 500 га в год. Подход с позиции интегрированной борьбы с яблоневой плодожоркой (*Cydia pomonella*) в плодовых питомниках позволяет на 70% снизить число химических обработок. При парше яблок (возбудитель *Venturia inaequalis*) интегрированный подход позволил снизить обработку фунгицидами на 30% на площади 100 000 га. В случае мелкозерных злаковых культур интегрированный подход затрагивает рациональное использование фунгицидов и гербицидов на посевах озимой пшеницы и ячменя. Интегрированная программа защиты картофеля выполняется, в основном, в направлении борьбы с колорадским жуком (*Leptinotarsa decemlineata*), которая в настоящее время осуществляется с помощью химической обработки инсектицидами на 77% посевных площадей. В Центральной и Восточной Европе специальные исследовательские и демонстрационные программы интегрированной борьбы, поддерживаемые USDA/AID, будут доведены до оперативного состояния к периоду 1992-92 годов и рассчитаны на применение в плодовых питомниках (яблоки, груши), на посевах мелкозернистых злаковых культур (пшеница, ячмень) и картофеля.

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