Danish Research Service
for Plant and Soil Science

Plant diseases and pests in Denmark 1983

100th annual report
Compiled by
The Research Centre for Plant Protection

Lyngby 1984

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A Century of 'Plant Diseases in Denmark', 1884-1983
by **Chr. Stapel**

The present edition of 'Plant Diseases in Denmark' is part of an unbroken series of 100 annual reports starting with the year 1884.

Emil Rostrup sent out the first one: 'Survey of Enquiries about Plant Diseases of Cultivated Plants received in 1884' (Oversigt over de i 1884 indløbne Forespørgsler angaaende Sygdomme hos Kulturplanter, Tidsskrift for Landøkonomi 1885: 278-296). Rostrup had probably no idea that this was to be the basis of hundred years of written reports on information and knowledge about the plant diseases and pests registered each year. The reports combined with the more detailed 'Monthly Surveys of Plant Diseases' (Månedsoversigter over Plantesygdomme) - which have been sent out since 1906 concerning agricultural plants and since 1916 concerning horticultural plants - constitute an invaluable storehouse of information among the literature on plant pathology in Denmark.

On the first of August 1883 Rostrup was appointed lecturer (later professor) of plant pathology at the Royal Veterinary and Agricultural University. Soon after, on the 1st of April 1884, he was furthermore appointed government adviser on plant diseases, primarily to the ministry, but with an obligation to assist agriculture, horticulture and forestry in matters of plant pathology. This had the effect that Rostrup received reports and enquiries from many parts of the country. This together with his own knowledge and investigations enabled him to report on the occurrence of plant diseases and pests not only in 1884, but every year until his death in 1905 - a total of 22 consecutive annual reports.

It was not as lecturer on plant pathology at the university, but in his capacity as advisor on plant diseases that Rostrup presented these reports, but there is no doubt that he was the first one to include the results of practical experience in the instruction at the Agricultural University and in guidances for the farmers, etc.

As appears from the title of the first annual report, it was largely based on enquiries received from farmers, gardeners and foresters. Note that the survey was at that time based on reports from practice, whereas the present annual reports are based on information from advisers. The reason is simply that the advisory service and agronomical research had not been developed. Rostrup himself was the first adviser on plant diseases, and his appointment as lecturer on plant pathology at the Veterinary and Agricultural University was the start of the education which later resulted in agricultural and horticultural advisers who were also familiar with plant pathology.

Rostrup's annual reports dealt primarily with agriculture, not because Rostrup was less interested in horticulture and forestry, but he usually reported on that in the special journals of horticulture and forestry. The annual reports were mostly about proper plant diseases (fungus and bacterial attacks), whereas pests were mentioned very little during the first years. This changed in 1892, when Rostrup sent out questionnaires to a larger circle of farmers. The replies provided a broader basis for the reports, not only on proper plant diseases, but also on pests. As to plant pathology, the reports obtained an even broader basis with the start of the Monthly Surveys.

In 1905 the Federation of Danish Farmers' Unions started a plant pathology research institute with Rostrup's assistant and colleague **Frederik Kølpin Ravn** as leader. Now the education in plant pathology was so advanced and the advisory and research services so well established that Kølpin Ravn was able to publish "Monthly Surveys of Diseases in Agricultural Plants" starting in April 1906. In this Kølpin Ravn published the following manifesto:

"The aim of this work is to give the no doubt considerable number of interested people a general idea of the state of health among our cultivated plants. Besides, a number of observations made in one area will be of interest elsewhere and possibly prompt others to make similar observations. The occurrence of many diseases will probably be better investigated when notice is given while the attack is at its worst and the interest consequently vivid. Finally, there may be cases where this kind of publication may contain recommendations for the prevention of an imminent attack. Thus the most important purpose of these surveys is to serve the interests of the moment, but hopefully they may serve as a supplement to Professor E. Rostrup's well-known annual reports, to which present and future scientists should still refer if they want information about the occurrence of plant diseases in this country."

This gives us an idea of some of Kølpin Ravn's visions. We understand that with Rostrup and him we are in the infancy of plant pathology, where knowledge about the actual distribution was needed, where much needed to be investigated, and where information on attacks might inspire and necessitate research. When he says that reports and experience from practice may lead to recommendations for preventing imminent attacks, we see the strategy of good farming to prevent attacks, which is continued in our work with prognoses, forecasts and integrated control. But Kølpin Ravn also realized that registration of diseases and pests is not only of momentary interest - in the long run it is of historical interest as a source of knowledge about the spread and importance of the attacks throughout the years.

For Kølpin Ravn there was no doubt that Rostrup's annual reports ought to be continued, but now with the monthly surveys as basis and supplement. Since 1906 the monthly surveys have been published without interruption with seven numbers a year covering the growth period April-October - a total of 546 surveys by the end of 1983. Based on the surveys, the improved education in plant pathology, and the development of the advisory service, the annual reports could be given a more systematic and representative character, and the form Kølpin Ravn chose for the reports has more or less been kept until today.

So we now have this collection of annual reports on the last 100 years and may ask if the visions that Rostrup and Kølpin Ravn had about their importance have been fulfilled. The answer is no doubt positive, although the surveys look very heterogeneous, influenced as they are by 100 years of different reporters from all over the country, by changing editors and authors, and also by the greater knowledge in the field of plant pathology gained by systematical research in the laboratories and fields in this country and abroad. A continuous outline of current knowledge and numerous details on plant diseases and pests and their occurrence have been given in the annual and monthly surveys. Over the years this has had an unmistakable influence, not only on articles and instructions in journals, but also on textbooks and handbooks, which has made questions of plant pathology seem very relevant to the farmers. Over the years, when plant pathologists have tried to submit a plant disease or a harmful insect to close examination regarding the influence of soil conditions, crop rotation, soil treatment, chemical treatment, etc., or special climatic conditions, the annual and monthly surveys have often inspired a more systematic and experimental investigation, which was precisely what Kølpin Ravn expected. There are numerous examples of this, but a more comprehensive study was made by Kølpin Ravn himself covering the first 25 years from 1884 to 1908: "25 Years of Observations of Diseases in Agricultural Plants" (25 Aars Iagttagelser over Sygdomme hos Landbrugsplanterne, Tidsskrift for Landbrugets Planteavl 16: 738-758, 1909). For a number of diseases and pests Kølpin Ravn tried to relate the attacks to special weather conditions or methods of cultivation and expressed the hope that the next 25 years would give further information and better understanding of these relations.

Ernst Gram picked up the thread and reported on the period 1884-1933: "50 Years of Annals on Plant Pathology" (50 Aars plantepatologiske Annaler, NJF Kongres Beretning, 1935: 57-61). His main subject was the relation between weather conditions and attacks of potato blight after application of Bordeaux mixture. If we move further on in time, we come to **Chr. Stapel** who reported on the period 1884-1958: "75 Years of Annals on Plant Pathology" (25 Ars plantepatologiske annaler, Horticultura No. 5: 116-119, 1961). This time the report concerned clubroot only, which had been mentioned for the first time in this country in Rostrup's annual report for 1884.

Like the present report, the three former jubilee publications only concerns a small part of the information given about plant diseases and pests, so there is plenty of material for present and future plant pathologists.

One difficulty is the fact that there is still no subject index in the annual reports, and in the monthly surveys only from 1954. This means that data given about an attack can only be found by going through 100 annual reports and several hundred monthly surveys, which may discourage many people. It would seem a worthy task for someone to remedy this by working out a systematic register, or rather continuously write out the most important data, which would thus be available to future researchers.

As mentioned before, the annual and monthly surveys contain numerous details on experience in practice, often in the form of monotonous repetitions, which may seem superfluous. It should be kept in mind, however, that a disease may very well be fully investigated and described by the plant pathologists, so that it is up to the farmers to use this knowledge in practice; but the results may have been forgotten or disregarded, so that examples showing the disastrous consequences of disregarding this knowledge in practice may prevent unfortunate repetitions. Thus the surveys also serve as guidance although that is not the main aim. Usually advice is given through other channels, mainly in special communications, agricultural journals and in text- and handbooks. The main purpose of the surveys has always been registration of actual attacks, often accompanied by information about special circumstances as to cultivation and climate, which might contribute to an understanding of the connection between the attack and the environment and thus possibly lead to further investigation of the attack.

In each annual and monthly survey topical diseases and pests are registered, and thus they serve the interests of the moment. Sooner or later, however, there will be a wish to see the development from year to year, as can now be seen for the last hundred years. This raises the demand for comparable data for each year, preferably in simple and clear terms giving the distribution and severity of the attacks and preferably the statistical probability. The surveys cannot give this - they are based on personal descriptions and not on figures. It might be worth considering whether modern technology and data processing age might give greater clearness and statistical certainty.

Fig. 1 is an example of how attacks by plant diseases over a number of years may be represented graphically - it covers 100 years as all six diseases were mentioned by Rostrup in the first annual report. It is a question of estimated assessments of the severity and dispersal of the attacks based on the descriptions month by month and year by year. Each attack is graded from 0 to 5, and the product of these two grades gives a numerical value (0-25), which may be changed into a column. Nothing absolute can be gained from this assessment, which only serves to illustrate the relative development of the attacks.

A similar assessment was made by Kølpin Ravn, when he reported on the first 25 years and by Gram in his report on the first 50 years, but without transforming the figures into diagrams - they were both content to pick out years with very widespread and severe attacks and to contrast them with years without or with weak attacks, and then they tried to explain the differences through methods of cultivation or climatic conditions. However, that did not give others a survey of the attacks over a sequence of years. This should be remedied by the diagrams in fig. 1, which are not the first of this kind, as a number of plant pathologists (including the author) has previously worked out similar diagrams.

Gram (1935) had a serious objection to the principle on which they were based: "Even in a limited area like Denmark, the conditions of attack can in many cases not be expressed in one term without misusing the material". Such a remark must make you reflect. But Gram said: 'in many cases', not in all cases! The special cases referred to are for instance differing attacks all over the country. For instance we may receive reports from the district of Vendsyssel describing widespread and severe attacks of a disease, whereas reports from the rest of the country speak of weak attacks. In this case the special conditions in Vendsyssel will be outweighed by conditions in the remaining much larger area, and it may certainly be said that the material has been misused. To gain clarity, it may be necessary to sacrifice details, and that means that, when using diagrams to examine the correlation between a disease and environmental conditions, you may have to make corrections by going back through the annual or monthly surveys - hence the wish for a subject index or special transcripts, which might make the process easier.

On the diagrams in fig. 1 I shall only make a few comments, which just cover the main outline of the development.

For club root (**Plasmodiophora brassicae**) a tremendous increase of attacks can be seen in the years 1884 to 1911 and subsequently an equally remarkable decrease, with the result that the disease has been practically without any importance in the country as a whole for the last 50 years. The pronounced increase in attacks correlated fairly closely with the increased growing of swedes and turnips with an area in 1884 of only 10,000 ha as opposed to 170,000 ha in 1911. But the size of the area and the consequent crop rotation has not been the only decisive factor - the area with swedes and turnips kept increasing and culminated in the nineteen fifties with about 220,000 ha. That the attacks since 1911 were nevertheless limited, is due to Kølpin Ravn's demonstration that drainage and liming was the way to limit the attacks, and there is no doubt that the resulting soil improvement was not only of importance in the fight against club root, but also helped to control certain other diseases and to improve cultivation as a whole. When there have been signs of more widespread attacks, it has almost always been because of failure to take the precautions that we know are necessary, such as crop rotation. The increasing growing of rape is often responsible for this.

Violet root rot (**Rhizoctonia violacea**), about which few reports have been received for the last 20-30 years was often noted at the end of the previous and the beginning of this century. It is a fungal disease which interested Rostrup a lot, not only because it was mycologically interesting, but also because it could be most harmful in practice. In 1885 Rostrup found that the rot was actually ravaging clover fields in many places on Sealand, Funen and Bornholm, where the attacks were particularly severe, especially on certain imported types of clover. The strange thing is that a few years later Rostrup reports that he has been searching in vain for attacks in clover fields, even in regions which had previously had serious attacks. On the other hand, he often found attacks in beetroots, swedes or carrots, and those crops are still the subject of attacks. Apart from the special conditions in 1885, it has always been the matter of few and scattered attacks, bad enough for those concerned, but without practical importance for the country as a whole.

There have been reports of attacks by **Sclerotinia trifoliorum** almost every year, going from insignificant attacks in half the years to considerable or sometimes severe attacks in the other years. It is weather conditions, especially rain in the autumn and mild winters, which are the decisive factor as to the dispersal and severity of the attacks - a correlation which Kølpin Ravn could see already from the first 25 years. Attacks seem to have decreased in the last twenty years, probably because of the present practice of having fields where grass is now more frequently undersown than clover, and with much nitrogen fertilization. The limited clover area does not offer great possibilities of attack by a crop rotation disease.

There were many severe attacks of black rust (**Puccinia graminis**) before and around the turn of the century, mainly in oat, more rarely in rye and barley and very seldom in wheat. In the annual reports from that time barberry was mentioned as sources of contamination, and as a consequence the 'Barberry Act' was passed in 1903. The extermination of contagious barberry bushes brought about a quick decline in the attacks of black rust, which have since then been more or less insignificant. Exceptions were 1937 and particularly 1951, the latter year showing widespread and severe attacks in wheat. In those years practically none of the infection came from domestic sources - it was a question of airborne infection with summer spores from the eastern continent.

Stripe smut (**Urocystis occulta**) is mentioned quite often by Rostrup in his annual reports, where he keeps expressing regret that attacks are overlooked by farmers. This was not only because diseased plants could easily be overlooked when hidden as bottom grass among healthy plants - it was also due to insufficient knowledge of the disease. This resulted in insufficient registration of the attacks, which was not remedied until the monthly surveys were sent out. The main thing is that the disease was more widespread and of greater importance by the end of the previous century than appears from registrations, and serious attacks were seen until the end of the twenties, where systematic treatment of the seed grains with mercurial fungicides quickly fought down the attacks. For the last 30-40 years there have been practically no attacks in rye fields. This may still be ascribed to consistent treatment of the grain seeds with fungicides.

At the bottom of fig. 1 the attacks of powdery mildew in cereals are illustrated, concentrating on barley mildew (**Erysiphe graminis f.sp. hordei**). Rostrup frequently registered attacks of mildew on cereals, most often on barley and wheat, but he did not consider the disease very important, and that was more or less the general opinion until the beginning of the nineteen fifties, where the attacks became more frequent, more widespread, and more severe than before. Mildew had now become a disease of actual importance to barley cultivation. The main reason was probably the increased nitrogen fertilization, which started after the 2nd World War. This confirmed the old knowledge that rich vegetative growth increases attacks of mildew and other obligate fungi like for instance various kinds of rust. The effect of nitrogen fertilization on mildew is confirmed when comparing this diagram concerning mildew on barley with diagrams on attacks on wheat, rye and oat. Those cereals also showed an increase in attacks from the beginning of the nineteen fifties. As the four cereals are infected by different kinds of mildew fungus, attacks on one kind do not influence the others. Thus it must be outside influences - probably nitrogen fertilization - which have brought about the increased attacks on them all. As for barley, airborne infection from winter barley fields in Northern Germany is of evident importance, as the area sown with winter barley has lately been increased considerably, especially in Schleswig-Holstein. Of course, it may be pointed out that in the fifties the barley strains were very susceptible to mildew attacks, but so were they during the preceding period, and still that did not result in systematic attacks. That the attacks decreased considerably in the ninteen seventies was also due to the increasing use of resistant barley strains, although we now know all too well that many of the resistant strains quickly became victims of new physiological races of the fungus with consequent attacks of mildew. However, all in all, the attacks are less severe than in the very susceptible strains grown in the fifties and sixties.

As mentioned before, the annual and monthly surveys contain a wide experience from practice, which has helped to influence the fight against plant diseases and pests by good preventive agricultural practice. Considering this, chemical control has not had a fair treatment in the surveys, and they hardly contribute very much to illustrating the importance and history of chemical control in this country. The reason is probably that the annual and monthly surveys started at a time when chemical control was practically nonexistent, and the consequent character of the surveys has been maintained, also after the introduction of chemical control.

Before the 2nd World War the systematic use of chemicals was limited to mercurial fungicides, which is a very special kind of chemical control. The real breakthrough of modern pesticides for spraying the fields came after the war, but it was not until well into the fifties that they were more generally applied.

Although the annual and monthly surveys do not really contribute to illustrating the development and importance of chemical control, they may indirectly reveal unfortunate long-term effects on the balance between harmful insects and their parasites, if there is such a long-term effect.

One objection to chemical control, especially with insecticides, is their all-round effect, which does not only influence the pests it is aimed at, but also without discrimination a number of other insects, harmful, useful and indifferent. Among the useful insects, parasites and predators may be mentioned as contributing to controlling pests. If chemical control hits these parasitizing and predatory insects harder than the harmful insects, it may make matters worse. Examples of this with a subsequent sudden and undesired propagation of pests have been seen. As this is of course an undesired effect, the use of the dangerous chemical will be stopped if it ever got beyond the test stage. However, an insidious, inconspicuous effect resulting in a a long-term propagation of the pest is more alarming. Such an effect should not be disregarded, but in that case it must be revealed as increasing attacks mentioned in the annual and monthly surveys, which hereby become the admonitory safety valve!

Examples of how the surveys are used for this purpose can be seen in fig. 2-5, which are diagrams of the most important pests in the crops (cereals, beetroots, swedes, and cruciferous seed crops), where chemical control has been considerable, and where the monthly surveys, which are most detailed, have been used as a basis. The important thing in this connection, where we want to examine adverse long-term effects, is that the 78 years from 1906 to 1983 may be split into a period of 45-50 years with practically no chemical control followed by a period (lasting until the present) of 30-35 with considerable use of chemicals.

Out of the 28 pests registered, only four have increased considerably since 1950, namely aphids in cereals (fig. 2 A), peach potato aphids in beetroots (fig. 3 E) and brassica pod midges and turnip seed weevils in cruciferous seed crops (fig. 5 B and C).

During the period without chemicals there have been similar outbreaks, which cannot be explained as adverse effects of chemical control, but must have other causes, and of course they may apply in the age of chemicals as well.

For the two latter harmful insects in cruciferous crops - the brassica pod midge and the turnip seed weevil - the increasing attacks coincide with increasing cultivation of their most important host plant, rape. The cultivation of rape started after the war, and rape is now grown on more than 100,000 ha. It is often seen that new crops result in high propagation of harmful insects, but it seems that both the attacks mentioned here have been decreasing during recent years, and that cannot be interpreted as the insidious effect of chemicals disturbing the balance between the pests and their parasites.

As for the peach potato aphid (fig. 3 E), it should be noted that it has practically not been registered during the time without chemicals, the reason being that it was hardly considered a pest. However, this view changed with the increasing attacks of beet yellows, where it turned out that the peach potato aphid was the most important virus vector. Thus it became a pest of great indirect importance and the main object of the monitoring and forecasting service, which since 1967 has helped to counteract the serious attacks of beet yellows. It is quite possible that peach potato aphids were just as numerous before, but not registered. Incidentally, the attacks seem to have abated a lot compared with the nineteen fifties, which seems to indicate that the balance between the peach potato aphid and its parasites has not been worsened by chemicals.

That leaves aphids in cereals (fig. 2 A). During the period without chemicals, sudden and violent attacks were often registered, but they were limited to one or a few years. Since the nineteen fifties this has changed into more lasting and severe attacks, which can hardly be explained by changes in the cultivation method or special climatic conditions, and where the possibility of a chemically induced effect cannot be precluded. This has made Danish plant pathologists show great interest in finding remedies against aphids in cereals such as forecasting, monitoring and integrated control in an effort to limit chemical control with the consequent unintended effects.

The recent use of the annual and monthly surveys to illustrate possible unfortunate long-term effects of chemical control was hardly imagined by Rostrup and Kølpin Ravn, but apart from that, the surveys have probably come up to their expectations covering both the immediate needs and the historical view of the occurrence of our plant diseases and pests. It is to be hoped that future plant pathologists will meet understanding and find ways to ensure continuity of the work done up till now.

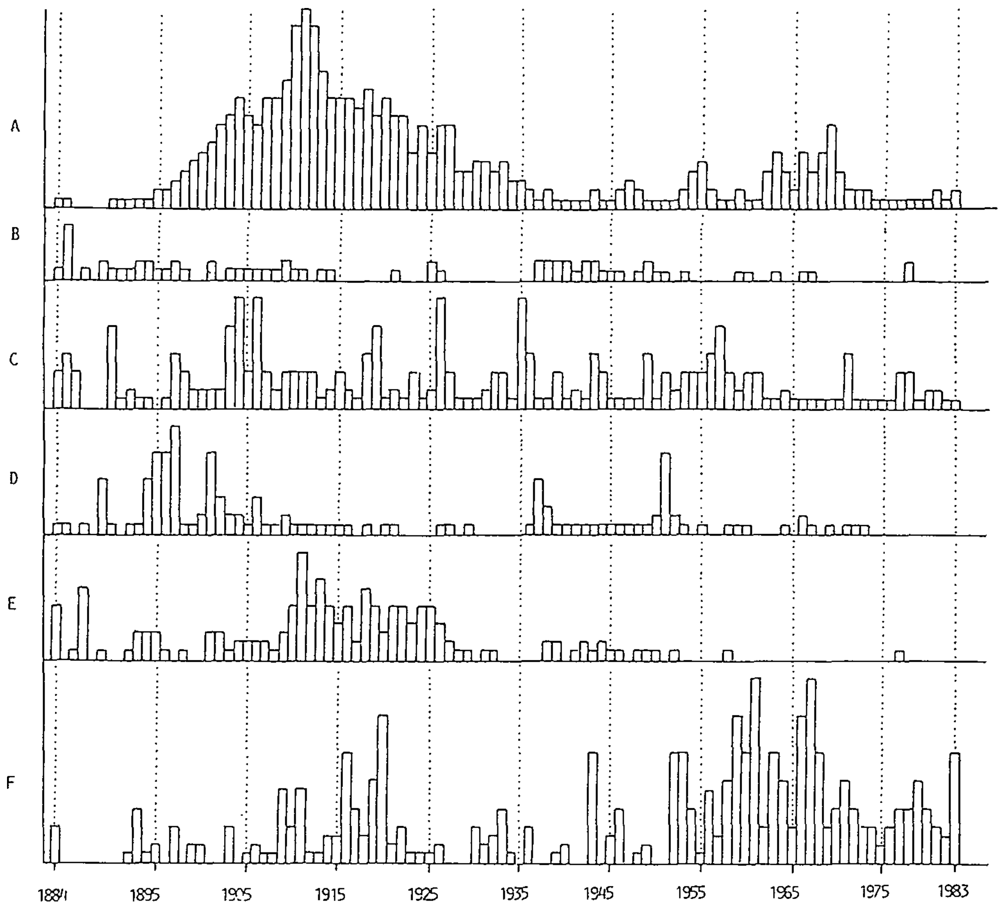

Fig. 1. Occurrence of attacks by various plant diseases in Denmark 1884-1983, estimated on the basis of annual and monthly surveys.

A. Club root (**Plasmodiophora brassicae**)
B. Violet root rot (**Rhizoctonia violacea**) on clover and various root crops
C. Clover rot (**Sclerotinia trifoliorum**) on red clover and other herbage legumes
D. Black rust (**Puccinia graminis**) on cereals
E. Stripe smut (**Urocystis occulta**)
F. Powdery mildew (**Erysiphe graminis**), mainly attacks on barley

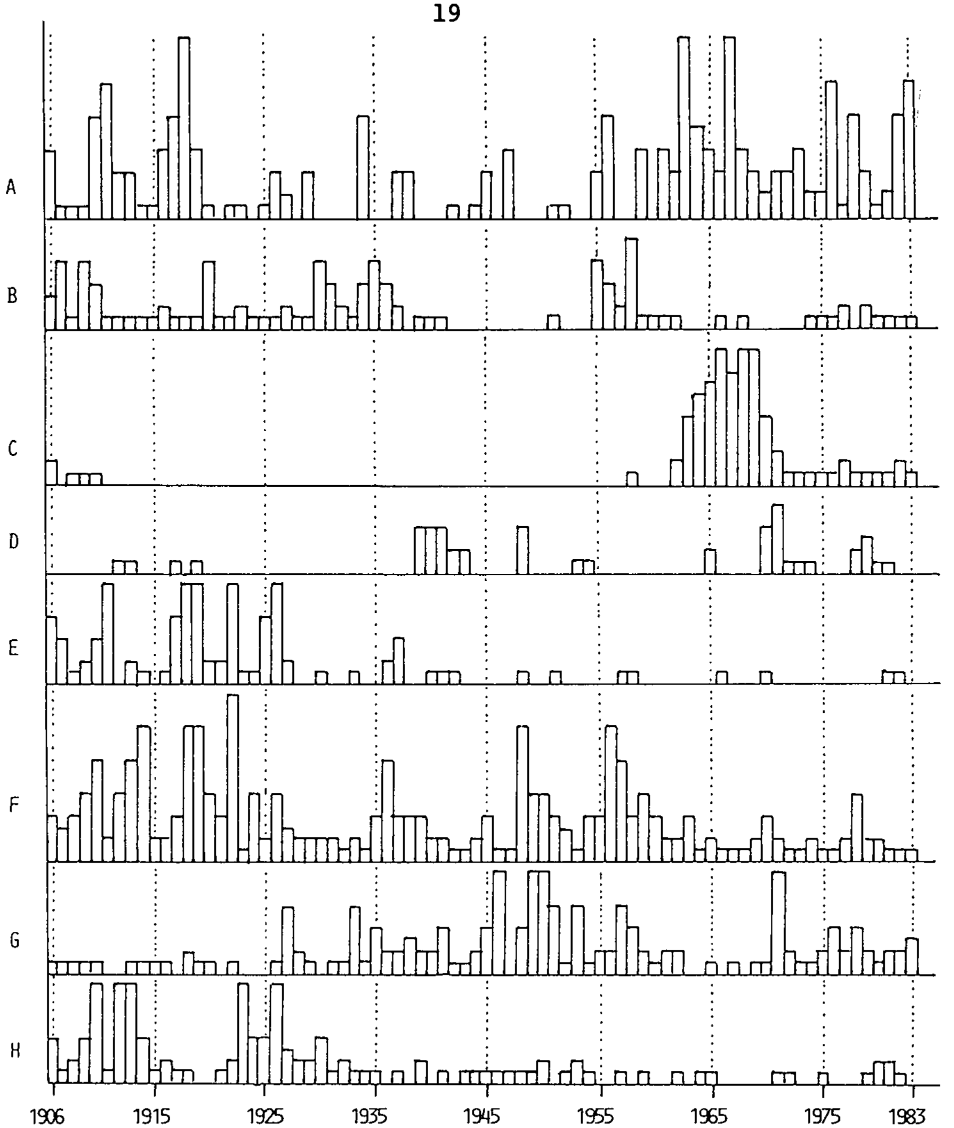

Fig. 2. Occurrence of pest attacks on cereals in Denmark 1906-1983, estimated according to the Monthly Surveys of Plant Diseases.

A. Aphids (**Aphididae**)

B. Wheat blossom midges (**Contarinia tritici** and **Sitodiplosis mosellana**)

C. Saddle gall midges (**Haplodiplosis equestris**)

D. Hessian flies (**Mayetiola destructor**)

E. Gout flies (**Chlorops pumilionis**)

F. Frit flies (**Oscinella frit**), spring and early summer attacks

G. Frit flies (**Oscinella frit**), autumn and winter attacks

H. Wheat bulb flies (**Hylemyia coarctata**)

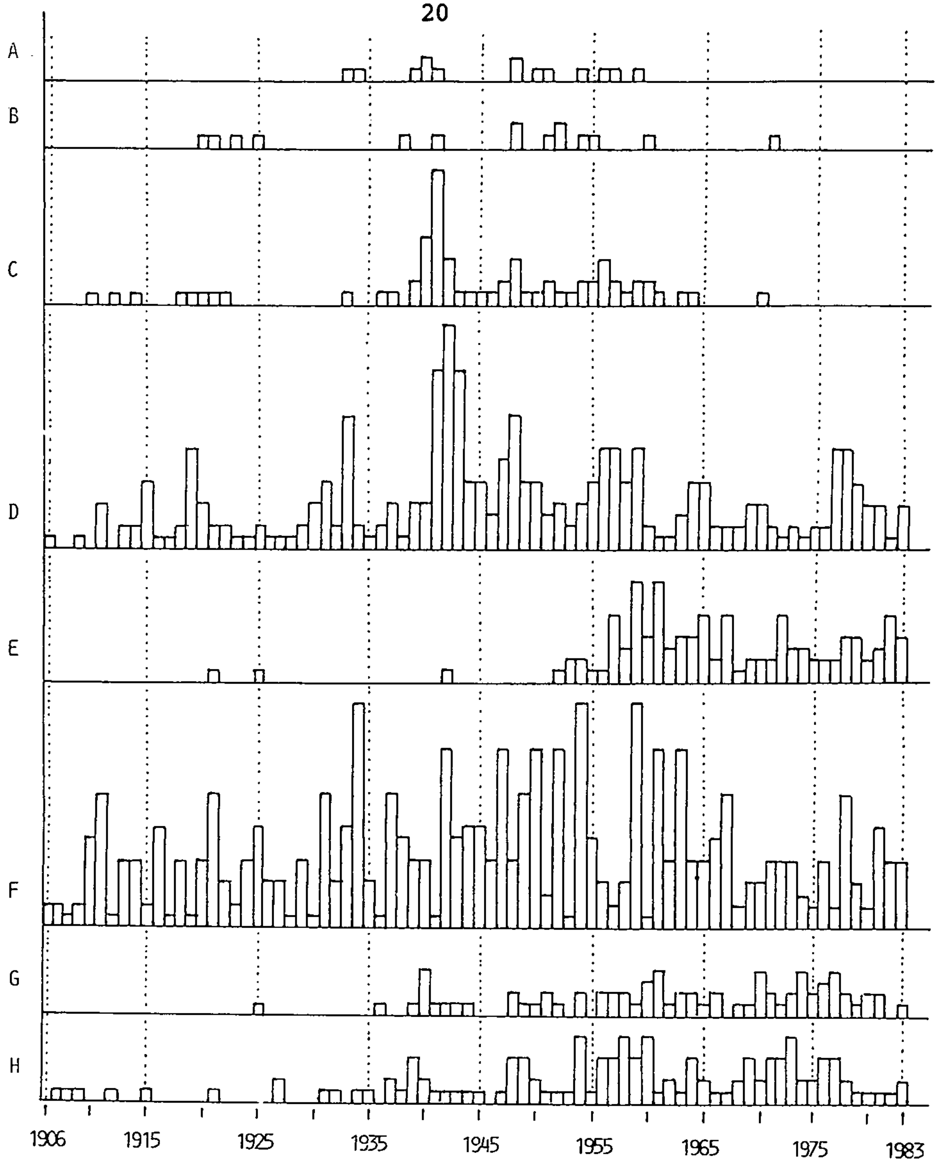

Fig. 3. Occurrence of attacks of pests on beetroots in Denmark 1905-1983, estimated on the basis of the Monthly Surveys of Plant Diseases.

A. 24-spot ladybirds (**Subcoccinella 24. punctata**)
B. Mangold flea beetles (**Chaetocnema concinna**)
C. Tortoise beetles (**Cassida nebulosa**)
D. Beet carrion beetles (**Blitophaga opaca**)
E. Peach-potato aphids (**Myzus persicae**)
F. Black bean aphids (**Aphis fabae**)
G. Potato capsids (**Calocoris norvegicus, Lygus rugulipennis**)
H. Pygmy beetles (**Atomaria linearis**)

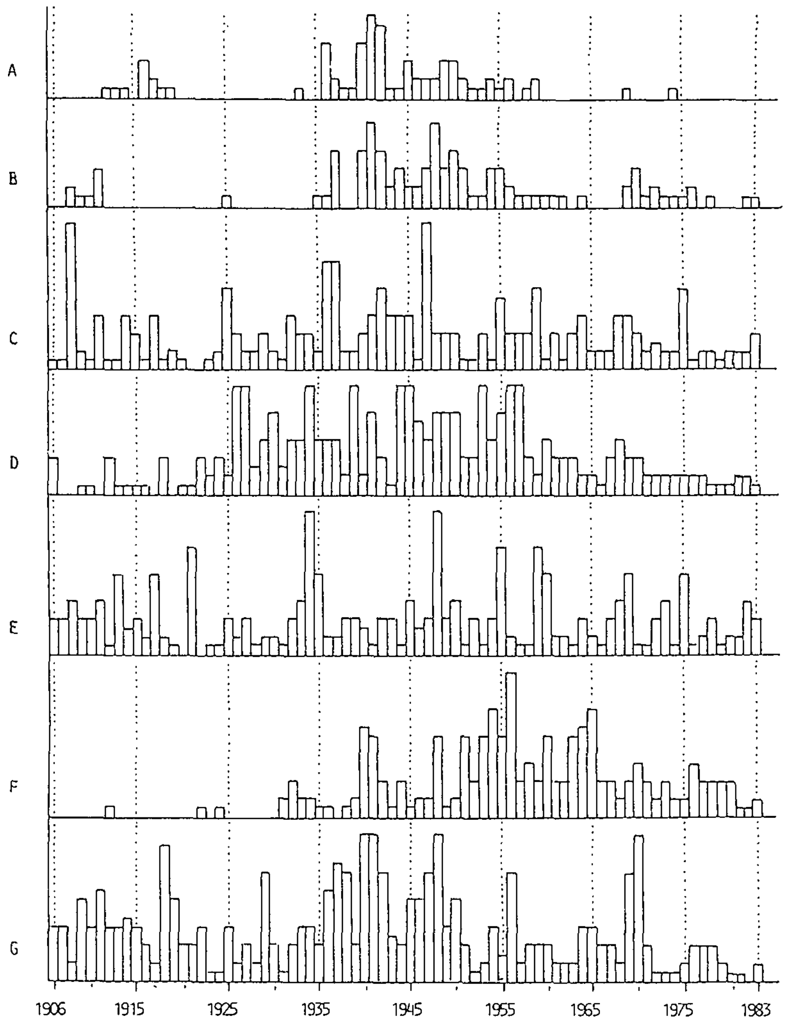

Fig. 4. Occurrence of pest attacks on cruciferous crops (mainly swedes and turnips) 1906-1983, estimated on the basis of the Monthly Surveys of Plant Diseases.

A. Cabbage bugs (**Eurydema oleracea**)
B. Turnip sawflies (**Athalia rosae**)
C. Cabbage white larvae (caterpillars, **Pieris spp.**)
D. Swede midges (**Contarinia nasturtii**)
E. Cabbage aphids (**Brevicoryne brassicae**)
F. Thrips (**Trips angusticeps**)
G. Flea beetles (**Phyllotreta spp.**)

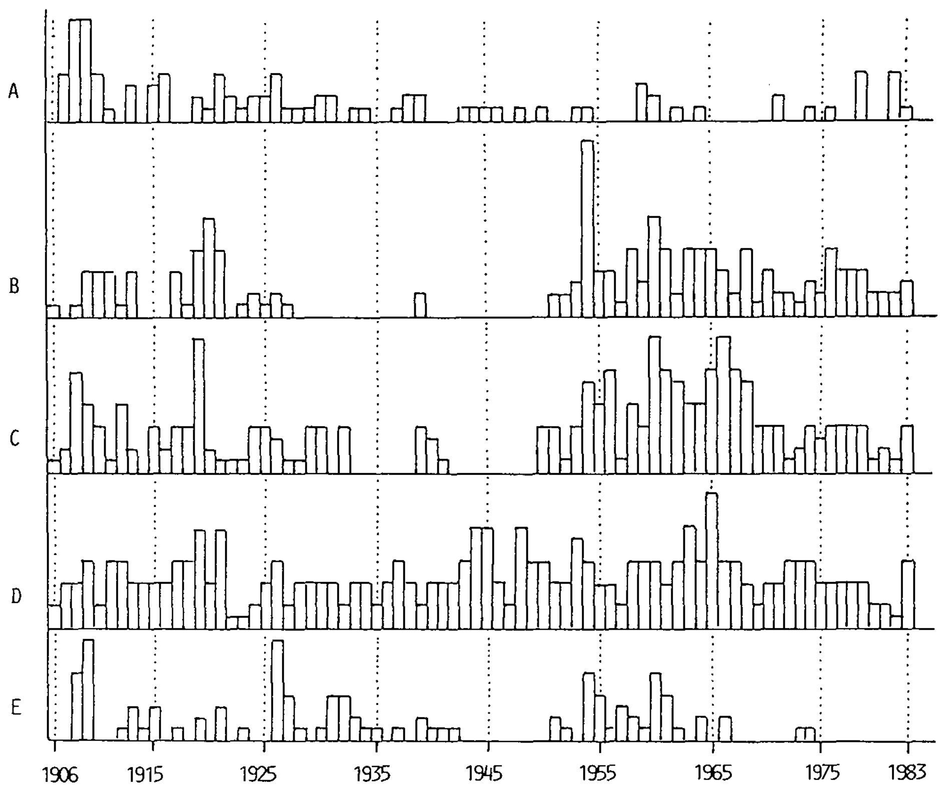

Fig. 5. Occurrence of pest attacks on cruciferous crops (mainly seed crops) in Denmark 1906-1983, estimated on the basis of the Monthly Surveys of Plant Diseases.

A. Cabbage stem weevils (**Ceutorrhynchus quadridens**)
B. Brassica pod midges (**Dasyneura brassicae**)
C. Seed weevils (**Ceutorrhynchus assimilis**)
D. Blossom beetles (**Meligethes aeneus**)
E. Cabbage stem flea beetles (**Psylliodes chrysocephala**)

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A. Institute of Plant Pathology

I. DIRECTORY

Director of Institute

H. Rønde Kristensen

Botany Department

Head: Ib G. Dinesen (acting)

Scientific staff:

Lone Buchwaldt

Diseases of oil seed rape and other seed crops

Ib G. Dinesen

Bacterial diseases of glasshouse crops, fruit trees and potatoes

Karen Bolding Jørgensen

Diseases of sour cherries; bacterial diseases of glasshouse crops and fruit trees

Henrik Albert Jørgensen

Diagnostics of fungi; diseases of horticultural crops and root rot of sugarbeets; Dutch elm disease; registration of scientific literature

Hemming Mygind

Fungus diseases of glasshouse crops and nursery plants; potato wart, testing for resistance; diagnostic work, especially root pathogenic fungi

Hellfried Schulz (part time)

Root and foot rot of cereals; take-all decline

Sten Stetter

Threshold values for leaf diseases of cereals

Boldt Welling

Diseases of cereals and grasses; storage fungi on grain

Virology Department

Head of Dept.:
H. Rønde Kristensen

Scientific staff:

Jens Begtrup

Electron microscopy

Purification and serology of plant viruses

Bent Engsbro

Viruses of agricultural plants; production of healthy nuclear stocks of potatoes

Niels Paludan

Viruses of vegetables and ornamental plants (herbaceous); production of healthy nuclear stocks

Arne Thomsen

Viruses of fruit trees, soft fruits and woody ornamental plants; production of healthy nuclear stocks

Zoology Department

Head of Dept.:
Jørgen Jakobsen

Scientific staff

Peter Esbjerg

Insect pheromones and cutworm population dynamics

Lars Monrad Hansen

Soil-borne pests on beets and potatoes; grower-based monitoring of pests in cereals

Lise Stengaard Hansen

Biological and integrated control of pests on glasshouse crops

Jørgen Jakobsen

Plant parasitic nematodes

Mogens Juhl

Natural enemies of cyst-forming nematodes

Fritjof Lind

Pests on oil seed rape; threshold values for pests in cereals; methods for testing insecticides

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The occurrence of insecticide resistant populations of Myzus persicae in Denmark

Jørgen Reitzel

Aphid population dynamics, particularly on potato and cereal crops; mass production of parasitic and predaceous species of insects and mites used as biological control of pests in glasshouses

Lise Samsøe-Pedersen

Methods to test side effects of pesticides on beneficial arthropods

Advisory service

Ole Bagger

Pests and diseases of agricultural plants

H. Schulz (part time)

Pests and diseases of agricultural plants

Lars A. Hobolth

Pests and diseases of horticultural plants

A total of 149 lectures have been given by the staff of the Institute of Plant Pathology and the Plant Protection Advisory Department at "Godthåb".

II. GENERAL SURVEY OF PLANT PATHOLOGY SUBJECTS 1983, H. Rønde Kristensen

In 1983 27 research workers and 34 laboratory assistance etc. were employed at the Institute of Plant Pathology.

10 students and 8 voluntary workers have participated in the work of the Institute for some time during the year, as well as 9 laboratory and office apprentices and 2 working under the employment scheme.

From October 15 Ib Dinesen, lic.agro., has been appointed acting head of the botanical department instead of Arne Jensen, lic.agro., who has been granted leave to go to Zambia as leader of an assistance programme on plant pathology - at least for one year.

Especially at the beginning of the year numerous tests were made concerning bacterial ring rot in potatoes - partly to examine export samples and partly to ensure the "meristem material". Trials concerning bacterial ring rot have also been made in the field and in the lab.

Bacteriological examinations have also been made in connection with the propagation of healthy nuclear plants for horticulture.

Work on fungal diseases has comprised determination of intensity and distribution of foot rot attacks in tests with crop rotation and chemical control. A system of forecasting and monitoring is being developed.

Efforts have been made to estimate threshold values for leaf fungi on cereals (including computer-based methods for calculating the damage threshold ("EPIDAN")).

The monitoring system for brown spot has been extended, and observations have been made concerning the spread of mildew infection from the much increased area of winter barley to spring barley fields.

Resistance tests for potato wart disease have been carried out to the usual extent. Investigations regarding damping-off and root rot in beetroots were also continued.

In rape, research has been done to control the most important fungal diseases, and experiments have been carried out to develop test methods (variety susceptibility) - especially regarding root rot.

In the greenhouse area the Botanical Department has worked on the mapping of physiological strains of downy mildew in lettuce and has done a considerable piece of work to establish healthy nuclear stocks of various glasshouse plants.

Nursery cultures have been examined for **Phytophthora cinnamomi** and **P. cactorum**, and a special research project on serious pests in sour cherries has been started (in co-operation with the Institute of Pomology).

At the Zoological Department the routine tests for potato cyst nematodes have been continued. Nematode patotypes have been determined, and their rate of development under varying temperatures is being examined. As part of a European co-operation (I.O.B.C.) investigations have been made regarding fungal parasites on cereal cyst nematodes. The population dynamics of these and other cyst-forming nematodes on cereals have been investigated.

Migrating nematodes (including virus vectors) are examined at the Zoological Department.

Other important fields of work are the development of standard methods for determining the effect of pesticides on the beneficial arthropods - and aphids in cereals. A country-wide registration of aphids in spring barley took place in 1983.

Efforts has been made to develop a semi-field method for testing the effect of pesticides on aphids and also to find lab methods for demonstrating the effect of pesticides on aphids in barley.

Aphid multiplication in 5 localities within potato growing areas has been surveyed by means of aphid tray traps.

The research on biological control of glasshouse pests, on insecticide resistance in peach potato aphids, on rape pests and on soil-borne pests in beetroots has been continued.

In order to monitor for attacks of cutworms on threathened crops examinations were made of the catch in pheromone traps set up in 15 localities.

At the Virological Department 3,000 samples have been examined with the electronic microscope (mainly the ISEM method).

Improved methods of preparation have made it possible to examine woody plants. Previously, these examinations were difficult or impossible.

Apart from the routine examinations the serological investigations (mostly by the ELISA method) were made to establish the relationship within the Luteo virus group.

Mapping and observations have been made regarding cereals and grasses, especially with a view to virosis in cocksfoot and winter barley.

The routine work on the "potato meristem programme" has been continued. Besides, research work has been carried out regarding storing in glass tubes, various forms of cultivation in vitro, etc.

Experiments at 4 research stations have shown that potato cuttings are far more susceptible to aphids and leaf-roll than plants from tubers.

Variety susceptibility tests concerning rattle virus have been continued, and a report on more than 20 years' work has been written.

The comprehensive work to establish healthy nuclear stocks of various horticultural plants has been continued. Also in this respect considerable research work has been done along with the routine tests.

In relation to various ornamental plant viroses efforts are made to develop more efficient test methods regarding sap and dry inoculation.

Besides, inactivation experiments are made with various viruses using low and high temperatures as well as antiviral agents.

Advisory Work. In 1983 the staff of the Institute of Plant Pathology have prepared 71 publications and given 111 lectures.

International Cooperation. The Institute of Plant Pathology has old traditions of international cooperation. The international relations have been strengthened in recent years by membership in international working groups, etc., within the different fields of plant pathology, and by participation in conferences and symposia, and by study visits or tours to research institutes in other countries.

Besides, considerable inspiration for the research work is gained from visits to the institute by numerous foreign colleagues.

Among the many international organizations through which international cooperation takes place the following should be mentioned: FAO, EEC, EPPO, ISPP, ISHS - the Plant Protection Commission, IOBC and the NJF Fourth Section.

In August 1983 the 4th International Congress on Plant Pathology was held in Melbourne, Australia, with about 1200 participants from about 60 countries. A total of 8 plant pathologists participated from Denmark, including 3 from the Institute of Plant Pathology, who all made contributions.

In 1983, 21 staff members have made 41 journeys to the following countries: Australia, Belgium, England, Finland, France, Holland, Italy, Norway, Sweden, Germany and Hungary.

The Institute of Plant Pathology has received visits from the following countries:

Finland, France, Holland, India, Israel, China, Morocco, Nepal, Norway, Portugal, Sierra Leone, Scotland, Sweden, South Africa, Thailand, Czechoslovakia, Germany, Uganda, Hungary, USA, Zambia and Egypt.

Plant Health Control and the production of healthy plants

The Plant Health Council, where the Institute is represented by 3 members, is an advisory body under the Ministry of Agriculture with a special view to public control of dangerous pests and diseases. At the moment the following pests and diseases are subjected to public control:

Bacterial ring rot, wart disease, potato nematodes, the Colorado beetle, black rust, mildew and rust on barley, wild oat-grass, stem nematodes, the San José scale, the South African carnation tortrix, fire blight and the muskrat.

In 1983 several districts had considerable invasions of Colorado beetles, so that the Government Plant Protection Service had to take comprehensive precautions including protective spraying. An emergency plan has been set up in order to wipe any hibernating beetles.

The spread of Dutch elm disease in this country has been very slow. However, it has been seen to spread both over short and long distances. The disease has spread fairly widely in the areas with no control measures, whereas the disease is almost totally suppressed where control measures have been taken. The Plant Health Council now advise that the municipalities should be required to intensify and coordinate the control.

Control of bacterial potato ring rot with a view to total suppression has been one of the chief concerns of the Plant Health Council and the Plant Protection Service. Therefore numerous tests by the immunofluorescence method have been made at the Institute for Plant Pathology.

A decisive part of the eradication programme concerning bacterial ring rot is the very comprehensive "potato meristem program" which was started in 1977.

The further propagation of meristem potatoes, which takes place with special growers, is now so extensive that all potatoes is expected to derive from meristem material by 1986.

The rules about winter barley, whose main purpose is to protect spring barley against infection from the winter barley, has been considerably modified in view of the increased growing of winter barley and the experience gained. However, growers of winter barley still have to take suitable precautions to prevent infection.

Potato nematodes are still a problem in commercial potato growing; here an intensified research and information work is under preparation.

The Plant Disease Act of 12th April 1957 has been discussed on several occasions during the year with a view to a necessary revision.

The Nursery Control Commission, which advises the Ministry of Agriculture and the Government Plant Protection Service on health control and the propagation of horticultural plants, has also been fully engaged in 1983.

In 1983 the obligatory health control of horticultural plants was carried out in approximately 2,500 establishments, the total number of inspections being 7,264.

By far the most important reasons for rejections and remarks were various pests, but on the whole health conditions must be considered satisfactory, which may be ascribed to the health control, the much intensified propagation of nuclear plant material and not least to the great understanding and cooperation of the plant produceres in connection with this work.

This interest is also reflected in an increasing demand for health propagation material from the commercial propagation station at Lunderskov and in many wishes and suggestions for establishment of new nuclear stocks received by the Institute of Plant Pathology and the institutes at the Research Centre for Horticulture.

III. ADVISORY WORK

1. Diseases in agricultural plants 1983

Ole Bagger

Cereals and grasses

Overwintering of winter crops was most satisfactory because of the very mild winter. Only in a few places the winter crops was injured by frost because of submersion. Also grass seed crops overwintered satisfactorily with only a few spots in some fields, where the grass seed crop was damaged because of surface water.

Yellow winter barley plants. As in 1982 a number of yellow leaves and leaf tips were seen in several winter barley fields in October. It was the oldest leaves which turned yellow, especially on compressed soil, for instance in headlands and in fields where large quantities of straw had been plowed down. The reason why the leaves are yellow is a temporary nitrogen deficiency combined with an oxygen deficiency. The symptoms became apparent around the 3-4-leaf stage, when the plants are going to get nourishment throught the roots.

Structural damage. Because of the abundant rainfall during the spring several spring barley fields, especially in southwestern Jutland, showed very poor sprouting due to bad soil structure. The wet weather during spring also had the effect that the sowing of spring seed was delayed in several parts of the country, most in southwestern Jutland.

Grey speck (manganese deficiency) was very widespread during the spring in winter crops. The attacks were estimated as more widespread and serious than usual. In spring crops the attacks of grey speck were fairly moderate.

Yellow tips (copper deficiency) only occurred as mild, insignificant attacks and were considered to be much more limited than usual.

Barley yellow dwarf was seen in a number of winter barley fields in April-May. The attack could be seen as small well-defined spots, where the plants were small and yellowish with a tendency to striped leaves. Due to the favourable spring weather there were many aphids in October and November, and they transmitted the barley yellow dwarf virus. Attacks were seen both in winter barley and winter wheat fields. In winter wheat only isolated plants were usually attacked, whereas the attacks in winter barley mainly occurred in spots.

Several attacks of barley yellow dwarf were seen in the spring barley fields in June and July. The worst attacks were seen in spring barley or oat fields, which had been sown late. In soil with a large quantity of organic material at Møn very serious attacks occurred in a few oat fields which had been sown late. Fields with a high content of organic material which had been sown at the normal time, i.e. about May 1, only showed mild attacks with 20-25 per cent infected plants. Early sown fields, i.e. about June 1, had 50-70 per cent infected plants. At Møn attacks were also seen in a spring wheat field sown at the beginning of May, which had 5-10 per cent infested plants.

Mildew (**Erysiphe graminis**) was present and fairly widespread in winter barley fields with some rather serious attacks. The attacks started very early in the autumn of 1982 assisted by the rapid growth of winter barley. For long periods the temperature in the autumn of 1982 was about 10^{o} higher than normal, and this increased both to the mildew attacks and the growth of the winter barley. In the spring of 1983 there was quite a lot of mildew also in fields which had been treated with Bayton or sprayed with Bayleton in the autumn. The attacks in such fields, however, were less serious than in the untreated fields. Attacks also occurred in winter wheat and rye fields during the autumn, but they were far milder than in winter barley. In the spring mildew was seen both in April and May. However, it did not spread because of the cool, wet weather. In June and July the mildew was fairly widespread with occasional serious attacks in the winter crops. The early sown fields had the most serious attacks. In the winter wheat fields the attack was also widespread and sometimes very severe, especially in June. Because of the wet weather in May and the beginning of June driving was difficult, and in several places treatment against mildew took place rather late, which was the reason why the attacks could not quite be controlled.

In the spring barley fields mildew was also very widespread, especially in June and in the fields sown late. The most serious attacks were found in places with winter barley in the neighbourhood.

Take-all (**Gaeumannomyces graminis**) also occurred in June with fairly widespread attacks, especially in the winter wheat fields. Several rye fields were also attacked in June with sporadic attacks of take-all. The attacks seem to have been more widespread in winter crops than previous year.

Eyespot (**Pseudocercosporella herpotrichoides**). The eyespot fungus was favoured by the mild winter of 1982-83 and by the good growth of the winter crops. Thus the attacks during spring were very serious, and when sending out the eyespot prognosis on April 22 it turned out that treatment was necessary in about 60 per cent of the wheat fields, 40 per cent of the beet fields and 10 per cent of the winter barley fields. The attacks were more serious than usual. In July the attacks on winter wheat and winter rye were very widespread and severe. Spraying against eyespot in growth stage 6 was made difficult by unusually wet weather. In several places control measures started rather late at a time where the plants had very dense foliage, so that the chemicals could not get down to the basis of the plants. In a few winter barley fields severe attacks of eyespot were also seen, but only in connection with insufficient crop rotation.

Net blotch (**Drechslera teres**). Pretty severe attacks were seen in winter barley fields in April and May. Because of the wet weather the attacks spread into the winter barley fields. Fairly widespread attacks were seen in June, especially in fields where barley had been grown previously. When the dry weather started by the end of June, the attack stopped.

Loose smut (**Ustilago nuda**) was fairly widespread in June with occasional severe attacks in the spring barley fields.

At the Danish State Seed Testing Station net blotch was found in 6 out of 159 winter barley samples. 4 samples only had up to 0.1 per cent, while 2 had 0.1 to 1 per cent diseased plants.

In spring barley loose smut was seen in 2,087 out of a total of 2,835 samples. 426 of the samples showed 0.01 to 0.1 per cent diseased plants. 1,334 samples had from 0.11 to 1 per cent, while 327 samples had more than 1 per cent diseased plants. Thus loose smut attacks were more widespread in 1983 than in the preceding years.

Loose smut of wheat (**Ustilago tritici**). 5 of the 725 winter wheat samples tested by The State Seed Testing Station had loose smut. They all had less than 1 per cent diseased plants. No loose smut was found in any of 40 spring wheat samples.

Loose smut of oats (**Ustilago avenae**) did not occur in the 148 oat samples examined by the State Seed Testing Station.

Bunt of wheat (**Tilletia caries**) was not found in any of the 725 winter wheat or 40 spring barley samples examined by the State Seed Testing Station. Bunt attacks were registered in a few winter wheat fields in August, for instance in Vendsyssel and near Roskilde.

Yellow rust of wheat (**Puccinia striiformis**) was seen in the southern parts of the country already in the autumn of 1982. In areas with good growth and weather conditions for winter wheat widespread and early attacks of yellow rust were registered. In the spring of 1983 continued attacks of yellow rust on winter wheat were easily found in the southern parts of the country. The attacks spread until the end of May, and fairly widespread attacks were seen all over the country. The attacks seem to be worst in the 'Anja' variety, but attacks also occurred in 'Vuka'. Only weak attacks were registered in the 'Kraka' variety. Because of the wet weather at the beginning of May it was difficult to drive into the fields to spray. In several places the spraying took place at a very late time, where the fungus was fully developed and the control less efficient. Where the spraying was carried out in time, and if necessary repeated in June, the yellow rust could be controlled.

Brown rust of wheat (**Puccinia recondita**) was fairly widespread in winter wheat fields, especially in fields which had only been sprayed once against rust. Such fields seem to have had much more severe attacks than other fields. All in all, however, the attacks of brown rust in wheat fields must be considered less severe than those of yellow rust.

Brown rust of barley (**Puccinia hordei**). Only weak attacks were seen in spring barley fields all over the country.

Leaf blotch of barley (**Rhynchosporium secalis**) was fairly wide-spread both in winter and spring barley fields. However, when the dry weather started in June, the attacks stopped, and they do not seem to have been of any importance.

Glume blotch of wheat (**Septoria nodorum**) occurred in the spring with weak and insignificant attacks. With the dry weather and drought the attacks stopped. Everywhere they were characterized as weak and insignificant in 1983.

Speckled leaf spot (**Septoria tritici**) occurred in widespread attacks during the spring. Vigorous and widespread attacks were found in practically all winter wheat fields during winter and the first wet spring months. They were often mistaken for attacks of glume blotch. In the wet months of April and May the fungus was often seen to go up with the plant, so that it was seen higher up on the plant than usual. As the weather became drier, the development of the fungus stopped.

Snow mould (**Fusarium nivale**). Only few and weak attacks were seen in the spring, and in 1983 snow mould was of no importance because of the scant snow-cover.

Snow rot (**Typhula incarnata**). Fairly widespread, but mostly weak attacks were seen in the spring of 1983. The attacks were most severe in winter barley fields with two or more successive crops of winter barley. However, there were no serious frost injuries. Attacks were found in first-year crops, but only in a weak form. In a number of winter barley fields the fungus was only seen as a brown colouring of the stem basis, which was often mistaken for attacks of foot-rot.

Mastigosporium leaf spot (**Mastigosporium rubricosum**) was found in several cocksfoot fields in May. The wet weather offered excellent opportunities for the spread of leaf spot. In other grass seed fields leaf spot fungi were seen, for instance on ryegrass, mainly caused by the fungus **Helminthosporium dictyoides**. Further, a number of leaf spots caused by various leaf spot fungi were observed. These leaf spot fungi on grasses are observed in certain years, but rarely with so severe attacks as was the case in the wet spring of 1983. Thus application of the fungicide Tilt 250 EC gave considerable crop increases in 1983.

Legumes

Overwintering of forage legumes was fairly good in spite of the hard winter.

Clover rot (**Sclerotinia trifoliorum**) occurred in the spring, but were without any great importance in the clover fields.

Ear blight (**Fusarium spp.**). In June patches of ear blight attacks were registered in June. The attacks were most severe in the clayey parts of the field, which were wettest at the sowing.

Verticillium wilt (**Verticillium albo-atrum**). Only weak attacks without any importance were seen in July in lucerne fields.

Grey mould (**Botrytis cineria**) was seen in a few pea fields. In several fields the so-called 'lime peas' occurred where the fungus had gone into the pod, so that the seeds became shrivelled, dry and "calcareous".

Sclerotinia rot (**Sclerotinia sclerotiorum**) was seen in a few pea fields. Near Viborg very vigorous attacks of sclerotinia rot occurred in one particular field. Peas had been sown in this field three times during the past 7 years.

Beets

Overwintering of seed beets sown to a stand was most satisfactory due to the mild winter. Overwintering of fodder turnips in clamps, however, did not go too well because of too high temperatures in many clamps, which was again due to the high winter temperatures. Vigorous sprouting took place in most pits and often resulted in putrefaction.

Strangles was seen in June in a number of beet fields. The attacks were described as not very widespread. As usual, the late-sown beets were most severely attacked.

Magnesium deficiency was fairly widespread in the autumn due to the dry weather conditions. However, the attacks were mainly described as weak and much less widespread than for instance in 1982.

Heart rot and dry rot (boron deficiency). Fairly widespread attacks were seen in the autumn. Fairly severe attacks occurred in a few fields, but in most of the fields the attacks were described as weak.

Virus yellows (**Beta virus 4**) was estimated as fairly widespread in the autumn of 1983, but with relatively weak attacks. They were described as somewhat weaker attacks than in 1982. They started rather late, so that they did not have any considerable influence on the yield. Thus a nice green top was was seen in several beet fields, after the rainfall, in September/October. However, the attack of virus was somewhat obscured by the many new leaves, but all things considered the attacks were estimated as relatively moderate and late.

Downy mildew (**Peronospora parasitica**) was not seen in 1983.

Mildew (**Erysiphe betae**) was fairly widespread in the hot and dry weather in September and October. The attacks started by the end of August and became widespread in the beginning of September when it started to rain and new leaves formed. The attacks were most severe in late-sown, drought-stricken fields.

Beet rust (**Uromyces betae**) occurred in extremely weak attacks at the beginning of the growth season.

Swedes, oil-seed rape and other cruciferous crops

Overwintering of rape fields was satisfactory all over the country. Due the extremely favourable growth conditions in the autumn of 1982 and during the winter, the winter rape had a very good start in the spring period.

Downy mildew (**Peronospora parasitica**) was seen in several winter rape fields in May as a result of the heavy rainfall. As usual only the lower leaves of the winter rape were affected. In June quite a few attacks of downy mildew were also seen in spring rape fields, but by the end of June the attack stopped because of the very dry weather.

Stem rot (**Sclerotinia sclerotiorum**) was insignificant in winter rape as well as in spring rape fields as a result of the dry weather especially during flowering. The attacks were estimated as much weaker than in the three previous years.

Grey mould (**Botrytis cinerea**) occurred in May in a number of winter rape fields as a result of the moist weather. However, the attack stopped in June with the onset of the drought.

Canker (**Phoma lingam**) was seen in a few winter rape fields during spring, but only in fields where winter rape had often been grown.

Leaf spot (**Alternaria spp.**). was only seen in very few places thanks to the dry weather by the end of the growth season.

Potatoes

The wintering of potatoes in clamps was, by and large, satisfactory, although part of the potatoes were too warm, whereas the storage in house was quite satisfactory. In May sprouting of potatoes was generally estimated as satisfactory. In a few places, however, the sprouting was somewhat irregular because of the moist, cool weather. Later, it turned out that there were great differences form place to place between the sprouting. In southern Jutland the problems with the sprouting were worst because of very heavy rainfall. Thus it was necessary to replant several potato fields near Brande, as the potatoes could not sprout in the wet soil, but was rotting in the field.

Tobacco rattle virus was fairly widespread in susceptible varieties. However, the attacks were described as weak.

Wet rot (**Bacteriosis**) was without any great importance in the autumn. Most potatoes had been lifted under favourable weather conditions. Only a few potatoes, which had for the most part been lifted late in wet weather suffered from wet rot. A few potatoes were damaged by frost in October when the night frost started. It mostly happened to potatoes where the ridging had been insufficient, and a few had frost injuries which spread as wet rot to the whole stock.

Blackleg (**Erwinia carotovora var. atroseptica**) was somewhat more widespread in June. The cool, moist weather during spring favoured the attack.

Common scab (**Streptomyces scabies**) occurred in the autumn with fairly widespread and sometimes severe attacks. The were much more vigorous than in 1982 and favourbed by the very dry weather. Fewer attacks of scab were observed in potatoes which could be watered.

Wart disease (**Synchytrium endobioticum**). No new cases of wart disease were registered at the Government Plant Protection Service in 1983.

Potato blight (**Phytophthora infestans**) was no problem in 1983 as the weather was much too dry. The first attacks of potato blight were seen by the end of June in early varieties. Around midsummer a few attacks were observed in the medium-early varieties. In July and August only very weak attacks were observed. However, the attacks seemed to spread somewhat by the end of August, and especially at the beginning of September.

Blight of tubers was very limited. Throughout the country the attacks were described as extremely weak. This also applied to the late varieties. Warnings against potato blight was sent out on June 5. The 2nd warning - especially concerning watered potatoes - was sent out on August 2.

Black scurf (**Rhizoctonia solani**) was fairly widespread in May and June where the weather was cool and moist. The attacks were considerably more severe than in the preceding years, and powdering the potatoes at the planting did not seem to have the usual good effect.

At the lifting in the autumn only weak and insignificant attacks occurred thanks to the dry weather.

Leaf blotch (**Cercospora concor**) occurred in a few potato fields, for instance near Roskilde, where a very severe attack was registered. It was partly due to the dry, hot weather.

Gangrene (**Phoma exigua**) was not very widespread in the latter half of the winter 1982-83 and only occurred with very weak attacks.

Caraway

Mycocentrospora acerina. Attacks of this fungus was found on caraway plants sent in at the beginning of June. Parts of the umbel took on a dark brown colour and withered. By examination of a great number of caraway fields attacks were found in practically all fields. Attacks of the disease have not earlier been observed in this country, whereas attacks of the same fungus were seen for instance on carrots in 1976. The fungus needs cool and moist weather in order to develop, and that condition was certainly fulfilled at the beginning of the growth season.

2. Pests 1983

Ole Bagger

Cereals and grasses

Cereal nematodes (**Heterodera avenae**). In the spring of 1983 the cereal nematodes were without any great importance although the attacks tended to be a little more severe than in the preceding years. The most serious attack was seen in oat, whereas the attacks in other kinds of cereals were weak and insignificant.

Grain thrips (**Limothrips cerealium**) and rye thrips (**L. denticornis**) occurred fairly early in winter crops, and yellowish leaf sheaths could be seen. The attacks spread somewhat in June and were fairly widespread, primarily in winter cereals. However, the attack seemed to come to a stop in June.

Bird-cherry aphids (**Rhopalosiphum padi**) and grain aphids (**Sitobion avenae**) were seen in the latter half of May in winter crops. The wintering of the grain aphid on bird cherry was very good in the favourable weather, and quite a number of aphids were seen in spring. During the last days of May the bird-cherry aphid was fairly common in spring-sown crops, especially on Lolland-Falster and the southern part of Zealand. In June numerous and widespread attacks were seen both in winter and spring crops. The grain aphid was prevalent. The attacks were more widespread than in the previous years, but still rather moderate. Attacks also occurred in both winter barley and winter rye fields in the latter half of June. That does not usually happen as both cereals normally escape being attacked by aphids. In July the attacks continued and were described as widespread and sometimes severe. The attacks in June were described as being as severe as in the drought year 1976 and were also very widespread in 1983. Already from the middle of June they weakened and petered out.

Wireworms (**Agriotes spp.**). Both during the spring and in October only weak and insignificant attacks were seen in the fields.

Leatherjackets (**Tipula paludosa**) occurred quite extensively in April and May, but produced relatively weak attacks. They were primarily seen in Jutland. The migration in August and September was considerable, so that a widespread attacks of larvae may be expected in 1984. As mentioned above, however, the attack of larvae in the autumn caused very little damage.

March flies (**Bibio hortulanus**) were of no great importance in the spring crops, primarily because the main part of the winter crop had been sown late, and the larvae had started to pupate when the sprouting started.

Potato stem borers (**Hydraecia micacea**) were observed in several fields, including some maize fields. The larva penetrated the small plants, and they usually died afterwards.

Saddle gall midges (**Haplodiplosis equestris**) only occurred with a few attacks. For the country as a whole the attacks were without any importance.

Frit flies (**Oscinella frit**) occurred in the spring with pretty widespread attacks in the winter cereal fields sown after grass seed. Migration started in mid-May, and a warning was sent out to the agricultural advisers. However, the migration was described as fairly moderate, and the attacks later on were moderate. In June the second generation appeared. It was also estimated as quite moderate. However, fairly severe attacks were seen in June in a few late-sown oat fields. In September a severe attack was observed in a few grass fields with Italian and 'Vestervoldisk' rye grass near Aalborg. However, the attacks of the third generation were described as somewhat more widespread thanks to the hot, dry weather. The attacks in the winter crops were fairly widespread, but mostly weak.

Leaf beetles (**Oulema melanopus**) occurred in June with fairly widespread attacks. The larva attacks were most noticeable.

Wheat gall midges (**Contarinia tritici** and **Sitodiplosis mosellana**). A few weak attacks were observed in July.

Garden chafers (**Phyllopertha horticola**) were fairly widespread in October, primarily in lawns, but always on light soil.In a few places attacks were seen in winter barley fields sown after grass seed.

Leaf weevils (**Phyllobius spp.**) were fairly widespread, also in a number of winter cereal crops sown after grass. In most cases they occurred in winter barley sown after grass seed, and in several places the thinning of the plants was so considerable that the fields had to be reploughed. Severe attacks were also seen in red fescue fields, usually in up to 3rd-year red fescue fields, which had to be reploughed because of the severe attacks. The attacks by leaf weevil larvae, which are primarily seen on light soils in Jutland, were extended to the islands in the spring of 1983, and attacks were seen in several places on Funen, Zealand, Moen, Lolland-Falster and Bornholm.

Legumes

Stem nematodes (**Ditylenchus dipsaci**) were generally insignificant both in the spring and in the autumn.

Clover seed weevils (**Apion spp.**). Only weak attacks were seen, also in the autumn in the undersown crop.

Pea and bean weevils (**Sitona spp.**) occurred in the autumn with fairly widespread attacks, for instance in clover grass fields. The characteristic crescent-shaped gnawings on the clover leaves were relatively widespread in September and were also seen in white clover fields.

Lucerne weevils (**Phytonomus spp.**). In June they were fairly widespread, for instance in white clover fields. Attacks were observed as lots of parasitic wasp cocoons were seen in the seed parts. The parasitic wasps (**Bathy plectes**) had been living on the lucerne weevil larvae, and the great number of parasitic wasp cocoons in the seens from each field indicate that the attack has been pretty severe, and the yield from several of the white clover fields was very small.

Beets

Beet nematodes (**Heterodera schachtii**) occurred with only a few weak attacks.

Millipedes (**Blaniulus spp.**) were very widespread in May because of the moist weather. The mild winter was part of the reason why millipedes were found in great numbers in beet fields. Because of the moist weather much damage was done by millipedes in June. About the middle of June the attacks petered out as the soil humidity decreased with the dry weather.

Cabbage thrips (**Thrips angusticeps**).A few weak and insignificant attacks occurred during the spring.

Capsid bugs (**Lygus rugulipennis, Calocoris norvegicus,** etc.). In May and June a number of attacks were seen in beet fields. In most cases, however, the attacks were described as relatively moderate.

Black bean aphids (**Aphis fabae**) were seen in a number of beet fields at the end of May, especially in the southern part of the country. By an investigation of 85 beet localities in the spring of 1983 eggs of black bean aphids were found in 25 per cent of the localities. The number was very low and much lower than in 1982 where 69 per cent of the beet fields examined had over-wintered blad eggs of black bean aphids. In July the infestations were fairly widespread as a considerable propagaton had been taken place since the last days of June. The propagation continued throughout July and at the beginning of August. However, the attacks in 1983 were not as severe as for instance in 1982.

Peach potato aphids (**Myzus persicae**). In the spring, 172 sprout samples were taken from beet clamps, and peach potato aphids were found in 30 per cent of the clamps. As there were quite a number of late remaining beet clamps, relatively early attacks of peatch potato aphids and consequently of virus yellows were anticipated in 1983. However, the attacks of peach potato aphids in June were weak and insignificant. In July fairly widespread and sometimes severe attacks were seen, and there had been a considerable build-up in numbers. The attacks continued in August. They were described as being somewhat weaker than in 1982 where peach potato aphids occurred in twice as many fields. Throughout the summer the attacks remained at a relatively low level, and this was reflected in the attack of virus yellows.

Tortrix moth larvae (**Cnephasia spp.**). The attacks started in the last days of May. In June the attacks were described as relatively severe and widespread. In several fields, mostly in Jutland, many beet leaves were spun together by the tortrix moth larvae.

Beet carrion beetles (**Blitophaga opaca**). The attacks were relatively weak and insignificant in May. In June fairly widespread and severe attacks were seen, especially by the larvae. However, the attacks were less vigorous than in 1980 and 1981. In 1983, the most severe attacks were seen in Jutland.

Pygmy beetles (**Atomaria linearis**). Only a few weak attacks were seen in 1983.

Beet leaf miners (**Pegomyia hyoscyami**) laid many eggs on beet plants at the end of May. The egg laying continued in June, and the infestation was described as relatively widespread and severe in 1982. The number of larvae hatched was not so considerable, and the larva attack was described as relatively moderate. In August the attacks of the larvae were extremely weak. Only in a few fields here and there, for instance near Nyborg, relatively severe third-generation attacks were seen.

Nutmeg moths (**Dicestra trifolii**) and cabbage moths (**Mamestra brassicae**) occurred in August and September with fairly widespread attacks in several beet fields. In many places patches in the fields were totally defoliated, so that only the stalks remained. During the period of dry weather, the larvae developed and stripped many fields throughout the country. When the rain set in at the beginning of September, the attacks slowly petered off.

Cutworms (**Agrotis segetum**). In the autumn cutworm considerable damage was caused by cutworm larvae gnawing the beets. Considerable gnawing was seen in sandy soils near Kolding. The most serious damage was on the 'Kyros' variety.

Swedes, oil-seed rape and other cruciferous crops

Cabbage thrips (**Trips angusticeps**) The attacks in May and June were weak and insignificant attacks.

Cabbage aphids (**Brevicoryne brassicae**) were widespread in July and August, with, at times, severe attacks right into September. However, the attacks stopped in mid-September, when it started to rain again. Several cruciferous cultures, often also spring rape, were damaged.

Blossom beetles (**Meligethes aeneus**) only occurred in the spring with relatively moderate attacks. Due to the fairly late sowing of spring rape in many parts of the country a number of blossom beetle attacks were seen in July when the weather became drier.

Tortrix moth (**Cnephasia spp.**) occurred in June both in swede and rape fields, where they spun the top leaves together. However, the attacks were not described as very important in those crops.

Stem weevil (**Ceutorrhynchus quadridens**) infestations were not very widespread in rape fields in 1983 and much weaker than in 1982 where larva attacks were seen in practically all spring and winter rape fields.

Seed weevils (**Ceutorrhynchus assimilis**) were fairly widespread in winter rape fields in May and June, but the attacks were weak.

Diamond back moths (**Plutella maculipennis**) were fairly widespread in all cruciferous plants and in many parts of the country. A vigorous propagation took place due to the dry and hot weather, and at the end of June and the beginning of July diamond back moths migrated from other parts of the country. The first attacks were observed in mid-June where the foliage was totally gnawed off by the numerous larvae. The attacks continued into August, but quickly died off during August. In several places, it was seen that late spraying in June against diamond back moths with a pyrethroid had a particularly good effect on the first attack of the diamond back moth and its larva. The was mainly concentrated in a belt across Funen, Langeland, southern Zealand, Moen and northern Lolland-Falster. Fairly severe attacks were also seen on Bornholm. In the other parts of the country the attacks were weaker.

Cabbage butterflies (**Pieris brassicae** and **P. rapae**) occurred in the nice warm weather in August and September with fairly widespread, but mainly weak attacks.

Cabbage leaf miners (**Phytomyza rufipes**) mined quite extensively in leaf stalks and ribs in several winter rape fields. The attacks were most severe on Bornholm, where relatively widespread attacks were observed, especially on the western part of the island.

Swede gall midges (**Contarinia nasturtii**) only occurred with fairly weak attacks, which did not cause much bacterial rot.

Brassicae pod midges (**Dasyneura brassicae**) started to fly at the end of May. Warnings against the 1st generation were sent out on May 24. However, the 1st generation was estimated to be fairly sparse. Warnings against the 2nd generation were sent out on June 27 based on catches in traps. The attacks of the 2nd generation were estimated as a little more widespread than usual in winter rape fields, whereas the attacks elsewhere were described as relatively weak. The attacks were also few and weak in the spring rape fields. In July, however, the attacks in the spring rape fields were estimated to be somewhat more widespread than in the preceding years. Still, the attacks were considered relatively weak.

Cabbage root flies (**Delia brassicae**). The occurrence in July and August was estimated to be very moderate. In the spring the attacks were also described as mainly weak and insignificant in 1983.

Potatoes

Potato cyst nematodes (**Heterodera rostochiensis**). Very few attacks were seen in 1983. Thus the attacks were described as much weaker than in the preceding years.

Colorado beetles (**Leptinotarsa decemlineata**) occurred in 1983 in very large numbers. In the last days of May, starting from the 20th, 23 beetles were found, who had been washed ashore on Falster. In the south of Jutland it was mainly a case of a few beetles found in gardens. In July a few eggs laid by Colorado beetles were also seen. During the whole of July very severe and widespread attacks were seen in several places in the south of Jutland. In July Colorado beetles were found as far north as Herning. More Colorado beetles were found in August. The number of habitats was extended as beetles and a few larvae were found in great parts of Jutland up till Herning, on Funen, Zealand, Lolland-Falster and Bornholm. Thus there has been a great immigration of Colorado beetles in 1983, and in southern Jutland the total number of places where Colorado beetles and larvae were found in 1983 was 993. Al in all, Colorado beetles were found at almost 2,000 localities throughout the country. New attacks of summer beetles were seen in several places, mainly in southern Jutland.

Turnip cutworms (**Agrotis segetum**) were fairly widespread, and occasionally very severe attacks were seen in the dry weather. However, the attacks were not as severe as in the drought year 1976.

Carrots

Carrot flies (**Psila rosae**). Fairly widespread attacks were seen in 1983. However, they were in most places described as weak.

3. Diseases and pests of horticultural plants 1983

Lars A. Hobolth

Physiogenic diseases

Damage caused by the weather. During the spring 'the rains' started, and several months had between 2 and 4 times the normal rainfall. These large quantities of water had the effect that many cultures were started in soil where the structural conditions were not in order, so that a number of seeds suffocated during the sprouting. As long as the large quantities of water were there, the surviving plants could manage the growth, but when the drought started, it turned out that the plants did not have the rooting system necessary for continuing their development under totally different growth conditions.

Among the cultures that were particularly influenced by the weather conditions the following may be mentioned: Chinese cabbage, where the flower stalk formed very early without previous forming of the head; cauliflower, where the heads were very loose and badly formed; and strawberries, which had large quantities of small berries, which must be ascribed to insufficient pollination.

During the summer the glasshouse gardeners who have cultures which must be kept in the dark had great difficulties keeping the temperature at an acceptable level under the blackout curtains.

Ethylene. During the mild winter the air exchange in the cold stores was in several cases insufficient. For instance tulips were damaged because of ethylene in the air. During the autumn the suspicion arose that some cultures suffered from ethylene damage, as it was seen that sensitive cultures like for instance Bougainvillea lost their buds after straw had been burnt in the neighbourhood of the glasshouses.

Tip-burn was found in many cultures although efforts had been made to give the plants a balanced nutrition. The small scattered cases of necrosis - popularly named 'comma faults', which were very common in the later crops of Chinese cabbage, must also be described as tip-burn.

Bitter pit was seen in a number of apple varieties, especially in the big fruits, in spite of a sufficient calcium supply.

Leaf analyses showing a fair content in the leaves lead to the conclusion that in certain conditions calcium cannot be transported from the leaves to the fruits.

Fungal diseases

In the course of the year we had attacks by fungal diseases which have practically not been seen for a number of years or only with weak attacks. The reason why the diseases spread so much was probably the special weather conditions in the spring and summer.

Pythium sp. was seen in many glasshouse cultures. The violence of the attacks may be due to the difficulties in connection with adjusting the watering and fertilization to the moist and dark weather conditions at the beginning and the later high degree of lightness and heat.

Phythophthora sp. As in the case of **Pythium**, this fungus was observed in many glasshouse cultures, and the conditions mentioned under **Pythium** apply here, too.

Late blight (**Phytophthora infestans**) was found in many glasshouse tomatoes late in the autumn. The attacks were probably connected with the overcast weather in the autumn and a wish to keep low temperatures in the glasshouses in order to maintain the quality of the crop.

Clubroot (**Plasmodiophora brassicae**) caused considerable damage in cabbage. The conditions were ideal for the fungus - high soil temperatures caused by great influx of light and the constant high soil humidity due to artificial watering.

Downy mildew of cabbage (**Peronospora brassicae**) was common in the first part of the growing period, but the attacks stopped developing when the air humidity fell and the temperature rose.

Peach leaf curl (**Taphrina deformans**). Many people were surprised to see the symptoms of this disease on the earliest developed leaves. The attacks have been more prominent during the spring than in a 'standard' year.

Plum Pocket (**Taphrina pruni**) was seen on many different kinds of **Prunus**. Attacks were observed on bird cherries, cherry plums and ameliorated plum varieties.

Leaf cast of pine and fir (**Lophodermium pinastri**) attacked various 1/0 and 2/0 **Pinus** where large quantities have been much damaged by the widespread attacks of the fungus.

Apple and pear scab (**Venturia inaequalis** and **Venturia pirina**) was very widespread at the beginning of the year because of the long, moist period, where infection spread very easily. It was almost impossible to control the infection as the soil could not carry any tractor or spraying equipment. Later in the year the spread of the fungus stagnated somewhat, but it could still develop and start weak new infections, because of heavy dewfall.

Strawberry mildew (**Sphaerotheca macularis**). Very severe attacks occurred, especially in Zefyr, both on leaves and fruits.

Powdery mildew of roses (**Sphaerotheca pannosa**). Severe attacks were seen in the spring on crops of roses for cutting. Considering the growth conditions attacks so early in the year were unexpected.

Fusarioses. This group of fungi attacked many different kinds of cultures. Thus widespread attacks by **Fusarium oxysporum** were seen in onion sets and freesia. The attacks on onion sets must be connected with the large quantities of rain, whereas the damages in **Freesia** have something to do with the high temperatures later in the year. There were attacks of **Fusarium culmorum** on leeks. This attack is fairly common and is often due to bad crop rotation.

Among the more special attacks of **Fusarium** attacks of **Fusarium semitectum** on **Yucca** should be mentioned. This fusarium is typical of the tropics, and the occurrence is due to the importation of infected trunks.

Grey mould (**Botrytis cinerea**) was found in many outdoor cultures, for instance in strawberries where the first part of the season was characterized by some very severe attacks.

At the same time severe attacks were seen in 2/0 **Abies** where the new year-shoots had withered because of the attack. In glasshouse cultures strong attacks were seen in cucumbers, tomatoes and peppers. Among potted plants the strongest attacks were found in **Exacum affine**.

Blue mould (**Penicillium expansum** and **P. brevi-compactum**) was found as a pathogen in cucumber, where the fungus penetrated into the wounds after pruning. Apparently, the usual control measures had little effect on blue mould.

Pests

Leaf nematodes (**Aphelenchoides spp.**) occurred with considerably more attacks than usual. The reason why such a wide dispersal was registered may be the long periods of rain, which favoured the spreading of nematodes.

Red spider mites (**Tetranychus urticae**). Apart from the damage in glasshouse cultures, attacks were seen in various outdoor crops. Thus severe attacks of red spider mites were found in blackcurrants.

Fruit-tree red spider mite (**Panonychus ulmi**) spread in many places during the long warm summer.

The broad mite (**Hemitarsonemus latus**) seems to have profited from the changes which have taken place in glasshouse cultivation, where the climate has been changed to save heating expenses.

Steneotarsonemus palidus is still destroying large quantities of asters by attacking the buds. The development of the flower stops at an early budding stage. It has turned out that in case the flower develops, the diametre is considerably smaller than that of an ordinary flower.

Sitka spruce aphids (**Liosomaphis abietina**). The wintering was favoured by the mild winter. Consequently, severe attacks were seen on blue spruce, white spruce and sitka spruce. The attacks were often so strong that the aphids only left green needles on quite new shoots.

Cabbage aphids (**Brevicoryne brassicae**). In the warm weather the cabbage aphids had excellent opportunities for developing. Where the fields could not be watered, it was almost impossible to control them as the translocation in the plants was much reduced.

Common green capsid bugs (**Lycogoris pabulinus**) attacked many cultures, but in lettuce the severest damage by the common green capsid bug was that remainders of the insect were found deep into the heads.

Diamond-back moths (**Plutella maculipennis**) were seen in great numbers late in the summer. The damage was the more severe because the larvae penetrated to the main shoot which they gnawed while they were well protected against control measures.

Garden chafers (**Phyllopertha horticola**) were much noticed in June because of lively flying. In September and October damage from larva gnawing could be seen in many lawns.

Marsh crane fly larvae (**Tipula paludosa**) were forced up in the lawns because of the large quantities of water. In some cases, the number of larvae was so enormous that they had to be swept up.

Snails (**Gastropoda**) thrived in the moist summer, and in many places they occurred in so great quantities that they were a considerable nuisance.

IV. BOTANY DEPARTMENT, Ib. G. Dinesen, Acting Head of Dept.

Experimental work

Bacterial diseases

Potato ringspot (**Corynebacterium sepedonicum**) (Ib G. Dinesen)

In January, February, March and December seed potatoes for export were tested with the immunofluorescence method. 6000 samples of 50 tubers were tested.

The development of a method for preparation of the bacteria from the tubers was finished.

An EEC project with the purpose of comparing the eggplant and the immunofluorescence tests for the diagnosis of the disease was continued in 1983.

The spread of the disease takes place through the tools, stores, etc. To find out which disinfectants could kill the bacteria some tests were carried out in the laboratory.

In the field, research was done to see if the disease could spread from a diseased plant to a healthy plant.

A project entitled 'Investigation of serological cross-reactions between sera against potato ringrot and nonpatogenic soil bacteria' has been started at the department. The cross-reactions are compared by means of the immunoelectroforetic method and immunofluorescence.

Fireblight (**Erwinia amylovora**)

As in the past two years, infections in a hawthorn hedge at the Institute of Landscape Plants, Hornum, were studied. The purpose was to test a model for warnings. In 1983 there was a good correlation between the weather and the infections, which were of little significance in 1983.

Production of healthy plants

a. **Kalanchoë blossfeldiana**

Plant material was delivered to the plant propagation station.

b. **Dieffenbachia maculata**

When the healthy stock plants were renewed, the basic part of the cuttings were tested for **Erwinia chrysanthemi.** All the samples were negative. In some plants, cross-reacting bacteria were found, but by isolation of the bacteria, no pathogens were found.

c. **Hedera helix**

The stock plants are inspected for visual symptoms of **Xanthomonas hederae** twice a year.

d. **Pelargonium hortorum**

By renewal of the stock plants, the basic part of the cuttings are tested for **Xanthomonas pelargonii.**

Fungal diseases

Take-all and eyespot in cereals (H. Schulz)

Take-all (**Gaeumannomyces graminis**). In 1983 1592 samples were examined for take-all disease. A small increase in infested spring barley fields was found in comparison with the previous two years.

Estimated moderate to severe attacks were found in 10 per cent of the spring barley fields, in 15 per cent of the winter barley fields, and in 10 per cent of the winter rye fields. The attacks in winter wheat were less severe than in 1982, but in one fifth of the fields the extent of the attack was higher than 20 per cent, yet this was mainly because of bad cropping systems.

Eyespot (**Cercosporella herpotrichoides**). The same number of samples were examined for attacks of eyespot. In the spring samples from 431 fields were also examined in order to make a prognosis and a warning system with spraying instructions for the winter cereals.

Meteorological observations and catch of spores showed good possibilities for the fungus from October to the snowfall in February and again from the first week of March to mid-April. Then again in May the cold and wet weather caused further infections.

It was assumed that there was a need for control in 60 per cent of the wheat fields, in 40 per cent of the rye fields and in 10 per cent of the winter barley fields.

In summer it was found that the attacks of eyespot in the winter cereal fields were more widespread than the previous year. More than 40 per cent of moderate or severe infections were found in 60 per cent of the wheat fields, in 40 per cent of the rye fields and in 15 per cent of the winter barley fields. In the spring barley, weak symptoms were found in 83 per cent of the fields examined.

Even if the attacks in 1983 were more widespread than in 1982, the intensity of infections in the single straw was mostly moderate.

<u>Sharp eyespot</u> (**Rhizoctonia cerealis**). Weak attack were found in 73 per cent of the winter wheat fields, in 22 per cent of the rye fields and in 49 per cent of the winter barley fields. In spring barley, attacks were found only in 2 per cent of the fields.

<u>Threshold values on leaf diseases in spring barley (Sten Stetter)</u>

During the years 1980-1983 field experiments were carried out with the aim of finding threshold values for leaf diseases.

Two kinds of results were obtained:

1) Development of a simple and umambiguous method for registration of mildew and rust.
2) Development of a computerbased model 'Epidan', which calculates the probability of an economic yield increase by spraying with different fungicides.

The model was tested in 1983 in about 60 experimental plots. Further tests will take place in 1984, but the model will be put into practical use in 1984 in about 1000 barley fields.

Variety mixtures in spring barley (Boldt Welling and Mogens Houmøller)

Three years' experiments with mechanical mixtures in spring barley showed that mixtures with different mildew resistance had a lower level of mildew attack than the average of the four single components. This was estimated when the attack was assessed as per cent cover of mildew on green leaves and also measured with spore trapping. The yield increase was 1.5-3 hkg/has (3-5 per cent). The effect of the mixture was reduced with application of Bayleton 25 WP.

Further experiments are planned with variety mixtures in winter barley, especially for the purpose of assessing the ability of mildew to survive the winter.

Net-spot blotch on barley (**Drechslera teres**) (Boldt Welling)

In 1983 the level of the disease was generally low. In a single field with a high inoculum level from debris there also was a high level of the disease. Assessments in 30 varieties showed a great variation in their susceptibility.

A high level of the disease was found in the varieties 'Triumph', 'Nery', 'Gunhild' and 'Caja'.

Surveys in winter barley fields 1983 (Boldt Welling)

According to the law, farmers have to spray the winter barley twice with fungicides in spring to protect the spring barley against diseases. Therefore surveys are carried out to follow the spread of mildew and rust from winter barley to spring barley.

77 fields were examined in the autumn of 1983. Very few attacks of mildew and net-spot blotch were registered - about 0-1 per cent in most of the fields. The same fields will be investigated in the spring of 1984.

The quality of stored grain (Boldt Welling and Anita Idoff)
In cooperation with the National Institute of Animal Science, investigations are carried out to follow the growth of storage fungi in grains stored under different conditions. The results from two years' experiments have been published.

Diseases in grass (Boldt Welling)
In co-operation with other Scandinavian countries the publication 'NJF grass disease descriptions' is under preparation.

Introductory investigations on **Polymyxa graminis** in wheat and winter barley (Boldt Welling and Bent Engsbro)
These investigations are carried out on a few samples of winter barley and wheat to see if **Polymixa graminis** is found as a vector for the virus disease BYMV. We still have not seen this disease in Denmark.

Cephalosporium graminium in rye grass and wheat (Boldt Welling)
Symptoms of **Cephalosporium graminium** disease were observed in April and May 1983 in first-year rye grass fields for seed production, especially where the straw from the previous crop could still be found in rows.

Only in one out of 33 samples, the fungus could be isolated.

Septoria diseases in wheat (Boldt Welling)
Heavy attacks of **Septoria tritici** were seen in 1983 on wheat with symptoms on the flag leaf, which is very seldom under Danish conditions. This was probably due to the heavy rainfall in April and May, which was spread over many days and offered optimal conditions for **S. tritici** as opposed to **S. nodorum** - the fungus which is usually seen.

Diseases in oil seed rape (Lone Buchwaldt)
Generally there were few attacks of diseases in oil seed rape. This

was due to the weather conditions in the growing season, especially the dry period in June and July.

Black leg (**Phoma lingam**) was widespread, but not severe, in the winter rape area of Southern Sealand. New areas with attacks of verticillium wilt (**Verticillium dahlia**) and clubroot (**Plasmodiophora brassicae**) were discovered. Other diseases were of minor importance.

Observations of apothecia formation and registration of spore discharge of the stem rot fungus (**Sclerotinia sclerotiorum**) resulted in a forecast that advised against chemical control.

Field trials with chemical control of stem rot and black spot (**Alternaria spp.**) only gave a vague idea of the right time for spraying fungicides, but the experiments will be continued.

A method for testing resistance against stem rot revealed some differences among rape varieties, which we will try to reproduce.

Potato wart (**Synchytrium endobioticum**) (H. Mygind)

From the Danish Potato Breeding Station at Vandel 357 tuber samples were sent in to be examined for wart resistance. As in the previous years the samples were divided into three categories: (1) new varieties to be tested for the first time (screening), (2) 2nd, and (3) 3rd tests of varieties tested one or two times in the previous years. The percentage of wart attack in the three categories were: 19.8, 14.1 and 0, respectively.

Control experiment with potato wart (H. Mygind and A. Nøhr Rasmussen)

Dazomet was incorporated in the soil (60 grams Basamid per sq m) in September 1982, and a good effect was observed in 1983. The treatment was repeated in the autumn of 1983 where Basamid was incorporated twice: once by spreading 60 g Basamid per sq m, digging 25 cm and mixing with a prong to ensure an effect in the underlying layer of soil, a second time by adding 60 g Basamid per square metre and mixing with a hand cultivator. The double treatment was necessary because dazomet is only effective in the soil layer in which it has been incorporated.

The results showed very good effect of Basamid. In addition to this effect against potato wart it seemed to have an effect on the potato cyst nematode (**Globodera rostochiensis**) as no cysts could be seen on the roots of all the plants examined in the plot. The plot had previously been much infested.

Grey mould (**Botrytis cinerea**) in glasshouse tomatoes (H. Mygind)

In 8 tomato nurseries the relative humidity (RH), the nitrogen level in the plants, and the content of nutrient minerals as well as sugars were related to all registered attacks of grey mould in the plants.

No clear correlation could be found between the elements in question and the frequency of grey mould attacks. This was finally confirmed after the data had been submitted to computer analysis.

Healthy nuclear stock of ornamental potted plants (H. Mygind)

New collections of **Campanula isophylla** plants have been prepared; these originated from meristems. 32 pieces of stem basis from 6 clones were tested on PDA plates. They all proved to be free from the vascular fungus **Fusarium tabacinum.**

Furthermore, 87 pieces of stem basis from 28 clones of **Hedera helix** and 6 pieces from 2 clones of **Ficus pumila** were tested. All the tested plant material was free from any pathogenic fungi.

Diseases on sour cherry (Karen Jørgensen)

In the orchards the problems were caused by the following pathogens: Prunus necrotic ringspot virus, bacterial canker (**Pseudomonas mors-prunorum**), **Sclerotinia cinerea**, and **Blumeriella jaapi**.

Periods of susceptibility for bacterial canker was studied by inoculation, and the best methods for showing Prunus necrotic ringspot virus was tested.

Strangles and root rot in sugar beets (H. A. Jørgensen and Niels U. Mikkelsen)

The investigations of the two previous years were continued along the same lines. Root rot occurred most frequently on light soils where the pH was relatively low, and where sugar beets were grown frequently in the rotation.

It was established that the fungus **Aphanomyces cochlioides** occurs very often in Denmark and seems to be quite as usual a cause of root rot disease as **Pythium ultimum** on seedlings of sugar beets. **Aphanomyces** invades the plants near the crown and spreads from there into the seed leaves whereas the attack of **Pythium** is localized in the root tips and extreme parts of the side roots.

Like last year, soil samples from areas in fields with diseased and with healthy plants respectively were analysed for pH, texture, mineral content, etc., and the results were compared with information about rotations, fertilizer, sowing time, etc.

Trials with seed disinfected with Tachigaren in combination with some other fungicides were carried out in containers as well as in fields. The results did not show any significant difference between the different treatments.

Red core (**Phytophthora fragariae**) in strawberries (H. A. Jørgensen)

Infection experiments on **Fragaria vesca** were carried out in greenhouse with pure cultures of the fungus received from Sweden, England and Germany. Roots of diseased plants imported from Sweden were also used as inoculation material in order to provide plant material which could be used as basis for comparison by identification.

'Duncan's test', the British method of detecting the disease, was also tried out under greenhouse conditions on trap plants of highly susceptible strains of **Fragaria vesca.**

In the laboratory, pure cultures of **Phytophthora fragariae** were grown on different nutrient media in order to compare their morphological and biological characters.

Downy mildew (**Bremia lactucae**) in lettuce (H. A. Jørgensen)

Tests for the resistance of greenhouse-grown lettuce and iceberg lettuce to downy mildew were carried out on a smaller scale than the year before. The main purpose was to find cultivars with a good resistance, and at the same time to map out the physiological races present in this country.

New attacks of fungal diseases in 1982 and 1983 (H. A. Jørgensen)

Among the samples forwarded to the Botany Department for diagnosis of fungal attacks the following few plant species had attacks which have probably not been observed in this country before; and some other plant species were discovered to be acting as hosts for fungi which had till then been found on more usual host plants:

1982 **Aphanomyces cochlioides** Drechs. on **Beta vulgaris**
Phytophthora cinnamomi Rands on **Chamaecyparis lawsoniana alumii** and **Rhododendron spp.**
Peronospora polygoni (Halst.) A. Fisch. on **Homalocladium platycladum**
Cercospora caricis Dearn. et House on **Cyperus alternifolius**
Phoma crataegi Sacc. on **Pyracantha coccinea**
Phoma rodorae Cooke on **Rhododendron sp.**
Phyllosticta codiaei Died. on **Codiaeum sp.**

1983 **Pythium irregulare** Buis. on **Primula acaulis**
Phytophthora megasperma Drechs. on **Raphanus sativus**
Phytophthora porri Foister on **Allium porrum**
Cercospora consociata Wint. on **Aphelandra squarrosa**
Acrothecium carotae Arsvoll on **Daucus carota**
Fusarium semitectum Berk. et Rav. on **Dracaena marginata**
Phoma forsythiae Cooke on **Forsythia sp.**

Diagnostic work (I. G. Dinesen, H. A. Jørgensen and H. Mygind)

In the course of the year the Botany Department has received 574 plant samples for diagnosis of bacterial and fungal diseases. It was mostly a matter of horticultural plants.

Registration of scientific literature has taken place as in previous years.

V VIROLOGY DEPARTMENT, H. Rønde Kristensen

1. Experimental work

In the diagnostic work at the department the ELISA method has found increasing application, and immunoreagents (IeG and enzyme-conjugated IgG) have been made from several antisera. More than 3,000 samples have been examined by electron microscopy during the year.

The relationship between mild beet yellows virus, potato leaf roll virus, and beet western yellows virus has been examined by serological as well as host plant investigations.

The occurrrence of virus in cereals and grasses has been observed regularly; as yet, the barley yellow mosaic, which is found in several European countries, has not been detected in Denmark.

Investigations show that potato plants coming from cuttings are much more susceptible to aphids and potato leaf roll than plants from tubers.

The susceptibility/sensitivity of numerous potato varieties to rattle virus has been investigated for a number of years. The investigations show that about 25 per cent of the varieties examined are tolerant to the disease.

In connection with the potato propagation programme the Institute of Plant Pathology has a "bank" of pathogen-free potato varieties comprising at the moment 54 varieties.

Much of the time of the department has been taken up with the establishment of virusfree nuclear stocks of various horticultural plants - ligneous as well as herbaceous. Apart from the routine work, research has been done to examine the composition of growth media and other conditions of growth.

Investigations regarding various isolates of the tobacco mosaic virus have been continued, including seed transmission of virus in pepper.

In the area of ornamental plants the efforts have been concentrated on virus problems in pelargonium, begonia, **Euphorbia, Kalan-**

choë and **Aeschynanthus.**

Virus Diseases of Agricultural Plants (B. Engsbro)

Barley mosaic

In the spring of 1983 90 fields - mostly in the southern part of the country were inspected for symptoms of barley yellow mosaic, which is transmitted by the soil-borne fungus **Polymyxa graminis.**

The disease was not detected in any of the fields.

Tobacco rattle virus in potato tubers

Over the years the susceptibility to tobacco rattle virus of 366 numbered potato varieties and 84 named ones have been examined.

It turned out that about one fourth of the varieties are resistant and another fourth very tolerant to the disease.

Among the varieties with resistance or great tolerance are many of the new varieties and number varieties from the Agricultural Potato Improvement Station at Vandel, Denmark.

The susceptibility of transplanted potatoes to aphid-borne virus diseases

In tests in 1982 healthy potatoes were planted out as "rock wool cuttings" with two planting times, or planted as pre-sprouted tubers in 4 localities without any known sources of infection in the neighbourhood.

There was a light attack of potato virus Y at all 4 test localities. Potato leaf-roll occurred with very strong attacks at 2 research stations, weaker attacks at the third locality and unimportant attacks at the fourth place.

In the crop from the 'rock wool cuttings' there were 0.8 per cent tubers with virus Y in the cuttings planted latest, 1.4 per cent in those planted first and 2.9 per cent in those bred from tubers.

Potato leaf-roll was found in 1 per cent of the tubers grown from tuber plants planted early, in 9 per cent of the earliest planted 'rock wool cuttings' tubers and in 22 per cent of those planted latest.

Only in 1 locality a difference was found between early and later withering. The sprayings were planned to take place 20th-25th July and 1st-10th August, but because of the large quantities of aphids in July they should have been put forward till 15th-20th July.

In the case of potato virus Y the transmission has probably taken place from local infection sources early in the season, whereas the potato leaf-roll has probably been transmitted from far away through the compact attacks of aphids, which occurred in July.

At that time the sprouted early planted potatoes had already obtained a considerable resistance because of their age, whereas the cuttings were still at the susceptible young stage.

The potato meristem programme

The production of healthy meristem stocks of potatoes was started in 1977 as a basis for the future propagation programme. The assortment now comprises meristem cultures of 54 potato varieties, which are also kept in a "bank" at the Research Centre for Plant Protection as cuttings in test tubes.

Virus diseases in fruit trees (Arne Thomsen)

Apple meristem-tip culture

After growing for three weeks in fluid medium with 1.5 mg IBA per l, roots formed on the minicuttings of the apple root stocks EMIX.

Tests have been made with and without shaking of the medium during the rooting period. The two treatments did not result in any difference in the root development.

However, the plants look best (more green) in the case where the medium was shaken.

Virus diseases in fruit bushes (Arne Thomsen)

Black currants, meristem tip culture

By cultivating minicuttings of black currants in a medium containing 0.1 mg BAP and 0.1 mg IBA per litre, reproduction was obtained 12 times in 6 weeks.

Propagation of black currants

Material from the varieties 'Ben Nevis' and 'Ben Lomond' was examined and found free from virus.

In vitro propagation of red currant

Material from the variety 'Stanza' was tested in 1983 and found free from virus.

In vitro storing of strawberries

Meristem plants with roots of the strawberry variety 'Zephyr' was kept alive for 34 months both with and without light at 4°C.

Virus diseases in vegetables (Niels Paludan)

Diagnosis of different TMV isolates from ornamentals and pepper plants was carried out by means of indicator plants, comprising tobacco and pepper species, and the serological ISEM method.

The antigenes and antisera used included the TMV strains tomato (DK 87:55), tobacco common (ATCC 135), pepper 8, and pepper 11 (Rast and Maat) with the corresponding homologous antisera for the 3 last-mentioned strains.

The TMV isolates all reacted with local symptoms in **Nicotiana tabacum** 'Xanthi' and with systemic symptoms in **N.t.** 'Samsun', **N. clevelandii** and the sensitive pepper variety 'Hot Lips', respectively.

Typical reactions of TMV tobacco strain was achieved with one isolate from **Aeschynanthus**, while all the other TMV isolates reacted unspecifically. Some of these TMV isolates reacted like both tomato and tobacco strains in **N.t.** 'White Burley', and other strains serologically like both pepper strain 8 and the tomato or tobacco strains.

None of the TMV isolates reacted serologically with the pepper strain 11, and none of 10 more closely investigated isolates were infectious to pepper plants with the resistant genes L2 and L3, respectively.

However, 8 of these isolates were infectious to pepper plants with the resistant gene L1 (the variety 'California Wonder'), though only to a fairly small extent ranging from 1 to 4 of in all 5 inoculated plants. This together with the lacking infection of pepper plants with the resistant gene L2 indicates that these isolates are not identical with the pepper strain 8, even if some serological reaction was achieved.

It may be concluded that many of our ornamentals may act as latent hosts for partly unknown TMV strains and thus act as serious sources of infection to susceptible cultures.

<u>Seed from pepper plants infected with different TMV strains</u> was tested after 5 and 24 months, respectively. The virus concentration was unchanged in seed infected with the tomato, tobacco and pepper-8 strains, respectively, regardless of the harvest method. However, the virus concentration on pepper strain 11 was considerably reduced with fermented seed only.

TMV-infected pepper seed was subjected to chemotherapy in order to inactivate the virus. A 10 per cent trisodiumphosphate solution for 2 hours was the most effective agent on tomato, tobacco and pepper 11 strains, but only had a slight effect on the pepper 8 strain. In that case a 5 per cent sodium hypochloride solution was most effective.

The seed germination was least influenced when using trisodiumphosphate.

TMV infection of seed plants when testing seed leaves without seed coat was found, but only in plants from untreated seed infected by the tobacco and the pepper strain 11.

Infection experiments on the **Capsicum annuum** 'Novi' with the resistant gene L3 showed TMV resistance against pepper strain 11 and hypersensitivity to TMV pepper strain 8, killing most of the plants.

Virus diseases in ornamental plants (N. Paludan and A. Thomsen)

Aschynanthus hildebrandii

Tobacco mosaic virus was demonstrated in plants from 5 different collections. The TMV strains tobacco, tomato and pepper 8 were diagnosed by means of indicator plants and serology. The TMV strains occurred both as single and as complex infections.

Begonia elatior. Infection trial with a virus-like agent from the **Begonia** variety 'Nixe' causing vein clearing and leaf curl in symptomless meristem-tip plants has failed. Furthermore, an infection trial with a systemic strain of tobacco necrosis virus, in combination with the fungus **Olpidium brassicae**, to Begonia plants failed as well, although the fungus was found in the roots.

Another virus isolate from the **Begonia** variety 'Nixe' has been diagnosed. The virus only caused symptoms in **Chenopodium**, and by physical investigations it turned out to be a very stable virus. A positive serological (ISEM) reaction was achieved with antiserum against carnation mottle virus, whereas this was not the case with antisera against different viruses belonging to the groups ilar, nepo, tobanecro and tombus (26).

The presence of carnation mottle virus was furthermore established in a virus isolate from 1970 from **Begonia cheimantha** with flower break in deformed petals.

Meristem-tip plants from virus-infected **Begonia** have not shown any symptoms in 32 of 36 plants.

Begonia plants in tubes can be stored for 1 year at 9-12°C with 16 hours' illumination.

Campanula isophylla is easily infected by the fungus **Fusarium tabacinum.** In order to delay the infection risk as much as possible, meristem-tip plants propagated from cuttings in tubes were delivered direct to the Propagation Station. It was shown that the fungus grew readily on used media; so as long as the media are without contamination, the plants are estimated as healthy.

Flowering control of white and blue clones originating from meristem-tip plants did not show any change in their character.

Cotoneaster meristem tip culture

Meristem plants with roots from Cotoneaster have survived being kept in vitro at 4-8°C for 2 years and 2 months.

Daphne meristem tip culture

Tests have shown that Daphne mézereum develops better in vitro at 21°C than at 26°C.

Deutzia meristem tip culture

Meristem plants with roots from **Deutzia magnifica** have survived in vitro for 2 years and 7 months. The best survival temperature is 20°C.

Euphorbia pulcherrima

Inactivation trial has been carried out using heat-treated mini-cuttings. **Poinsettia** mosaic - and **Poinsettia** cryptic virus were inactivated in 16 and 1 per cent respectively after 5 months' treatment at 34°C, but not after 2 and 3.5 months.

<u>Kalanchoë spp.</u>

Infection trials with virus isolates from **K. blossfeldiana** and **K. daigremontiana** were carried out using sap and dry inoculation to **Chenopodium quinoa**. Virus transmission was achieved at all the testings carried out in the months of June, July, September and November, the sap inoculation from **K. daigremontiana** being the most favourable one.

Virus infection was demonstrated in 8 of 10 isolates, and serological reaction achieved with antiserum against the **Kalanchoë** virus 1 received from Dr. R. Koenig. Physical investigations of sap from local lesions in **Chenopodium quinoa** showed reactions typical for a Carla virus.

Inactivation experiments with several virus isolates were carried out using heat treatment and meristem-tip culture. Presumably, 4 out of 6 virus isolates have been increasingly inactivated during a prolonged heat treatment at 34°C.

Kalanchoë plants in tubes have been stored with good results for 1 year at 12°C and 16 hours' illumination.

<u>Pelargonium hortorum</u>

Infection trial with the variety 'Springtime Irene' was carried out in order to estimate the effect on leaf and flower symptoms. In the period from August to December, the pelargonium flower break virus (PFBV) caused a development of chlorotic spots in the younger leaves. At the same time, the virus caused leaf curl and chlorotic to yellow bands and streaks, but only in a few leaves. Furthermore, white streaks could be seen on the petals.

Double infection with PFBV and tomato ringspot virus increased the symptoms both in leaves and flowers.

It was possible to diagnose both of the viruses directly in **Pelargonium**, using either sap inoculation to **Chenopodium quinoa** or the serological ISEM method.

The nuclear stock collection comprises at the moment 18 **Pelargonium** varieties distributed on 34 clones.

Syringa meristem tip culture

Meristem tip cultures have been established in 1983 from **Syringa vulgaris** attacked by virus. No symptoms have been registered in the meristem plants.

Propagation

In 1982 the following valuable species and varieties of ligneous ornamental plants have been examined and found to be free of virus infection:

Acer pennsylvanica
Acer rubrum
Acer tegmentosum
Acer tschonoskii
Baccharis magellanica 'Baca'
Betula verrucosa 'Viby'
Cornus mas 'Macrocarpa' (I_2)
Deutzia 'Eburnea'
Deutzia magnifica
Euonymus 'large surface'
Euonymus 'Radicans'
Euonymus 'tall & sturdy'
Euonymus 'Vegetus'
Hippophae rhamnoides
Ligustrum vulgare
Ligustrum vulgaris 'Listrum'
Lonicera peryclymenum
Mahonia aquifolium'Magu'
Malus 'Makamik- (I_2)
Malus sylvestris
Prunus (I_2)
Rosa 'Ripollo'
Rosa pimpinellifolia low

Rosa pimpinellifolia 'Rofola'
Rosa pimpinellifolia tall
Sorbus alnifolia
Vaccineum vitis-ideae 'Vacmi'

Serology (Mogens Christensen)

Antisera and immunoreagents

In 1983 no new antisera have been produced, but partly for our own diagnostic work and partly for delivery to other institutions immunoreagents (IgG and enzyme-conjugated IgG) have been produced from the below-mentioned viruses for use with ELISA (Enzyme Linked Immuno Sorbent Assay):

Potato virus M, potato virus S, potato virus X, potato virus Y, beet western yellows virus, Prunus ring spot virus, barley yellow dwarf virus.

In connection with each virus several antisera were used.

Investigation concerning the relationship within the luteo virus group

By means of serology (the ELISA method) and various indicator plants (11 different plant species) investigations have been made to establish the relationship within the luteo virus group. Isolates of the following three viruses have been investigated: potato leaf-roll, beet mild yellows virus and beet western yellows virus.

It may be concluded from the results that the two latter viruses are closely related (possibly identical), whereas leaf-roll virus and the other two viruses are serologically distantly related.

Investigations have shown that cruciferous plants, especially rape, may be infected by beet mild yellows.

Electron microscopy (J. Begtrup)

During the year more than 3,000 individual samples have been analysed by electron microscopy using the ISEM technique. This is a considerable increase in the diagnostic work at EMLAB (the electron microscopic laboratory).

One reason is that it has now become possible to carry out EM analyses of trees and bushes and other plant species, where a high content of tannins previously made it impossible to produce specimens which could be used for examinations by electron microscopy.

This problem has been overcome by addition of 2 per cent polyethylene glycole (PEG) MW 6000 to the usual phosphate buffer (0.1 M, pH 7.0). Successful experiments have also been made with addition of other glycoles, for instance polyvenylpyrolidon, for precipitation of many of the disturbing substances. This has improved the serological reaction by ISEM analyses, so that a better decoration of the particles has been obtained.

Survey of new plants examined by electron microscopy in 1983

Plant species	Demonstrated directly in	Virus
Allium fistilosum	leaves	Shallot latent virus
Begonia elatior	test plant **Ch. quinoa**	Carnation mottle virus
Fragaria vesca	leaves	Strawberry virus C
Kalanchoë blossfeldiana	leaves	Kalanchoë virus 1
Pelargonium hortorum	flowers and leaves	**Pelargonium** mottle virus
Pelargonium hortorum	flowers and leaves	Tomato ringspot virus
Phlox borealis	test plant **N. clevelandii**	Tomato blackring virus
Prunus avium	flowers and new leaves	Prunus ringspot virus
Rosa sp.	leaf buds and leaves	Prunus ringspot virus
Rubus rubrum	leaf buds	Raspberry ringspot virus
Sambucus nigra	leaf buds and leaves	Elderberry virus A

2. New attacks of virus diseases 1983 (B. Engsbro, N. Paludan, A. Thomsen)

Viruslike symptoms were observed in the following species:

Buxus sempervirens
Hedera helix
Jasminum nudiflorum
Wistaria sinensis

Virus infection was detected in the following species:

Begonia cheimantha	carnation mottle virus
Begonia elatior	carnation mottle virus
Brassica napus (spring rape)	beet mild yellows
Caryopteris spp.	tobacco ringspot virus
Epimedium peraldianum	tobacco necrosis virus, strain A
Heliopsis scabra	potyvirus
Kalanchoë blossfeldiana	kalanchoë virus 1
Kalanchoë blossfeldiana	potyvirus
Pentas lanceolata	tomato ringspot virus
Phlox subulata	arabis mosaic virus
Phlox subulata, borealis,douglasii	tomato blackring virus
Rosa spp.	prunus necrotic ringspot virus
Rubus idaeus	arabis mosaic virus
Sambucus nigra	arabis mosaic virus
Schizostylis coccinea	bean yellow mosaic virus
Sinapis arvensis (charlock)	beet mild yellows virus

VI. ZOOLOGY DEPARTMENT, J. Jakobsen

Experimental work

Potato cyst nematode (**Globodera rostochiensis, G. pallida**) (J. Jakobsen and L. Monrad Hansen)

Identification of pathotypes of potato cyst nematodes (PCN) from gardens

The pathotype determinations of populations were continued in 1983. Among the 600 populations examined in 1982 30 were suspected of being another pathotype than Ro-1. Further examinations confirmed that one locality contained **G. pallida** (probably pathotype PA-3). The other populations with the exception of three gave few or no cysts on resistant cultivars. (One of the three gave 30 cysts on 65.346/19 and none on the others, one had 8 cysts on 'Frila' and none on the others, and finally one sample gave 9 cysts on 60.21.19 and one or two on the other cultivars.)

The stylet length of larvae developed on resistant cultivars was measured. For each sample 10 larvae from 3 cysts, i.e. 30 larvae in all, were measured. The results showed that such measuring of the stylet length was a reliable method of demonstrating the presence of **G. Pallida.** The average stylet length of **G. Pallida** was 25.6 whereas the other populations had average lengths varying from 21.1 to 23.7.

Corresponding measurements were carried out on the stylets of larvae from Ro-1 developed at 3 temperature levels in a test under conditions where the soil temperature could be controlled.

The measurements did not show any correlation between stylet length and temperature.

The importance of the soil temperature for the rate of development of potato cyst nematodes

Experiments showed that the temperature sum necessary for the development of potato cyst nematodes is lower at low than at high temperatures.

At a basis temperature of 6°C 231 degree-days went before white females could be seen on the roots at an initial temperature of 8°C. At an initial temperature of 12°C the corresponding figure was 312. The cultivar used was 'Bintje'.

Examination of soil samples from potato grading stores, etc., for potato cyst nematodes

To find out how widespread potato cyst nematodes are in the potato fields of Jutland A) the Grindsted grading store, B) potato-flour factories and C) the Danish Distilleries agreed to take out soil samples from the potato plots they received.

700 samples in all were sent in and examined for potato cyst nematodes in the usual way. Only 4 of the samples examined contained a few potato cyst nematodes.

In the case of some of the 700 samples it is possible to find out from what locality they come.

During the spring further samples will be taken from those fields to estimate whether the results from soil samples taken in the normal way agree with those from samples of soil clinging to the potatoes when they are handed in at the potato grading stores, etc.

Examination of soil samples from seed potato areas, etc., for potato cyst nematodes

About 6,300 soil samples from propagation areas were examined for the Government Plant Protection Service and the National Committee for the Propagation of Potatoes. Potato cyst nematodes were found in 1.2 per cent of the samples examined. This is an increase on 1982, where potato cyst nematodes were found in 0.6 per cent of the samples.

Testing new potato crosses for resistance

At the Vandel potato breeding station 6 tubers of about 225 cultivars were tested for resistance to Ro-1 and 50 cultivars for resistance to PA-2 and PA-3 respectively.

Cereal cyst nematodes (**Heterodera avenae** and **Heterodera hordecalis** (J. Jakobsen and M. Juhl)

Propagation of cereal cyst nematodes by one-sided crop cultivation

The propagation of cereal cyst nematodes in a long-term microplot experiment at the 'Borris' Research Station was negative in 1983 no matter whether the nematode-susceptible varieties were oat or barley.

At a property in Western Jutland, where widespread attacks of **Heterodera hordecalis** were seen in 1978, the density of the population in the individual fields was registered in the following period. Contrary to what is the case with **Heterodera avenae,** the number of **H. hordecalis** is reduced drastically (by more than 90 per cent) by cultivation of one single crop which does not act as host for this species of nematode.

Examinations concerning the influence of the winter temperature on the parasitizing of cereal cyst nematodes were continued. The results from 1983 confirm those of the previous years: high winter temperatures further the fungus parasitizing of the nematodes.

Nematode-parasitizing fungi

The investigations concerning fungal parasites on cereal cyst nematodes in an experiment with varying quantities of nitrogen were continued.

The experiment comprises 6 quantities of nitrogen with and without treatment with a fungicide. The population density of cereal cyst nematodes and the frequency of eggs and larvae parasitized by fungi is registered in spring and autumn.

On the whole, the results corresponded to those of the previous years. The propagation was least in the plots which had the biggest quantity of nitrogen and greatest in the part of the test area which was treated with Captafol. The parasitizing of eggs and larvae seems to correlate positively with the nitrogen quantity.

Contrary to the results of the previous years the population density went down in all plots in the course of the growing season of 1983. The decrease may be due to extreme weather conditions where an unusually heavy rainfall was followed by almost no rain in June and July.

Beet cyst nematodes (**Heterodera schachtii**) (L. Monrad Hansen and M. Juhl)

In a pest control experiment made by the 'Maribo' breeding station the density of beet cyst nematodes was determined.

In the autumn of 1981 the soil was treated with two doses of DD and Metam-Na. This treatment did not prevent the propagation of beet cyst nematodes in 1982 and 83, but gave a considerable increase in the yield in 1982, and the best of the treatments (500 l DD) also gave a considerable increase in the yield of beets in 1983.

In 1983 spring barley was grown in a number of the treated plots where beets had been grown in 1982. The spring barley also gave a significant increase in yield after the treatment of the soil.

New experiments with Metam-Na treatment were started in the autumn of 1983.

Formalin treatment of an area infested with beet cyst nematodes (M. Juhl)

Parts of an area used for propagation of beet cyst nematodes were treated with formalin in 1981 and 1982. The purpose of the treatment was to find out whether the formalin treatment would influence the propagation of beet cyst nematodes as is known from the cereal cyst nematodes. The density of beet cyst nematodes in the spring of 1982 in treated and untreated was 240 and 21 eggs per g of soil respectively. The corresponding figures in the autumn of 1983 were 390 and 12 eggs per g of soil respectively. It appears from the results that the formalin treatment resulted in an extremely high increase in the beet cyst nematode population. This effect should be ascribed to the fact that the nematode-parasitizing fungi are destroyed by the formalin treatment. Corresponding tests were made in 1983 in soil infected with potato cyst nematodes. The rate of propagation of that nematode species was not influenced by the formalin treatment.

Ditylenchus radicicola as a pest in lawn grass (J. Jakobsen)

In the late summer of 1983 samples were sent in from the Copenhagen Sports Centre to be examined for pests. It turned out that the grass had severe attacks of the grass rootgall nematode **Ditylenchus radicicola.** This species has not previously occurred as a pest in this country, but it has been found here and there on lyme grass in salt meadows. Among the samples examined most galls were found on the roots of annual meadow grass (**Poa annua**) - an average of 4 galls per plant. On red fescue (**Festuca rubra**) 2 galls were found per plant and on perennial rye grass (**Lolium spp.**) half a gall per plant.

The content of nematode eggs per gall also depended on the plant species. The highest number of galls was found on annual meadow grass with an average content of 150 eggs per gall.

Soil-inhabiting pests of sugar beets (L. Monrad Hansen)

Soil samples from 9 seed dressing and granulate tests were examined in collaboration with the sugar factories.

The compounds used were Promet, Ambush, Oncol, and Curaterr. Due to the scarce occurrence of soil-inhabiting pests and unusual growth conditions the results of these tests cannot be interpreted.

Investigations of soil samples from 6 tests with fungicides were carried out for the Danish Office for Crop Husbandry. At a collembola index of 12.0 some effect was obtained with Curaterr and

Promet.

The possibility of making a negative prognosis for the presence of collembola based on soil samples taken in the autumn was further investigated.

Soil samples from 27 fields were examined in the autumn and the spring.

Roughly speaking, the tests confirmed earlier results, so that the number of collembola was small in the spring in the fields where a small number of collembola had been found at the autumn examinations. However, 4 fields with low autumn numbers had fairly high numbers of collembola at the investigations in the spring.

Because of the rainy spring the investigations (which are made when the beets have 1 or 2 permanent leaves) took place 4 to 8 weeks later than usual. The late time of the sampling may have made a further propagation of collembola possible and may be the reason for the deviating results.

The investigations are continued in 1983/84.

Migrating nematodes as pests in beets ("Docking disorder") (L. Monrad Hansen)

Some fields on Funen with symptoms resembling "Docking disorder" were examined for the occurrence of the nematode genera **Trichodorus** and **Longidorus**.

Trichodorus was found only in one of the 3 fields examined - however, not in numbers which confirmed that it was an attack of "Docking disorder". The investigations will be continued in 1984 in fields with typical symptoms.

Registration of aphids in selected propagation areas (J. Reitzel)

Aphids were caught in different areas in Jutland. Twice every week the catches from 3 Moericke traps were sent in from the areas in question.

The purpose of placing 3 Moericke traps in each area in different regions of Jutland was (1) to find out the variation in the occurrence of aphids between the different fields, and (2) to establish whether it is necessary to have more than one tray trap to get a fair impression of the density of the aphid population. The results from 1983 showed that one trap per field was sufficient to give a reasonable idea of the aphid population, provided that the tray trap was placed in the standardized way. Besides, the test result showed that there was no unambiguous connection between the geographic position of the fields and the occurrence of aphids.

The investigations were made to have a better basis for deciding on the dates for the compulsory withering of seed potatoes.

Aphids in spring barley (J. Jakobsen, H. Scheller, O. C. Pedersen, F. Lind, L. Monrad Hansen)

In 1981 and 1982 Jens Danielsen, University of Arhus, was making studies for his thesis about registration methods for determining the density of aphid populations in spring barley. These investigations were continued in a nationwide grower-based registration programme for aphids in spring barley.

Contact to about 500 growers all over the country was established through the agricultural advisers.

The growers made weekly observations of aphids in spring barley from the beginning of June till mid-July.

This registration made it possible to estimate the need for control by means of a simple model containing a computer program, which would automatically write out instructions to the individual growers when the relevant figures had been entered.

1983 was characterized by fairly vigorous attacks of aphids in spring barley. In the southern parts of the country they came early and were seen in most spring barley fields. In western and northern Jutland the attacks occurred somewhat later and were less severe.

The grower registrations of aphids were of importance for the general warnings via the 'Plant Protection Newsletters', and most of the participating growers expressed satisfaction with the registration programme. Most growers profited from the regular observations of the aphid population, whereas the instructions received about control measures were of use only to part of the growers.

A statistical processing of the data collected in 1983 did not enable us to correlate the yield to a number of factors which we had beforehand considered important for the yield - such as time of sowing, use of fertilizer and aphid control. However, the lack of correlation may be due to the very special growth conditions in 1983.

The programme will be continued in 1984 where both aphids, mildew and rust will be registered. An effort will be made to double the number of participating growers so that the basis for a statistical analysis of the collected data may be improved.

The importance of ground beetles as predators on aphids in cereals (H. Scheller and P. Esbjerg)

Experiments were made with different types of traps, preservation fluid and densities of traps for catching beetles in a spring barley field. At the same time aphids were counted. The ground beetle species were dissected, and their gut content was examined for remains of aphids to get an impression of the importance of the individual species as aphid predators. The investigations showed that **Agonom dorsale** was the most efficient species, but the number of beetles belonging to that species was small compared with the ground beetle **Bembidion lampros** which is a fairly efficient predator on aphids.

By close analysis of the number and importance of the ground beetle species in the catch it was demonstrated that ground beetles may be of considerable importance as a restraining factor for the propagation of aphids in the early part of the growth season.

Semi-field method for determining the effect of pesticides on aphids (J. Jakobsen)

The efforts to develop a method for determining the effect of pesticides on aphids in cereals, which is independent of the natural infestation in the field, have been continued.

The method is based on cereals grown under uniform conditions in containers in a plastic-covered area. A certain number of aphids is introduced to each unit before or after treatment with insecticides. After treatment and introduction of aphids the density of the aphid population is determined at regular intervals, and the yield is registered.

In spite of an improved watering system a sufficiently uniform growth in the pots was not obtained, and it has not been possible to get a reasonably homogeneous propagation of aphids in the individual repetitions (4) of each treatment either.

Pests in oil-seed rape (F. Lind)

The reaction of various spring rape varieties to insect attacks were investigated. The experiments were carried out under semi-field conditions and comprised 6 varieties which were exposed to a certain quantity of blossom beetles. Five of the examined varieties increased the number of pods when attacked by blossom beetles, whereas the sixth variety 'Olga' had a striking decrease in the number of pods on the plants which were attacked. Although the plants were able to compensate for the blossom beetle attack by developing a larger number of pods, the attacks resulted in a decreased grain yield because the grain weight of the attacked plants was lower than those which had not been attacked, or because part of the pods were barren. However, there were great differences between the number of barren pods on the varieties examined.

The registration of pests in winter and spring rape was continued in co-operation with rape growers.

Compared with 1981 and 1982 the attacks of cabbage seed weevils and brassica pod midges in winter rape were moderate in 1983, whereas the pest attacks in spring rape were approximately the same as in the two previous years.

Flying activity and propagation of turnip moths (**Agrotis segetum**) in relation to weather conditions

In 1983 turnip moth males were caught by means of pheromone traps in 19 localities. In 3 of the localities detailed meteorological registrations were made by means of automatic measuring equipment.

The purpose of the registrations is to relate the catch of turnip moth males to the actual population density after corrigation for the weather, so that trap catches can be used for determining the damage threshold as well as registration of the flying activity.

The cutworm attacks were widespread due to the dry and warm weather in July. Based on the catch of turnip moths in pheromone traps farmers were advised to take control measures against cutworms on 3 occasions.

In areas where no control measures were taken the damage done by cutworms was considerable. For instance 60-90 per cent damage was seen in beetroot in sandy areas on Samsoe and 25-35 per cent damage was registered in carrots in Lammefjorden.

Experiment with the effect of virus and some pesticides on cutworms (P. Esbjerg)

In co-operation with the Zoological Institute, the Royal Veterinary and Agricultural University and the Institute of Pesticides a field test has been made with a baculo virus which is pathogenic to cutworms and with the insecticides permethrin, parathion and acephat.

Control of cutworms was tried in a redbeet field. The effectivity of the control was determined by counting 200 beetroots per plot. Of the pesticides used permethrin had the best effect, and the virus treatment had less effect than the pesticides.

The three pesticides in question were also tested in pots with radishes as test plants. In each pot a cutworm was put which was about to hatch (6th instar). 30 pots were used in each test stage. 24 hours after the cutworms had been put out, the pots were treated. None of the pesticides showed a satisfactory effect in this test, whereas satisfactory results were obtained with permethrin, where younger cutworms were used (3rd instar).

Pheromone traps for codling moths, pea moths, and plum moths (P. Esbjerg)

An Oecos pea moth trap sent in by the Nordisk Alkali Biokemi company was tested in a co-operation with the Institute of Pesticides, the Plant Protection Advisory Department at "Godthåb" and the Zoological Laboratory at the University of Århus. The trap was placed in 15 localities with two traps per field. Only 3 of the localities gave a catch of more than 20 pea moths per week, whereas catches were low at the other localities. The pheromone traps functioned satisfactorily as to the specific attraction of pea moths only.

Because of the small density of pea moths it was impossible to decide whether the English threshold values would be valid under Danish conditions.

Pheromone traps for codling moths, pea moths and tortrix moths received from the Hoechst company were also tested.

The codling moth traps have been tried before with satisfactory results. Consequently, they were set up at a number of localities on Sealand and Funen to assist in deciding the relation between trap catches and damage thresholds. However, the results from 1983 are of limited interest because only modest and late attacks by pea moths were registered.

The species of moths caught in the plum fruit moth trap must be determined before it can be said whether the pheromone is specific for the plum fruit moth.

Biological/integreated control of pests on greenhouse vegetables (L. Stengård Hansen

The experiments with biological control of aphids by means of the aphid gall midge **Aphidoletes aphidimyza** were continued. Experience shows that it is essential that the gall midges are put out while there are very few aphids in the greenhouse. However, it has proved difficult to register the first weak attacks of aphids. If the use of gall midges is based on the aphids observed, the aphid population may become rather dense before the gall midges are well established. To make up for this drawback precautionary measures should be taken, either by introducing gall midges and a species of aphids which does not attack the greenhouse culture in question or by putting out a small number of gall midges at 2 weeks' interval from the start of the growth season. The production of gall midge pupae in the growth season was about 10,000, partly for our own tests, partly for nurseries where they were interested in using this kind of control measure on their own.

Control of thrips by means of a predatory mite **Amblyseius mackenziei** has started. Production facilities for large-scale propagation of the predatory mite has been established, and predatory mites were set out in some cucumber nurseries with thrips attacks. These initial experiments showed that the predatory mites did limit the propagation of thrips, but they were introduced into too late in relation to the thrips attack, and the number was too small to keep up with the thrips attack.

Development of test methods for determining the effect of pesticides on selected beneficial species (L. Samsøe-Petersen)

The experimental work in order to develop a laboratory test method for determining the effect of pesticides on the rove beetle **Aleochara bilineata** was continued. Standard breeding of onion flies and rove beetles has been established, and standardized test conditions have been developed. Because of problems with diseases among the rove beetles it has not been possible to try out the test method so often that its reproducibility could be established. The work on developing the method and trying it for tests of pesticides on **Aleochara bilineata** will probably be finished by the summer of 1984. The work is financed by the National Agency of Environmental Protection.

Insecticide resistance of peach potato aphids (O. Carsten Pedersen)

In 1981 investigations were started to determine the insecticide resistance of populations of peach potato aphids. The investigations were based on sampling and collection of peach potato aphids in potato and beet fields as well as in greenhouses. In 1983 about 100 populations of peach potato aphids were examined, mainly from Lolland-Falster and Sealand. The numbers of resistant and non-resistant populations were equal, and few medium-resistant or highly resistant populations were found.

The investigations in 1983 were supported financially by the Sugar Mills, the Research Commission on Sugar Beet Cultivation, and the Beet Yellows Commission.

Propagation of certain noxious animals and assistance with testing pesticides on these species (J. Reitzel, P. Esbjerg, L. Samsøe-Petersen)

Laboratory cultures of thrips, peach potato aphids, whiteflies, colorado beetles, etc., have been established for test use. Special assistance was given to the Pesticide Research Institute in connection with the development of test methods for thrips, leafminers and colorado beetles.

Routine propagation of noxious and beneficial species

In connection with several of the investigations made by the the department there is a need for laboratory cultures of a number of noxious and beneficial species of insects and mites.

To meet this need a buildup of new propagation facilities has been started, so that such propagation of many species can become a matter of routine. This will ensure strict species isolation and hygiene, and the possibility of meeting requests 20 different species at any time.

B. PESTICIDE RESEARCH INSTITUTE

I. DIRECTORY

Director of Institute

E. Nøddegaard

Scientific staff:

Bent Bromand

Insecticides for agricultural purposes

Kirsten Junker*)

Fungicide resistance in plant pathogens. Occurrence and importance of powdery mildew and snow mould in cereals

Bent Løschenkohl

Fungicides for control of diseases in oil seed rape, potatoes, beets, peas and vegetables

Bent J. Nielsen

Fungicides for control of diseases in cereals, maize and grassland

Steen Lykke Nielsen*)

Reduction in the use of pesticides by changing dose and spraying time for apple trees and black currants

A. Nøhr Rasmussen

Fungicides, insecticides and nematicides for greenhouse and nursery purposes

E. Schadegg

Fungicides and insecticides for fruit growing and gardening purposes, secretariat, List of Approved Products

*): Paid by means of special

II. GENERAL SURVEY, by E. Nøddegaard

The Agricultural Chemicals Approval Scheme

The Institute of Pesticides carries out trials and investigations to obtain a sufficient basis for approval of pesticides and plant growth regulators. Further, the institute carries out evaluation of data for efficacy in connection with the registration of pesticides and plant growth regulators by the National Agency of Environmental Protection.

The approval scheme

The scheme is carried out in accordance with an agreement between the Ministry and Agriculture and the Danish Agrochemical Association as the representative body of the agrochemical industry.

With effect from January 1, 1984, the agreement is changed on the following points:

The results of the testing, which were formerly given confidentially to the companies, may now be used in accordance with the provisions of the Marketing Act.

A registered mark can now be used by the chemical companies on labels, in advertisements, leaflets, etc., of approved pesticides and growth regulators, and it will be used by the Danish Research Service for Plant and Soil Science when mentioning the approved chemicals.

The time-limit for application for all agricultural chemicals is now February 1 with the exception of fungicides for winter crops, where the time-limit is August 15.

The test fees have at the same time been increased by about 30 per cent, and new payment regulations have been introduced.

Products with satisfactory efficacy are entered into the list of "Pesticides and plant growth regulators approved by the Danish Research Service for Plant and Soil Science for control of plant diseases, pests and weeds, for withering of seed crops and potato haulm and for growth regulation".

The list of approved products is revised annually out in January. A list of additions and amendments is issued in April. Only products registered by the Environmental Protection Agency for use according to the approval may be entered into the list.

The Evaluation Scheme

In connection with the registration of pesticides and plant growth regulators by the National Agency of Environmental Protection and arising from the Ministry of Environment's Act No. 212 of May 23, 1979, on Chemical substances and Products, the Institute carries out evaluation of data for clearance for efficacy of pesticides and plant growth regulators.

Efficacy data and other information needed for registration are sent by the chemical firms to the National Agency of Environmental Protection, who forward the efficacy data to the Pesticide Institute.

After evaluation of the data the Institute reports to the Agency whether or not the results can be considered sufficent to fulfill the requirements for efficacy in connection with registration by the National Agency of Environmental Protection.

The efficacy data required can be from trials carried out either by official agencies or by chemical firms. It does not have to be from trials carried out in Denmark, but can be from other countries, whose climate and agricultural practices are similar to those of Denmark.

Old products

The classification of pesticides made by the Toxicological Board shall remain valid until January 1, 1986. After this date pesticides shall be sold by manufacturers or importers only if they have been registered by the National Agency of Environmental Protection.

In connection with the registration of the products the efficacy also has to be evaluated. In accordance with an agreement between the Agency and the Research Centre for Plant Protection this re-evaluation is also carried out by the Pesticide Institute.

Experimental work

III. AGRICULTURE

Spraying against stem and leaf diseases in cereals (Bent J. Nielsen)

Eyespot (**Pseudocercosporella herpotrichoides**)
When the investigations were started in April, 65 per cent of the tillers were attacked by the eyespot fungus. Spraying took place at stage 6, and the results were estimated in July where the level of attack in untreated had fallen to 41 per cent. The average effect of compounds with carbendazim or benomyl was only 26 per cent, whereas the efficacy of prochloraz was about 77 per cent. The best effect was obtained with a mixture of carbendazim and prochloraz, where the efficacy after spraying was 83 per cent. In spite of heavy attacks the eyespot did not influence the yield so much because of very fine weather conditions before the harvest.

For several years a decreasing effect has been seen after spraying with benzimidazol compounds (carbendazim, benomyl). In co-operation with the Botanical Department samples have been taken from a large number of wheat fields which are tested for resistance to carbendazim.

Leaf blotch of wheat (**Septoria tritici**). Contrary to previous years glume spotch (**Septoria nodorum**) only occurred in weak attacks, whereas moderate to heavy attacks were seen of leaf blotch because of the wet spring.

The tests showed good control after spraying with propiconazol and prochloraz + mancozeb, triadimefon + captafol and fenpropimorph + chlorothalonil. Triadimefon and triadimenol had a good effect on speckled leaf blotch in two experiments.

Yellow rust (**Puccinia striiformis**). Yellow rust occurred with very heavy attacks in the varieties Vuka and Anja. Propiconazol, triadimefon, triadimenol, fenpropimorph, fenpropimorph + chlorothalonil and diclobutrazol + fenpropimorph had a good effect after spraying at the start of the epidemic.

Powdery Mildew (**Erysiphe graminis**) in wheat. Mildew occurred in several experiments with moderate attacks. The effect of the compounds was as mentioned under yellow rust. However, there was a longer effect after spraying with triadimenol and fenpropimorph + chlorothalonil than after other compounds.

Powdery mildew (**Erysiphe graminis**) in barley. The effect of the compounds in barley against mildew was more or less as in wheat. In one experiment the efficacy of tridemorph and ethirimol was good, whereas the effect of sulphur and sulphur + thiram only lasted for a short time.

Net blotch (**Drechslera teres**) in barley. In June heavy attacks of net blotch were seen in several winter barley experiments. Of the compounds tried only propiconazol and prochloraz had a good effect. In spring barley the attacks were moderate, and a good effect was obtained with compounds containing propiconazol, prochloraz and to some extent chlorothalonil and pyrazophos.

Leaf blotch (**Rhynchosporium secalis**). Some attacks of leaf blotch were seen in winter barley, but in the experiments the attacks were to some extent overshadowed by the more vigorous attacks of net blotch. The best effect was seen after treatment with propiconazol and prochloraz. A good effect was also found after treatment with triadimenol and fenpropimorph.

Seed treatment of cereals (Bent J. Nielsen)

Seed treatment against stripe smut (**Urucystis occulta**) of rye and bunt (**Tilletia caries**) of wheat

On the whole the effect against stripe smut of the tested compounds was good (carbendazim, bitertanol, triadimenol, metfuroxam and furmecyclox).

However, the effect of compounds with carbendazim and furmecyclox was less good against bunt of wheat. Compounds containing triadimenol and metfuroxam had a slightly weaker effect at smaller dosages.

In experiments with overdoses in wheat, reduced emergence could be seen after seed treatment with compounds containing triadimenol, furmecyclox, metfuroxam and bitertanol.

Leaf stripe (**Drechslera graminea**). Of the fungicides (triadimenol, imazalil, fuberidazol) tested in spring barley it was found that Baytan bejdse IM, Sportak bejdse (prochloraz), Arbusan U (metfuroxam, imazalil, thiabendazol) and EK 182 (prochloraz, furmecyclox) had a good effect at normal dosage.

Loose smut (**Ustilago nuda**) of barley. Only after treatment with Arbosan U (metfuroxam, imazalil, thiabendazol) and Baytan bejdse IM (triadimenol, imazalil, fuberidazol) was a sufficiently good effect obtained, whereas compounds with pure imazalil or prochloraz were inadequate.

Treatment against fungal diseases in potatoes, root crops, industrial crops and vegetables grown outdoors (Bent Løschenkohl)

Seed treatment of winter rape, spring rape and peas

7 compounds have been tested in winter rape in full and half strength and +/- Sachrust. No difference was found in the germination

capacity. There were no diseases except a mild attack of downy mildew (**Peronospora destructor**).

In spring rape 6 compounds have been tested in full and half strength and +/- Sachrust in 5 field tests. There were no attacks or differences between the compounds.

6 compounds have been tested in normal dosages +/- Sachrust in 3 field tests. There was no difference between the compounds.

Treatment of potatoes against black scurf (**Rhizoctonia solani**)

9 compounds have been tested in 2 fields tests. At early planting the sprouting was 10-20 per cent better, but there was no effect at normal planting. Rovral 50 WP and Monceren gave increases in yield of about 25 per cent. There was no attack of black scurf in the crop.

Spraying of rape against fungal diseases

7 compounds have been tested in 1 experiment with treatment against **Phoma lingam**, and 7 compounds in 4 experiments with treatment against dark spot (**Alternaria spp.**). No attacks were registered except from 2 tests with attacks of dark spot. The experiment did not show any difference in yield between the treatments.

Spraying of potatoes against late blight (**Phytophtora infestans**)

9 compounds have been tested in 3 experiments with two varieties each. Ridomil MZ 63 WP had the best effect with about 100 per cent increase in yield at heavy attacks. Sandofan M8 (SAN 371 F 8 per cent, mancozeb 56 per cent) and Patofol (ofurace 6 per cent, mancozeb 64 per cent) had the same effect as Ridomil MZ 63 WP.

In 3 tests with optimum time spraying, the effect was considerably better at 2 sprayings with Ridomil MZ 63 WP than at 6 sprayings according to requirement with Manacol.

Spraying of cepa onions against blight of onions (**Peronospora destructor**)

4 compounds were tested in 5 experiments. In the dry summer there were no attacks of blight and only one weak attack of grey mould (**Botrytis sp.**) in one of the experiments. No influence of the spraying was registered.

Spraying of peas against fungal diseases

3 compounds were tested in 2 experiments. There were no attacks, and no influence of the spraying was registered.

Pests in agriculture and outdoor vegetables (Bent Bromand)

Bird-cherry aphid (**Rhopalosiphum padi**), rose-grain aphid (**Metopolophium dirhodum**), and grain aphid (**Sitobion avenae**) in barley and wheat

A number of synthetic pyrethroids and a new formula of phosalon were tested in 3 experiments in spring barley and 3 in winter wheat. In barley an increase in yield of 4-8 hkg per ha in grain was obtained, and in wheat the increase in yield was 8-11 hkg per ha with heavy attacks of aphids. With several of the pyrethroids there was a clear reduction in the number of aphids after 4 weeks. The trials were only sprayed once.

Aphids in potatoes (**Aulacorthum solani**) and other species

Experiments were made with spraying against aphids with pirimicarb, fenitrothion as well as 3 pyrethroids. The aphid attack was not very heavy. All the compounds showed very fine effect at counts after 2 weeks.

Frit flies (**Oscinella frit**) in maize and undersown grass

2 experiments with incorporation of granulates and spraying were

carried out in maize. The attacks were weak, and therefore the registered effect was small, which may be due to late sowing because of wet weather.

In undersown grass 3 experiments were made with spraying 1 week after harvest of the cover crop. Because of the dry summer there was very little regrowth in two of the trials and the registered effect of the treatment was very small.

In the last experiment - with irrigation and good regrowth, the attacks were reduced from 10 per cent infested shoots in untreated to 0.2-1.5 per cent in treated stages. 5 synthetic pyrethroids were used for the experiments.

Pea aphids (**Acyrthosiphon pisum**) and pea moths (**Cydia nigricana**) in peas

The expanding pea area has led to an increased interest in control of pea aphids and pea moths. 3 spraying experiments were made, 2 of which showed heavy attacks of both pests. Spraying took place after pea moths had been caught in pheromone traps. The aphid compounds pirimicarb and demethon -S- methyl as well as 4 synthetic pyrethroids and fenitrothion were tested. All the compounds had a very good effect against aphid attacks, but pirimicarb and demithon -S- methyl did not have any effect on the attack of pea moths, and fenitrothion had a moderate effect on pea moths. It looks as if the longer effect of pyrethroids are of essential importance.

Blossom beetles (**Meligethes aeneus**), cabbage seed weevils (**Ceutorrhynchus assimilis**) and brassica pod midges (**Dasyneura brassicae**) in rape

The experimental work on synthetic pyrethroids was continued. Generally pyrethroids had a very good effect on the three pests mentioned. Only fluvalinate was a little less effective. A new formula of phosalon has not been sufficiently effective.

Spinach leaf miners (**Pegomya hyoscymi**) and bean aphids (**Aphis fabae**) in beets

2 experiments with rather different results were carried out. After the wet spring and the subsequent drought, the test area was very inhomogeneous, and the results must be treated with some caution. Several phosphorous compounds and synthetic pyrethroids were included in the experiment. Generally, the pyrethroids seemed to have slightly less effect on the spinach leaf miners than the phosphorous compounds.

Soil-borne pests in sugar beets

Together with the Danish Sugar Mills and the Zoological Department experiments were made with seed treatment and incorporation of granulates against soil-borne pests, such as nematodes, collembola, pigmy mangold beetles, wireworms, etc. Proper registration of the results could only be made of collembola, where carbofuran granulate had better effect than furathiocarb treatment. A later survey of the attacks by spinach leaf miners and bean aphids gave the same result.

Seed treatment against flea beetles (**Phyllothreta spp.**) in rape

5 experiments were carried out in the spring, but because of the late and wet spring no attacks of flea beetles were seen. The experiments were carried out with full and half dosages as well as with and without Sachrust treatment. The sprouting figures were noted, but the results varied too much for any certain conclusion to be drawn.

Incorporation of granulate against carrot flies (**Psila rosae**) and cutworms (**Agrotis segetum**) in carrots

The pest attacks were relatively weak in the experiments with chlorfenvinphos, diazinon and carbofuran. In one experiment the attacks of both pests were reduced by about 50 per cent by all compounds, and yield increases of 15-30 per cent were obtained.

Incorporation of granulate against onion flies (**Delia antiqua**)

Only weak attacks of onion flies were registered. Thus the results were few and uncertain.

Control of the cabbage root fly (**Delia brassicae**) in cauliflower

A new way of controlling the cabbage root fly was tried. Cabbage plants were treated at the true 3-4 leaf stage and transplanted 3 weeks later. Most suitable is non-systemic chemicals, which adhere to the cortex of the roots and later prevent the larvae of the cabbage root fly from entering the roots. Chlorfenvinphos reduced the propagation of the cabbage root flies to one fifth, while the results with oxamyl and acephat were less promising.

Control of the cabbage root fly (**Delia brassicae**) by means of egg traps

The egglaying of cabbage root flies was registered by means of egg traps at Arslev, Skælskør and at Virumgaard. An egg trap consists of a felt roll which has been glued together at the bottom and then cut up at the side. The roll is placed round the stem of a cabbage plant, so that it fits tightly. The cabbage flies will then lay their eggs between the felt layers. After removal of the egg trap and opening of felt roll the cabbage root fly eggs can easily be counted.

The experiment showed that the egg-laying of the 1st generation took place from mid-May to mid-June. The 2nd generation laid eggs from 20th July till 20th August. The egg-laying curves are a fairly certain indication of when control measures should be taken.

Laboratory experiments with control of the colorado beetle (**Leptinotarsa decemlineata**)

Adult colorado beetles were sprayed in a pressurized spray tower (a Potter Tower) with various concentrations of a number of insecticides, and the mortality of the bettles was noted. Parathion, fenitrothion and Zolone were described as unsuitable. Gusathion 50 and Ambush could be used at increased dosages, and Birlane 24 EC, Ripcord, Decis and Sumicidin 10 FW had a very good effect.

Procuring samples for residue analyses

The following number of samples were taken for residue analyses: Wheat: 16, spring rape: 34, undersown grass, 56 and Chinese cabbage 44.

IV. HORTICULTURE (E. Schadegg)

Fungal diseases

Apple scab (**Venturia inaequalis**). 1983 was the third year of testing approved products against apple scab. As in previous years there was a very serious scab infection in 1983. The results obtained were almost the same as in the 2 previous years, new compounds like Rubigan, Baycor 25 WP and Topas C 50 WP had the best effect. Sulphur compounds and benzimidazols were least effective. Thiram had a slightly better effect in the Spartan variety where the scab infection was not so pronounced.

Apple powdery mildew (**Podosphaera leucotricha**). A number of compounds representing the various types of compounds approved for use against apple powdery mildew were compared in the approved dosage. Bayleton 5 WP, Rubigan and Topas C WP were significantly better than the sulphur compounds. Benomyl, binapacryl and Plondrel were less effective than sulphur compounds in this experiment, but the difference was not significant.

Pear scab (**Venturia pirina**). The attacks of pear scab were very moderate. The best effect was obtained with Orthocid 83 and Topas C 50 WP.

Leaf rollers (**Torticidae**). A number of compounds, especially pyrethroids, were tried against leaf rollers. Cyfluthrin was best in both trials, and permethrin had least effect. Azinphos-methyl had a good effect in the experiment where the larvae were small (5-10 mm) at the time of spraying, whereas the effect was less good in another experiment which was carried out with big larvae (20-25 mm).

Green apple aphids (**Aphispomi**). Experiments with control of apple aphids were carried out in newly planted trees and older trees. They were sprayed with 3 dosages: normal, half and double. The assessments were made just before spraying, and 1 and 4 days after the spraying.

The effect of Zolone F10 and DLG Dimethoat 505 was nearly the same as the effect of the reference product Meta-Systox.

Fruit tree red spider mite (**Panonychus ulmi**). A number of new compounds were compared with approved compounds. Cropotex, which has an influence on the molt, was one hundred per cent effective when used 10 days before hatching. When used after 80 per cent of the winter eggs had been hatched, the effect was considerably less good. When spraying took place after all the eggs had been hatched, the effect 4 days after the spraying was only 40 per cent. However, 15-20 days after the spraying the effect was 100 per cent.

The compounds Mitac and Danitol 10 FW had a slow effect, but 21-28 days after spraying the trees were free from mites.

Cybolt and Sumicidin were up to 100 per cent effective 3 days after spraying.

Reduced pesticide application for fruit growing (Steen Lykke Nielsen)

The project started in 1983. Work was done on apple scab and blackcurrant gall mites.

Experiments were made with combinations of various quantities of liquid and dosages of captan to try out a hypothesis that the dosage may be reduced if the quantity of liquid is reduced. A method of spraying with a fluorescent dye was employed. This method gives information about the deposit, the number of droplets per leaf area unit, and the average droplet diameter. The results clearly showed that the effect of captan on apple scab went down with a decreased dosage. As to the quantities of liquid the results were not unambiguous. Thus the results obtained until now cannot be said to confirm the above-mentioned hypothesis.

Blackcurrant gall mites. The migration of the mites was observed. The mites appeared from the galls in mid-May corresponding to the time of flowering of the blackcurrant plants. Living mites were found in old galls right until the beginning of July.

Spraying experiments were made with two systemic compounds to find out whether the mites can be controlled inside the galls and whether the sprayings should be placed after harvest to reduce or avoid residue contents in the currants. Oxamyl and methomyl wee used, and the effect was compared to that of the standard compound, endosulfan, which is a contact compound. The figures showed that the blackcurrant gall mites cannot be controlled by means of systemic compounds in the galls, and that spraying after harvest does not have any effect on the mites. However, the experiments showed that oxamyl and mathomyl had a contact effect on the mites which was at least as good as the effect of endosulfan.

Fungicide resistance of plant pathogenic fungi (Kirsten Junker)

In 1983 the Research Council project "Fungicide resistance of plant pathogenic fungi, especially occurrence and importance in mildew and snow mould" was started.

To examine the resistance of mildew against ergosterol-inhibiting fungicides, tray traps with barley plants treated with fungicides were placed in fields. The seed of the plants had been treated with increasing quantities of triadimenol, fenpropimorph and ethirimol. No mildew with resistance against the 3 active ingredients was found in the experiment.

Attacks of **Gerlachia nivalis** were examined on wheat grains partly from the 1982 harvest, and partly from the 1983 harvest. 2700 wheat grains from 1982 were examined, and 2 per cent turned out to be infected. 68 per cent of the isolates which were tested on agar containing carbendazim were able to grow with very high concentrations (the minimum inhibiting concentration (MIC) was more than 1000 ppm). Of the 1983 harvest about 10,000 wheat grains from

23 experiments were examined. The attack of **Gerlachia nivalis** was very weak, and isolation of the fungus was only possible from 1 per cent of the grains.

V. NEW PESTICIDES TESTED IN 1983 (E. Schadegg)

In 1983 the Pesticide Research Institute evaluated a total of 184 compounds, including reference compounds, in 171 experiments. 107 were fungicides and 77 were insecticides. 16 of them were fungicides and 6 were insecticides for seed treatment of cereals, other seeds and potatoes, and 4 were insecticide granules.

The pesticides mentioned below have been approved by the State Research Service for Plant and Soil Service:

Brown rust (**Puccinia recondita**) of wheat:
Bayleton 125 EC, Baytan 250 EC, Tilt 250 EC, Corbel Star, Bayleton 25 EP, Corbel

Brown rust (**Puccinia hordei**) of barley:
Bayleton 125 EC, Baytan 250 EC, Tilt 250 EC, Corbel, Corbel Star

Frit flies (**Oscinella frit**) in maize, cereals and grass
Sumicidin 10 FW, Cymbush

Winter moths (**Cheimatobia spp.**):
Baythroid, Sumicidin 10 FW

Fruit tree red spider mite (**Panonychus ulmi**):
Cropotex, Cybolt

Snow mould (**Fusarium spp.**) in spring barley:
Arbosan U, EK 182

Blossom beetles (**Meligethes aeneus**):
Baythroid, XN 100

Gloeosporium rot on apples:
Topas 50 WP

Grey mould (**Botrytis cinerea**) on strawberries:
BAS 43603 IF, Topsin

Grey mould (**Botrytis cinerea**) on blackcurrants:
Rovral 50 WP

Yellow rust (**Puccinia striiformis**) in wheat:
Bayleton 125 EC, Baytan 250 EC, Tilt 250 EC, Corbel, Corbel Star

Strawberry tortrix moth:
Ripcord

Potato cyst nematodes (**Globodera rostochiensis**):
Vydate L, Basamid granule, Di-Trapex

Potato blight (**Phytophthora infestans**):
Ridomil MZ 63 WP

Leaf rollers (**Torticidae**):
Baythroid, Sumicidin 10 FW

Eyespot (**Cercosporeslla herpotrichoides**) in winter crops:
Sportak 45 EC, Delsene 75 WP, Derosal Fl.

Powdery mildew (**Erysiphe graminis**) in cereals :
Bayleton 125 EC, Baytan 250 EC, Corbel Star

Powdery mildew (**Erysiphe spp.**) in ornamentals:
Baycor 300 EC

Whitefly larvae (**Trialeurodes vaporariorum**):
Appland

Loose smut (**Ustilago nuda**) in spring barley :
Arbosan U

White rust (**Puccinia horiana**) in chrysanthemum and hyperica :
Baycor 300 EC, Plantvax 20, Saprol

Brassica pod midge (**Dasyneura brassicae**):
XN 100, Baythroid

Cabbage seed weevil (**Ceutorrhynchus assimilis**):
XN 100, Baythroid

Leaf strip (**Drechslera graminea**) in spring barley :
Arbosan U, EK 182

Black spot (**Diplocarpon rosae**) in outdoor roses :
Baycor 300 EC

Green apple aphids (**Aphis pomi**):
Zolone Flo, DLG Dimethoate 505

Powdery mildew (**Podosphaera leucotricha**):
Topas 50 WP

C. PLANT PROTECTION ADVISORY DEPARTMENT, GODTHAB
Låsbyvej 18, 8660 Skanderborg

Head: A. From Nielsen

Scientific staff:
Johs. Bak Henriksen
Søren Holm
J. Simonsen

The department was established in 1979 in order to initiate a closer co-operation within plant protection between the National Agricultural Research Council and the National Committee on Crop Husbandry. The main aims are extension of service in plant protection and testing of pesticides for use in agriculture. These aims are carried out in close co-operation with the staff of the National Department of Crop Husbandry within this area.

Experimental work

Resistance of potato late blight to metalaxyl (S. Holm)
In 1983 only few isolates were tested. The isolates were collected from fields with unsatisfactory effect of metalaxyl.

The laboratory test showed normal sensitivity of all isolates.

Warning for potato late blight (S. Holm)
Based on the negative prognosis and the blitecaster, warnings were released on July 5 and August 2. The blitecaster recommended 4 (5) sprayings in varieties for starch production.

Cnephasia spp. on peas (S. Holm)
Attacks were common in 1983. Investigations of single pea plants showed that attacks before flowering reduced the number of pods by about 40 per cent. Furthermore, it was shown that attacks on the

main shoot had no influence on the development of pods from secondary shoots.

Shootflies in grass (S. Holm)

Investigations concerning the flying time in relation to the sum of temperature have been carried out in order to improve the warning service.

Field experiments have been concentrated on testing various control measures in grasses and in winter wheat.

Diamond-back moth (**Plutella xylostella**) in spring rape (J. Simonsen)

An estimate of the damage by these larvae was made in a heavily infested field.

With 30-40 per cent damaged plant surface, the yield reduction was 15-20 per cent.

The degree of damage and the yield reduction in single siliqua were compared. With 25-50 per cent surface damage the yield was 20 per cent lower than in undamaged.

Defoliation and soft rot during storage of potato tubers (J. B. Henriksen)

Haulm of the varieties Hansa and Bintje was desiccated on three different dates. Tubers were lifted on two dates, and part of them were stored at 4°C, others at 12°C for the first two weeks ("cured") and then at 4°C. Most bacterial soft rot developed in the control lots lifted at the earliest date and stored uncured.

With early lifting, curing at 12°C reduced the amount of tubers infected by rot. With late lifting curing increased soft rot among tubers of the Hansa variety.

Method of lifting and infection of potato tubers (J. B. Henriksen)

Potato tubers harvested in the autumn of 1982 by two-stage harvesting, potato combiner, or by potato combiner followed by grading at harvest were planted in the field in 1983. The number of blackleg-infected plants and weak plants was smallest when lifted by two-stage harvesting, and highest when lifted with potato combiner + grading.

In the storage season 1983-84 the percentage of tubers with visible damage after peeling and rot-infected tubers was smallest when lifted by two-stage harvesting, and highest when lifted by potato combiner + grading.

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