A REPORT PREPARED FOR THE

HORTICULTURAL DEVELOPMENT COUNCIL

A STUDY OF RESEARCH WORK ON DISEASE PROBLEMS OF PROTECTED CROPS IN HOLLAND

AUTHOR

Dr G M McPherson

Department of Plant Pathology

MAFF/ADAS

Leeds

REPORT ON A VISIT TO THE NETHERLANDS

16-22 MAY 1988

OBJECTIVES OF THE VISIT

To establish and develop contacts with Plant Pathologists at Naaldwijk, Wageningen (IPO) and Aalsmeer, and to discuss the current disease situation, control strategies and research on protected crops.

SUMMARY OF FINDINGS

1. 50% of research funding at Naaldwijk is raised by a levy of 0.2% on returns from the Grower Association Auctions.

2. The advisory service is entirely government funded at present; it is considered that commercial funding will be encouraged within the next few years.

3. Lettuce are sampled 10 days before cutting and screened for residues of all pesticides used on the crop; harvesting is delayed if high levels are found.

4. Soil sterilisation with methyl bromide is no longer widely practiced. Its use is restricted to certain crops and under specified conditions. The Government aims to eliminate all remaining uses within 5 years.

5. Pollution of waterways by fertilisers and pesticides in run-off rockwool solution is causing great concern. High priority has been given to the development of an effective re-circulating system. Heat, ozone and ultra-filtration are regarded as the main contenders for sterilisation of re-circulating solution.

6. Botrytis is not a problem in most protected crops, probably due to improved control over the glasshouse environment.

7. Botrytis resistance to dicarboximide fungicides is uncommon. The use of formulated fungicide mixtures (eg vinclozolin + thiram) may account in part for this difference compared to the UK.

8. Fusarium crown and root rot of tomatoes has increased from a low incidence in 1987 to become a major problem in 1988. Infection most probably occurred during propagation or at planting out. Disease spread was greater in soil-grown crops than in rockwool crops. Hygiene, fungicides, biological control agents and resistant rootstocks and cultivars are all being investigated as control measures.

9. Tomato powdery mildew occurred for the first time in Holland in 1986 and spread rapidly over the country in 1987, affecting many crops. Several fungicides currently give good control.

10. Milk is used to reduce spread of TMV in sweet peppers.

11. Yellow vein virus of sweet peppers is probably common though not serious in Holland.

12. A fusarium fruit and stalk rot is affecting some crops of sweet peppers; the species has not been identified.

13. Lettuce growers have switched to cultivars containing R genes 6, 16 or 18 since the occurrence of metalaxyl resistance in Bremia lactucae. Growers also use metalaxyl + zineb (Ridomil Zeta) and fosetyl-Al (Aliette) against lettuce downy mildew. The combined R gene strategy with fungicide use has proved effective.

14. Basilex is recommended as a post-planting spray for control of lettuce bottom rot.

15. Cucumber black stem rot (Mycosphaerella bryoniae) is strongly influenced by glasshouse climate. Practices to reduce high relative humidity and condensation on plants have been widely adopted by growers in Holland.

16. Fruit infection rather than stem lesions or shoot death, is the main cause of loss due to black stem rot in Holland. Internal fruit infection can be reduced from 5% to 1% by appropriate control measures.

17. Work at Aalsmeer has demonstrated cross-protection against carnation fusarium wilt using non-virulent isolates of Fusarium oxysporum f. sp. dianthi. The use of antagonists against carnation wilt is also being investigated.

18. Cyclamen anthracnose is now of less importance following adoption of advice on hygiene, irrigation and fungicide sprays. Seed treatments are being investigated. A wide range of cultivars has been shown to be susceptible to this disease.

19. Aalsmeer has found no evidence that cyclamen wilt is seed-borne. Infection is believed to occur during propagation and establishment.

20. Fungicide sprays have not proved effective against botrytis petal spotting of gerbera. A study at Aalsmeer is investigating critical aerial spore load and optimum conditions for flower infection.

SUGGESTED POINTS OF ACTION

1. Regular liaison with the Dutch extension and research services should be encouraged. This could become increasingly important if there is a reduction in the funding of near-market R & D in the UK.

2. Further publicity should be given to the symptoms of fusarium crown and root rot and the threat it poses to the UK tomato crop. A routine fungicide treatment should be considered for imported tomato plants in an effort to prevent or delay the establishment of the disease in the UK. Information on resistant rootstocks and cultivars is available and should be collated as soon as possible. The pathogenicity of Fusarium oxysporum f. sp. radicis-lycopersici to sweet peppers should be investigated.

3. The epidemiology of root diseases of pot plants in ebb and flow bench systems should be investigated. In particular, work is urgently required to investigate movement of pathogenic organisms and subsequent infection in relation to the duration of flooding, and disease development after transfer from ebb and flow benches to less than perfect drainage environments. Work is also required on the use of fungicides in ebb and flow systems and bench disinfection between crops.

4. The Dutch authorities are placing considerable emphasis on the development of re-circulating nutrient systems for protected crops in order to relieve the pressure on water supply and to lessen pollution of waterways by run-off nutrients and pesticides. Developments in this area should be monitored closely and systems investigated which appear promising. Disease epidemiology in re-circulating systems in conjunction with partial or complete sterilisation of re-circulating water by heat treatment should be studied further.

5. Dutch plant pathologists are investigating electrophoresis as a method for the detection of infection by fungal pathogens at an early stage, before obvious symptom development (eg fusarium wilt in cyclamen). They consider that this technique may allow rapid screening for disease and assessment of disease incidence in young plants, mother stock or valuable material. This system should be evaluated in comparison with monoclonal antibodies, comparing sensitivity, speed of development and cost.

6. The symptoms of TMV in sweet peppers should be brought to the attention of UK growers.

7. Seed treatments for the control of cyclamen anthracnose should be evaluated.

8. Work at Aalsmeer on biological control of fusarium wilt in carnations by cross-protection with avirulent strains of Fusarium oxysporum f. sp. dianthi and the use of antagonistic micro-organisms should be carefully monitored.

9. Work at Aalsmeer on the epidemiology of Botrytis cinerea in gerbera is relevant to other diseases caused by B. cinerea (eg petal spotting in cyclamen and chrysanthemums, ghost spotting in tomato) and could be of great value in predicting imminent disease problems. Liaison with Aalsmeer regarding progress of this work should continue.

10. Clearance for the use of post-planting sprays of Basilex on lettuce to control rhizoctonia bottom rot should be pursued.

11. HDC should encourage and perhaps assist attendance by relevant research staff at the annual conference at Ghent on diseases of protected crops. This would help to ensure that information gained by other workers is rapidly made available to the UK protected crop industry.

TECHNICAL NARRATIVE

VISITS TO AUCTION AND GROWERS

Westland Vegetable Auction - The Dutch clock auction was in progress with lettuce and Chinese cabbage being sold. In the Dutch clock auction cost is represented on a clock face, a clock hand descends from a high value, and the first bid, made electronically, stops the clock. The successful bidder can purchase all or part of a lot. This method of auction allows rapid sale and a large throughput of produce. In an adjacent warehouse tomato fruit ready for auction showed some quality defects (ghost spot, gold speck and russeting). Pesticide residue testing is carried out routinely on produce selected at random; growers found to be exceeding agreed limits are initially warned and, if excess levels continue to be found, their produce is excluded from the cooperative marketing arrangements. This presents severe difficulty in marketing produce.

Sweet Peppers - We visited a leading pepper grower in the Wateringen area with Astrid Kip, a MAF tomato and pepper adviser based at Naaldwijk. Production was mainly of cvs Delphin and Plutona on rockwool slabs. Crop growth appeared uneven. The main problem causing poor quality and fruit rejection was sun scorch.

Tobacco mosaic virus (TMV) was present in the crop, affecting small groups of adjacent plants. Affected rows had been roped off to warn pickers in an attempt to minimise spread. Symptoms of TMV were a) a faint leaf mosaic, particularly in the younger growth; b) small yellow blotches on leaves (cf MII-16 reaction in tomato); c) distorted, 'bumpy' fruit; d) blotchy fruit due to uneven ripening. We were informed that TMV is a serious problem in sweet peppers this year.

TMV had been confirmed in the crop by a host test. The pepper plants had not been inoculated with a mild strain to protect them against subsequent infection by severe strains. As a precaution against spreading TMV while training plants, workers dip their hands in a powdered milk and water suspension (50:50) between working each plant. Experimental work at Naaldwijk supported this measure - the milk is believed to inactivate virus particles. The practice is only carried out in the first part of the season, up to fruit picking. A new Enza Zaden cultivar, Madora, is resistant to TMV, but is not widely grown at present.

Other problems currently causing concern in pepper crops were:

1) A fruit and stalk rot caused by a species of Fusarium. This was not apparent in the crop visited and the species involved has not been determined.

2) A weakening of stem base tissue (foot rot). No primary pathogen had been isolated and it was thought that cultural factors, especially planting technique, might be responsible for this disorder.

3) An Olpidium - transmitted virus disease, yellow vein virus, is considered probably common though not serious in Holland. Visual diagnosis is not easy as symptoms resemble those of nutrient deficiency.

4) Pythium root rot in rockwool culture is considered to be a common problem. Previcur N (propamocarb hydrochloride) is used routinely.

Further visits that morning were curtailed due to a head-on collision by our host with another car. Fortunately no-one was injured but the police were

called to the scene of the accident in order that details could be taken; the other car driver was considered responsible.

Tomatoes - Three visits were made to selected tomato growers with Carla Penninx, a MAF tomato adviser based at Naaldwijk.

1. Jack Schulte, Middelbroekweg 93, Honselersdijk

2. Rene Zwinkels, Strijpkade 4a, Wateringen

3. John van Zeil, Wenpad 3, Poeldijk

Jack Schulte - The nursery comprised a 1 ha computer-controlled multispan house growing high-wire rockwool tomatoes cv Turbo. The crop was planted in late November, cropped until early July and then removed. Inter-plants were planted 26 April and cropped until early November. It was considered that better fruit quality was obtained late in the season through inter-planting. No disease problems had been experienced in the last 3 years, or were obvious in the crop when we visited, and no botrytis fungicides had been used since converting to the rockwool system of culture.

Rene Zwinkels - The nursery comprised a 1 ha block (20,000 plants) of rockwool tomatoes cvs Counter, Criterium and Rapide. The main disease problems encountered by this grower were fusarium crown and root rot (Fusarium oxysporum f. sp. radicis-lycopersici) and powdery mildew (Oidium sp).

Fusarium Crown and Root Rot

Infection was limited to isolated plants scattered throughout the nursery. Plants were probably infected at an early growth stage. Control measures had comprised removal of infected plants and a portion of underlying rockwool slab, followed by application of Bavistin and Previcur through the irrigation lines. Previcur was considered necessary as a precaution against pythium as Bavistin was believed to eliminate natural antagonists of pythium.

It was interesting to note that often only one plant becomes infected in a slab, the adjacent plant remaining healthy. Similarly, replacement plants placed on slabs at sites of previously infected plants often remain healthy.

Powdery Mildew

Powdery mildew had occurred on this nursery in April 1987 and had been controlled with sprays of Baycor (100 ml/100 l) and Nimrod. Baycor at the above rate caused some marginal leaf scorching, but the grower had found that a reduced rate of 80 ml/100 l was effective and did not produce obvious phytotoxic symptoms. There were varying reports by different growers as to the relative efficacy of Nimrod and Baycor. At the time of our visit powdery mildew had not recurred.

John van Zeil - The nursery comprised 1 ha of soil-grown plants on a light, sandy loam soil. By mid-May this grower had lost approximately 10% of plants due to fusarium crown and root rot. Infection and subsequent spread seemed considerably more severe than with the previous case in rockwool. Accurate disease diagnosis had taken several weeks due to initial mis-diagnosis as Phytophthora root rot.

The initial symptom of fusarium crown and root rot was wilting of random plants, developing as plants came under stress due to fruit load. No obvious external stem base symptoms were evident at this stage. Within 4-6 weeks plants developed a brown lesion at the stem base, occasionally with a slight white or pinkish mycelial growth. At this stage adventitious rooting was often present up the stem. A chocolate-brown internal staining was very marked, extending 25-30 cm up the stem. Rooting was very poor and frequently cortical tissues appeared water-soaked and rotten.

The grower had used grafted plants alongside paths, the aim being to ensure sufficient rooting in a difficult area. The original roots had not been excised, and fusarium crown and root rot was clearly visible on many plants, but affecting only the original root system and not the grafted rootstock. All grafted plants appeared healthy.

Irrigation of the crop was by low level sprinklers and it appeared that this system of irrigation created water splash which could be responsible for secondary spread.

Many infected plants had been removed, placed in a skip, treated with formalin, and dumped. To try and control further disease development the grower had applied a Derosal (carbendazim) drench to all plants. Soil sterilisation with methyl bromide was not considered effective, and the grower had been advised to remove the crop in September, replant with lettuce and then switch to sweet peppers the following year.

VISIT TO GLASSHOUSE CROPS AND EXPERIMENT STATION, NAALDWIJK

We were welcomed to the station by the Deputy Director (Research) Dr Ir G Weststeijn, and the Head of the Pests and Diseases Department, Dr Ir L Bravenboer.

Organisation - Drs Weststeijn and Bravenboer described the organisation and work of the station. There are 5 departments working on problems of glasshouse vegetables - soils, water and nutrition; physiology; horticulture and glasshouse climate; economics and management; pests and diseases. The current main areas of work in the pathology department are investigations of fungal transmitted virus diseases, root diseases in substrates and biological control. The station is state owned though 50% of its research funding is in the form of a levy (0.2%) on sales at the Grower Association Auctions. The advisory service is entirely government funded although it was considered that this situation would change to commercial funding within the next few years.

Crop Protection at Naaldwijk - Drs Bravenboer and Steekelenburg discussed current plant disease problems in Holland and disease control strategies.

1. Residue Testing - Produce from auctions is examined for pesticide residues by the Central Institute for Research on Food (CERO) at Zeist, Utrecht, the testing being paid for by the Central Bureau of Auctions. Samples of lettuce are taken 10 days before cutting and screened for residues of all chemicals used on the crop; results are usually available within 2 days and if high residues are detected harvesting is delayed. If non-approved chemicals are detected the crop is not marketed.

Methyl bromide is no longer widely used and growers require permission from Government before treatment of soil is allowed. Its use is restricted to certain crops (eg tomatoes and some flower crops; not cucumbers or lettuce) and then only if the crop to be treated is greater than 20 m from the nearest dwelling. The current aim is to obviate the need for methyl bromide usage within 5 years.

Routine testing has shown that by restricting the use of methyl bromide, by leaching prior to planting, and by using undersoil drainage systems, the level of bromide found in produce at market can be kept safely below maximum permitted levels.

We had discussions on the use of Basilex on lettuce. Current Dutch recommendations are for post-planting spray(s) within 14 days of planting out at 0.4 g product/m^2. There is a residue tolerance of 1 ppm ai and in 1987 99% of samples were within this limit. It has been found that the use of Basilex can lead to a taint problem in succeeding crops (eg celery), particularly on cooking.

2. Lettuce Downy Mildew - Since the occurrence of a metalaxyl resistant strain (NL15) of Bremia lactucae in Holland, growers have switched to cultivars containing R genes 6, 16 or 18; this has proved effective in controlling metalaxyl-resistant downy mildew. More recently, clearance has been granted for the use of Aliette applied as a foliar spray. The current recommendations in Holland are - drench young plants during propagation; apply 1-2 post-planting foliar sprays, up to 14 days before harvest.

In addition, it is recommended that plants are sprayed with Ridomil Zeta (metalaxyl + zineb) shortly before delivery.

Growers have also been using Previcur as a post-planting spray. It is currently not approved but it is anticipated that it will be approved in the near future. Previcur is approved in Germany for lettuce downy mildew control.

Detailed fungicide trials work on downy mildew is under way at Venlo.

Miss A Block, IPO, Wageningen is currently determining virulence phenotypes of downy mildew isolates (NL strains) and R gene combinations of new lettuce cultivars.

3. Botrytis - This disease is not a major problem in many glasshouse crops probably due to improved environmental control. There have been no reports of disease control failure following the use of dicarboximide fungicides, although limited tests have shown a reduced sensitivity. Growers in Holland use Ronilan T (vinclozolin + thiram) as a formulated product and this may account in part for the reduced incidence of resistant strains compared with the UK.

There is no recommendation for the use of Daconil (chlorothalonil) to control botrytis on lettuce.

4. Root Diseases in Substrates - Special emphasis is being placed on developing a re-circulating system of rockwool culture. Many systems for sterilisation of re-circulating solution have been examined and 3 are undergoing further evaluation, namely:

1) Ultrafiltration
This filters to 1 um particle size. The system is effective but filters are extremely expensive. Larger pore, less expensive filters are currently being evaluated.

2) Heat treatment
Solution is heated to 90^{o}C for a few minutes followed by cooling in a heat exchanger. The technique is rapid, is thought to offer great potential and has been taken up already by a few growers.

3) Ozone treatment
Two methods of ozone generation have been evaluated UV generation and chemical generation. Treatment with ozone is slow (greater than 6 hours).

The 3 treatments listed above were all under evaluation. Initial experiments were unsuccessful as the pathogens used (Fusarium and Verticillium) failed to spread in the re-circulating solution. Subsequently, Olpidium has been used as a model pathogen with Solanum villosum as the host. Apparently the resting spores of Olpidium are very easy to find in the root tissues. Difficulties had already been experienced in that Olpidium appeared to spread by means other than through the re-circulating system.

Limited experiments with pesticides (eg Previcur) had failed to detect product breakdown following heat, ozone or filtration treatment.

The impetus for development of an effective re-circulating system has evolved from concern regarding pollution of waterways with run-off rockwool solution. It has been estimated that the run-off from 1 ha of rockwool tomatoes is equivalent to 6,000 kg/annum of dried nutrients. There is similar concern over the quantity of pesticides entering waterways from such systems.

4. Cucumber Black Stem Rot - After 10 years of research, Dr Steekelenburg has come to the conclusion that currently the disease cannot be controlled other than by effective hygiene and cultural practices.
We had extensive discussions on the disease and the following points of interest emerged:

1) Although not published, van Steekelenburg considers that symptomless systemic infection of stems by Mycosphaerella bryoniae does occur.

2) The pycnidial spore stage usually occurs at the onset of lesion development followed shortly afterwards by the perithecial stage.

3) Even if infection with M. bryoniae is not visible as spreading stem lesions or fruit rot, infection of the growing tips can result in yield loss. In artificial inoculation tests with pycnidial suspensions, it has been demonstrated that shoot vigour and fruit number may be reduced by up to 10% over a 4-week period.

4) Glasshouse climate strongly influences the incidence of infection, with disease being more prevalent under conditions of low temperature, high relative humidity and when free water occurs on the leaf surface. Practices to reduce these conditions have been adopted widely by cucumber growers in Holland.

5) It is considered that the development of spreading lesions on stems is influenced by host physiology and environmental conditions at the time of infection.

6) The main cause of loss by black stem rot in Holland is fruit infection rather than stem lesions leading to plant death. Up to 5% of the fruit may have internal infection, but this can be reduced to less than 1% by appropriate control measures.

7) Benomyl is still considered to be the most effective fungicide, followed by chlorothalonil and tolyfluanid. Where powdery mildew is present, EBI fungicides are recommended as these give some control of mycosphaerella. If botrytis is present, dicarboximides would be recommended. To have an effect sprays must start early, at the first sign of infection, and continue at regular intervals.

8) Commercial breeders are making some progress in producing disease resistant cultivars. Generally, there appears to be very little correlation between plant and fruit susceptibility to infection, although some new commercial breeding material does have resistance to both; this material has yet to be released.

9) Some powdery mildew resistant cultivars grown in southern Europe show fruit resistance to mycosphaerella. However, these varieties show leaf necrosis under low light conditions, and 10% less fruit production than northern European cultivars.

10) Resistance to benzimidazole and dicarboximide fungicides has been found in isolates of mycosphaerella.

5. Fusarium Crown and Root Rot of Tomato - The following points of interest emerged during discussion:

1) Fusarium crown and root rot was first reported in Holland in 1987.

2) Observation of infected crops indicates that infection most probably occurrs during propagation or at planting out. Further spread in the growing crop appears limited, possibly a result of high temperatures during the summer growing period.

3) Symptoms take 10-14 weeks to develop.

4) In experiments at Naaldwijk, disease spread and symptom development appeared slow in rockwool crops. Under experimental conditions, symptomless infection was clearly demonstrated.

5) Biological control systems are being evaluated, notably Trichoderma harzianum MTR35d (ex Israel) applied as a peat blend formulation. In early trials, T. harzianum has reduced infection by 50% when applied at seeding and by 30% when applied at transplanting. This organism has been the most promising to date. Other organisms examined include Pseudomonas putida and a Streptomyces sp (Mycostop).

6. Tomato powdery mildew (Oidium sp.) - This disease appeared in autumn 1986 on a few nurseries in Holland, and was not considered to be a major problem. It reappeared in spring 1987 and spread over the country and could be found on many holdings. Baycor and Nimrod were both very effective, 2 sprays usually being sufficient for control; the tomato powdery mildew pathogen appears to be more sensitive to fungicides than Erysiphe fuliginea on cucumbers.

IVT and commercial breeders are currently screening for powdery mildew resistance and have found useful genetic resistance in wild species.

7. Cucumber Penicillium Stem Rot - This disease has been reported at a low incidence in Holland since 1986. The fungus has been isolated consistently from vascular tissues although artificial inoculation experiments have been largely unsuccessful.

The same disease has recently been noted in the UK, in both the Lea Valley and Humberside, and the species involved identified as P. oxalicum (syn. P. crustosum).

8. Tomato Calyptella - This disease has still not been confirmed in Holland. We consider that this may be due to differences in systems of irrigation.

INSTITUTE OF PLANT PROTECTION (IPO) WAGENINGEN

We were welcomed to the institute by Dr Ir Minks (Head of Integrated Control) and Dr Fokkema (Head of Ecology and Soil Ecology).

The Institute is a foundation under supervision of the Ministry of Agriculture and Fisheries. The work of IPO is concerned with protection of plants against fungi, bacteria, viruses, viroids, insects, mites and nematodes as well as with the effects of air pollution on plants. The research findings mainly support the advisory services, the plant protection service, inspection services for propagation material, plant breeding and environmental hygiene.

The institute has recently been reorganised and now comprises the following sections: Ecology; Soil Ecology; Physiology and Resistance (subsections on physiological aspects and genetical aspects); Detection and Biotechnology; Integrated Control (subsections on biological aspects and quantitative aspects). Plant pathologists are located in different sections, some being outstationed at Naaldwijk and Aalsmeer Experimental Stations.

Dr Fokkema (Ecology) described work on phyllosphere microorganisms, including their interaction with pathogens and fungicides, and more recent developments in relation to air pollution.

Dr Gerlach (Soil Ecology) has been heavily involved with resistance breeding, but more recently has been involved with work on Sclerotinia sclerotiorum, soil-borne diseases (particularly fusarium wilt of cucurbits), and breeding lines for fusarium crown and root rot control. Points of interest were:

1) In Holland, sclerotinia appears to be an increasing problem in vegetable crops, including potatoes, and greater emphasis is being placed on work on this disease.

2) In crops where flowering does not occur (eg lettuce, celery, chicory, carrots) the primary infection site is thought to be senescent lower leaf tissue which develops at full canopy cover. In crops such as celery, very young shoots may also be infected.

3) Dr Gerlach considers that tomato fusarium crown and root rot resistance is controlled by a single dominant gene and therefore new resistant cultivars may be developed in the near future. The brown and corky root rot resistant rootstock Vicores is reported to be resistant to fusarium crown and root rot while KNVF is highly susceptible.

Unfortunately Miss Bloc was not available during our visit and we were therefore unable to have detailed discussions on lettuce downy mildew.

VISIT TO RESEARCH STATION FOR FLORICULTURE, AALSMEER

We were welcomed to the station by Dr Rattink (Head of Phytopathology and Nematology), who briefly described the organisation and work of the Research Station. The station is divided into 6 departments: Cultivation (subdepartments optimalisation of cultivation and farm management); Product Quality subdepartments starting material post-harvest); Technical Research Support (subdepartments water conservation and nutrition, production factors, crop protection); Nursery (subdepartments cultivation technique) and farm technique); General Department (support); Information Technology.

The station is financed by the Dutch floricultural industry (50%) and the Ministry of Agriculture (50%). The protected flower and pot plant industry now exceeds 4,500 ha and continues to expand, although there is increasing competition from other European countries, notably Denmark.

Dr Rattink outlined his work on fusarium wilt (Fusarium oxysporum f. sp. dianthi) of carnation. Points of interest were:

1) New cultivars are examined for resistance to race 2, the only race known in Holland, using a mixture of 10 isolates (microconidia only) injected into the root zone, and assessed for symptoms 4 to 6 weeks later. More recently, they have examined cultivars for resistance to other races as a high percentage of cuttings and plants are now exported.

2) Recent work has demonstrated cross-protection using non-virulent isolates of F. oxysporum f. sp. dianthi isolated from carnation; cross-protection was only effective when pre-inoculation was carried out at least 7 days prior to inoculation with pathogenic isolates.

3) Work has recently commenced examining the use of antagonists to control fusarium wilt.

Dr Ir Amsing described recent work on control of cyclamen anthracnose (Colletotrichum gloeosporioides). This disease first appeared throughout Europe, including Holland and the UK, in 1986, affecting especially cv Rosamunde although other cultivars have been shown to be susceptible. It has been demonstrated to be carried within seed; symptom expression can take 3-4 months at 15-17^{o}C. Many growers in Holland sprayed captan and Euparen M at 2 week intervals until flowering, and this treatment gave moderate disease control. Other fungicides (thiram, benomyl) were found to be less effective. Work by Garibaldi (Italy) has shown that prochloraz Mn is also effective as a preventative spray.

A programme advocated by Aalsmeer for control of anthracnose comprised fungicide sprays at 14 day intervals, using Euparen M (0.1%) during the early growth stages, followed by captan (0.2%) from the onset of flowering; the latter product is reported to be less damaging to flowers. However, it is questionable as to whether this programme would control primary seed-borne infection. Aalsmeer are currently generating naturally contaminated seed to further evaluate spray programmes and also to investigate seed treatments.

Following advice on hygiene, irrigation and fungicide programmes, the disease is no longer regarded as a serious problem commercially.

Ir A Kerssies described his work on petal spotting of gerberas caused by Botrytis cinerea, electrophoretic methods for early detection of fungal pathogens and work on fusarium wilt for cyclamen.

Botrytis Infection of Gerbera - Gerbera is an increasingly important crop in Holland with recent emphasis on rockwool production. It is anticipated that greater than 90% of production will be on rockwool within 2-3 years. The crop is usually grown for 2 years and flowers continually after a 6 week establishment phase. There are currently over 350 cultivars available.

One of the main disease problems is petal spotting due to Botrytis cinerea. Petal spotting rarely develops during cropping, more usually symptoms develop after picking and following a period in transit. A study is underway to investigate critical aerial spore load and optimum conditions for flower infection. Initial work has demonstrated that infection only occurs when the relative humidity is greater than 93%.

Interestingly, in rockwool crops there is a lower incidence of leaf and stem base infection by botrytis, but petal spotting continues to be a persistent problem. Fungicide sprays have not proved effective against this phase of the disease.

Fusarium Wilt of Cyclamen - It is considered that this disease is definitely not seed-borne but infection occurs during the propagation and establishment phase. However, symptoms rarely appear during early growth and may take up to 4 months to appear. Current work is aimed at identifying infected plants before symptom expression, by the use of electrophoretic methods. The development of electrophoretic methods for early detection is considered worthwhile on ornamentals as the expense involved for producing specific monoclonal antibodies for minor crops is considered difficult to justify.

Tour of Glasshouses - A tour of the glasshouses, led by Ir A Kerssies, concentrated on disease control experiments in progress. Of note was the ebb and flow system of production for pot plants. It is claimed from limited experimental work that pathogens fail to spread in these systems. However, on questioning, it would appear that the pathogens tested to date are moving through the crop and it is only symptom expression which is prevented or delayed. It is of great concern that ebb and flow systems may provide ideal conditions for the rapid distribution of certain pathogens (eg fusarium, pythium, phytophthora) and that pathogens, once introduced, may produce symptoms if plants are subsequently grown under a sub-optimal watering regime. In addition, if symptomless infected plants occur, pathogens may unwittingly be spread between nurseries.

Aalsmeer Flower Auction

Ir Kerssies accompanied us to the Aalsmeer flower auction. This auction site is vast, covering an area in excess of 50 ha. An immense range of flowers are marketed here throughout the year.

ACKNOWLEDGEMENTS

We would like to thank the staff of the research stations and nurseries visited for providing informative discussion and hospitality so generously.

In particular we would like to express our sincere appreciation to Dr Bravenboer, Dr van Steekelenburg, Dr Rattink, Dr Amsing and Ir Kerssies for the time they spent with us and for making accommodation arrangements which allowed our visit to run so smoothly. Also we would like to wish Dr Bravenboer a happy retirement and his successor Dr Steekelenburg every success in his new post.

The provision of funds for this visit by the Horticultural Development Council is gratefully acknowledged.

The benefits of a the visit was well proven through the detailed and wide-ranging discussions which took place with Dutch researchers and growers and through the consolidation of ideas and is to be encouraged.

ITINERARY

16 May — Travel by air from Stansted to Schipol, Amsterdam then by hired car to Hotel Ingemar, Hoek van Holland.

17 May — Glasshouse Crops Research and Experiment Station, Naaldwijk. Introduction to station with Dr Ir G Weststeijn (Deputy Director) and Dr Ir L Bravenboer (Head of Pests and Disease Department).
Visits to vegetable auction and holdings with Astrid Kip (am) and Carla Penninx (pm)

18 May — Glasshouse Crops Research and Experiment Station, Naaldwijk. Discussions with: Dr Ir G Weststeijn, Dr Ir L Bravenboer and Dr Ir N A M Steekelenburg.
Conducted tour of glasshouse experiments in progress at Naaldwijk.

19 May — Institute of Plant Protection (IPO) Wageningen.
Introduction by Dr Ir A K Minks (Head of Department, Integrated Control).
Discussions with Dr N J Fokkema (Head of Department Ecology and Soil Ecology), Dr P H Smits (Insect Pathology), and Dr Ir M Gerlach (Soil-borne fungal diseases and antagonists).
Conducted tour of Institute facilities and experiments in progress.

20 May — Research Station for Floriculture, Aalsmeer.
Introduction to station with Dr Ir H Rattink (Head of phytopathology and nematology). Discussions with Dr Ir J Amsing and Ir A Kerssies.
Visit to Flower Auction, Aalsmeer.
Conducted tour of glasshouse experiments in progress.

21 May — Amsterdam

22 May — Travel by air from Schipol, Amsterdam to Stansted UK.