

Recent advances in vegetable virus research

—ISHS 9th conference of the vegetable virus
working group meeting in Turin, Italy, 22-27
August 1998

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J D Fletcher
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Overseas Travel Report No. 240

**Recent advances in vegetable
virus research—ISHS 9th
conference of the vegetable virus
working group meeting in Turin,
Italy, 22-27 August 1998**

J D Fletcher

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1 EXECUTIVE SUMMARY

I travelled to Turin, Italy, in August 1998 to attend the ISHS 9th conference of the Vegetable Virus Working Group meeting. The trip was co-funded by Crop & Food Research and the New Zealand Vegetable and Potato Growers' Federation. The conference is a unique opportunity for researchers working specifically on viruses of vegetable crops to discuss their work. Vegetable crops covered included tomatoes, Cucurbita (squash, cucumber, zucchini, melons, etc.), peas, Alliums (onions, shallots, garlic), brassicas (cauliflower, cabbage). Topics covered include descriptions of new diseases, control strategies, detection and diagnosis, new approaches to continuing problems, and opportunities for collaboration.

The objectives of the trip were to:

1. improve my knowledge and capability in the understanding and control of vegetable viruses and related diseases. This is the first opportunity I have had to meet with colleagues I have communicated with for the past 10 years through our annual newsletter,
2. present a conference paper on squash virus epidemiology, which will be an opportunity to publicise progress we have made in the understanding and control of the two viruses (ZYMV and WMV2) that are important to our squash industry. It will also allow discussion with colleagues, particularly on possible approaches to virus control used by others that may be relevant to New Zealand, and
3. visit Dr Jaques Derron at the Swiss Federal Station at Changin-Nyon to update myself on their strategies to control virus diseases of potatoes and other field crops.

Key observations include:

1. the continued emphasis on ELISA, a system we routinely use,
2. new diseases of interest including whitefly-transmitted geminiviruses of tomatoes. Vectors of these diseases, e.g. *Bemisia tabacii*, are already in New Zealand. It appears that these diseases can be controlled by carefully eliminating alternative hosts,

3. reflective mulches, net covers and UV-absorbing plastic were all discussed as successful ways of controlling aphid-borne viruses. Oil sprays, when carefully applied, can also reduce the incidence of viruses transmitted by aphids,
4. conventional breeding of resistant cultivars continues to be important and can be enhanced by genetically modified resistance or cross protection. Tailoring viruses in the future to be defective as vectors and protecting plants with a cocktail of mild viruses may be options,
5. the ease of vegetable produce transportation between countries is likely to aggravate future disease problems.

Our work on ZYMV and WMV2 was well received. We are amongst the leaders of research on seed transmission of viruses in squash.

The conference was an excellent opportunity to extend my networks with virus researchers and I made contact with some research teams who may be interested in collaborating with Crop & Food Research in the future.

2 INTRODUCTION

The Vegetable Virus Working Group is a network of virus researchers that extends throughout the world and specializes in research on vegetable viruses. The Group meets every three years, usually in Europe. This is one meeting where discussion and presentations are focussed on the needs of virologists specialising in vegetable diseases. It is an opportunity to meet with some of the world leaders in vegetable virus research. Vegetable crops covered included tomatoes, Cucurbita (squash, cucumber, zucchini, melons, etc.), peas, Alliums (onions, shallots, garlic), brassicas (cauliflower, cabbage). Topics covered include descriptions of new diseases, control strategies, detection and diagnosis, new approaches to continuing problems, and opportunities for collaboration.

3 TRAVEL DETAILS

3.1 Itinerary

20-21 August 1998	Travel from Christchurch to Turin, Italy
22-27 August	Conference, field trip and research station visit
28-29 August	own arrangements
30 August - 1 September	Travel from Turin to Christchurch.

3.2 Financial support

VegFed Fresh Vegetable R&D Committee	\$2500
Crop & Food Research	<u>\$3200</u>
TOTAL	\$5700

3.3 Contacts made

A list of the 73 attendees is attached in Appendix I. The small size of the conference ensured easy and meaningful discussion with almost all of those present.

4 OBJECTIVES AND RESULTS

4.1 Objectives

- Objective 1:** To improve my knowledge and capability in the understanding and control of vegetable viruses and related diseases by attending the 9th Conference of the ISHS Vegetable Virus Working Group, Turin, Italy. This is the first opportunity I have had to meet with colleagues with whom I have communicated for the past 10 years through our annual newsletter.
- Objective 2:** To present a conference paper, on squash virus epidemiology. This forum is an opportunity to publicise progress we have made in the understanding and control of the two viruses (ZYMV and WMV2), which are important diseases to our squash industry. Presentation of my paper will also allow discussion with colleagues and an update on possible approaches to virus control used by others that may be relevant to New Zealand.
- Objective 3:** To visit Dr Jaques Derron at the Swiss Federal Station at Changin-Nyon to update myself on their strategies to control virus diseases of potatoes and other field crops.

4.2 Results

4.2.1 *Objective 1*

A copy of the programme of presented papers is attached in Appendix II.

Sessions were organised around particular themes. On Day One we covered identification, characterisation and new diseases. Of particular interest was the continued emphasis on the use of ELISA, a system we use, as a cheap and easy method for virus detection and identification. New, more sensitive and expensive systems should only be used when there are no alternatives. One example is the PCR-based system 'Taq Man', which uses fluorescent markers to record a real time analysis of virus, nematode, bacterial or fungal product. This proven system has been approved for purchase by our research group.

New diseases of interest include whitefly-transmitted geminivirus diseases of tomatoes. In New Zealand we now have some vectors (e.g. *Bemisia tabacii*) which are

capable of transmitting such diseases. In fact, it was pointed out that whitefly can transmit tomato yellow leaf curl virus (TYLCV) sexually amongst themselves, thus amplifying the disease risk if live insects enter our country. Other diseases included those of shallot, garlic, brassicas and peppers. Zucchini yellow mosaic virus (ZYMV) and watermelon mosaic virus 2 (WMV2) have recently been recorded in Holland, resulting in speculation that long distance transmission by aphid vectors was responsible for the spread of these diseases, a view not always supported by all.

Ecology and epidemiology were covered on Day Two. Geminiviruses were under discussion again. It was encouraging to learn that these diseases can be controlled by careful elimination of alternative hosts (crops or weeds), thereby breaking the vector reproduction cycle. The importance of turnip mosaic virus (TuMV) in Italian brassica crops was discussed. This virus, and its many strains, is regarded as very important in Europe. In New Zealand TuMV certainly affects vegetables and has recently devastated some forage brassica crops in Canterbury. Bean and radish viruses were also discussed, as was the risk assessment of genetically modified tomato crops. Experimental results indicated that there was no flow of genes responsible for producing transgenic proteins to nearby trap tomato plants through pollen or other means.

Squash viruses were covered with our own work (see below) and a fascinating review of ZYMV research. This virus may spread through seed, displayed fruit at markets, and associated crop weeds. New techniques, such as monoclonal antibodies and PCR, are available to study disease movement and evolution. These tools were used to study changes in pathotypes in Martinique where, for example, one farm was found to have three serotypes and two pathotypes of ZYMV.

On Day Three there was an emphasis on virus control, including genetic engineering. Aphid-borne viruses and their control were discussed. The success of reflective mulches, attractive yellow mulches (aphids are cooked on the hot surface), net covers (which exclude aphids) and UV-absorbing plastic (reduces crop attraction, camouflage), were all discussed.

Reducing virus transmission using oil sprays and the importance of careful application were covered. The use of conventional breeding for virus resistance or tolerance continues to be very important, but can be enhanced by genetically modified resistance or cross protection with mild virus strains (ZYMV-W, TMV- Rast). There may be risks, and these include synergism between different viruses, reversal to wild type from a weak strain, or cross-transfer of genetic material (heterogenous encapsidation) between viruses. Future trends may include tailoring viruses to be defective as vectors and protecting plants with a cocktail of mild viruses. An important observation was that the ease of vegetable produce transportation between countries is likely to aggravate future virus disease problems—we need to be even more on our

guard. Other papers reported conventional resistance to onion yellow dwarf virus (OYDV) in garlic, radish as a source of resistance to TuMV, and tolerance to TLCV amongst wild tomatoes. Transgenic resistance possibilities included cucumber mosaic virus (CMV) in tomatoes, bean common mosaic virus (BCMV) in beans, lettuce mosaic virus (LMV) in lettuce and TLCV in tomatoes.

The final session covered host pathogen interactions. An extremely informative survey was presented demonstrating work on virus movement in plants using a green fluorescence protein attached to potato virus X (PVX). Movement of virus in mature or young leaves is complicated by whether or not these leaves are storing or producing food. Movement is more widespread in older storage leaves. Root-transmitted viruses, whether inoculated onto leaves or roots, tend to concentrate higher in the roots, as do leaf viruses. Virus movement has to be facilitated by protein, for example in cucumber mosaic virus (CMV). These proteins may be similar for many viruses. They appear to form tubule-like filaments on the cell surface. Similar studies on TYLCV demonstrated the movement of viruses into the cell nucleus with the help of a replication-associated protein (T-rep). Other interesting work measured the importance of antioxidant enzymes in a plant's response to virus infection; there appears to be a close correlation.

4.2.2 Objective 2

Our work on ZYMV and WMV2 was well received, particularly by colleagues who are acknowledged experts on these viruses. They consider our preliminary work on seed transmission an important step, since no one else has such sound data. They were impressed with our epidemiological studies on weeds because they too have few natural cucurbit weeds and have had difficulty finding overwintering hosts. I supplied copies of my data and notes to these colleagues. I feel I made a useful impact and have made some helpful contacts for future research.

A display of poster papers complemented the formal session. Of particular interest were those on TuMV stereotyping; resistance of Cucurbita, including pumpkin, to WMV2 and ZYMV; differentiating strains of ZYMV; virus culture collection and storage; new disease records; epidemiology; pepper and tomato diseases.

Evening tours of the botanical gardens and of the facilities of our hosts, the Istituto di Fitoviologia Applicata, were most interesting. Virus research is undertaken by a staff of about 50. They service mostly northern regions, but work closely with other similar institutes. Interestingly they collaborate closely with other European centres to the point where their research committee has two outside researchers (France and Germany) vetting their projects. Funding is centralised but complimented through provincial research sources, e.g. in Savoy and Liguria. Their 20-year-old facilities would be the envy of most in New Zealand, beautifully constructed and carefully designed.

A field trip to the coastal province of Liguria was most stimulating. We visited production areas for basil (*Ocimum basilicum*), a very important fresh crop around Albenga. Crops are glasshouse grown in cool weather and field grown in summer. Crops are hand harvested daily and bunched for market sale. Bulk hand harvesting for pesto (paste) is also very important. Crop value can reach \$1 million/ha. They suffer from a range of fungal root diseases (*Fusarium*, *Rhizoctonia*, *Pythium*), leaf diseases (*Botrytis*, black spot), but few viruses. A serious problem facing the industry is the replacement of methyl bromide for soil sterilisation. Use of solarisation is promising as is use of antagonistic fungi as a bio-control. The region is also noted for its flower, potted plants and garden centre produce. Large glasshouses and sheltered areas are given over to this. Research support is provided by the provincial government to the Albenga Regional Centre for agricultural experimental aid with a magnificent glasshouse facilities (1450 m²) built with local and EC support. Research focuses on flower and ornamental production and pollution control. Technical advice, pathology support and chemical analyses are also provided. We also visited a local grower-cooperative that markets products and supplies materials and advice. Growers can present problems in the morning and if no satisfactory answer is given a technical rep will visit their property that afternoon to sample or advise. Further on (it was 32°C outside!) we surveyed a glasshouse crop of peppers seriously affected by tomato spotted wilt virus (TSWV), potato virus Y and CMV (a common problem in this region). Most had seen this sort of depressing display in the past, but what was encouraging were the four rows of tolerant or resistant selection's standing up extremely well under the virus attack. These lines are bred conventionally and will be released over the next two seasons. The technical aspects of the day were offset by a magnificent lunch and a tour of medieval Albenga.

4.2.3 Objective 3

This objective was not achieved because Dr Derron had other commitments and was not available for me to visit.

5 ACKNOWLEDGMENTS

I wish to acknowledge the generous financial support for this visit from the New Zealand Vegetable and Potato Growers' Federation.

6 APPENDICES

Appendix I List of participants

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Appendix II List of oral papers and poster presented

PROGRAMME

Saturday, 22

19.00-21.00 Welcome buffet

Sunday, 23

9.00-9.15 Opening of the Conference

SESSION I: IDENTIFICATION, CHARACTERISATION AND NEW DISEASES

9.15-9.45 Chair: J. Vetten

Key lecture: H. Huttinga

9.45-10.00 DISTINGUISHING CHARACTERISTICS OF SOME NEW WHITEFLY-
TRANSMITTED CRINIVIRUSES INFECTING TOMATO

Wisler G. C., Duffus J. E., Liu H.-Y. and Karasev A. V.

10.00-10.15 EVIDENCE FOR A PHYTOREOVIRUS IN LEAF-CURL AFFECTED TOBACCO
IN SOUTH AFRICA

Rey M.E.C., Boccardo G., D'Andrea E., Calvers-Evert J. and Paximadis M.

10.15-10.30 APICAL NECROSIS OF TOMATO CAUSED BY A STRAIN OF PARIETARIA
MOTTLE ILARVIRUS

Lisa V., Ramasso E., Ciuffo M. and Roggero P.

10.30-10.45 IDENTIFICATION OF TMV STRAINS FROM EGGPLANT, TOMATO AND
PEPPER ON BIOLOGICAL PROPERTIES

Gnutova I.V., Tolckach V.F. and Gnutova R.V.

10.45-11.30 Coffee break

11.30-11.45 SUSCEPTIBILITY OF TOMATO AND PEPPER CULTIVARS UNDER
GLASSHOUSE CONDITIONS TO INFECTION WITH SOME
TOBAMOVIRUSES

Mamula D. and Juretic N.

11.45-12.00 FURTHER EVIDENCE THAT SHALLOT YELLOW STRIPE AND WELSH
ONION YELLOW STRIPE VIRUSES ARE DIFFERENT STRAINS OF A
DISTINCT POTYVIRUS

van der Vlugt R.A.A., Steffens P., Cuperus C., Barg E., Lesemann D.-
E., Bos L. and Vetten H.J.

12.00-12.15 A CARLAVIRUS IN SLOVENIAN GARLIC IS RELATED TO CARNATION
LATENT VIRUS AND DIFFERS FROM GARLIC COMMON LATENT VIRUS

Mavric I., Ravnikar M. and Milne R.G.

12.15-12.30 ZUCCHINI YELLOW MOSAIC VIRUS AND WATERMELON MOSAIC VIRUS
2 INFECTIONS IN THE NETHERLANDS

Verhoeven J.Th.J. and Roenhorst J.W.

12.30-14.30 Lunch

- 14.30-15.00 Chair: **M. Barba**
Key lecture - G. Adam: TOSPOVIRUSES - A NEVER-ENDING STORY?
- 15.00-15.15 DETECTION OF IRIS YELLOW SPOT TOSPOVIRUS IN ISRAEL
Gera A., Kritzman A., Cohen J. and Raccah B.
- 15.15-15.30 MOLECULAR DIAGNOSIS OF GARLIC DWARF REOVIRUS
Marzachi C., Lot H. and Boccardo G.
- 15.30-15.45 COMPARISON OF THE 5'-END NUCLEOTIDE SEQUENCES OF TURNIP
YELLOW LUTEOVIRUS ISOLATES
Schubert J., Rabenstein F., Graichen K., and Richter K.
- 15.45-16.15 Coffee break
- 16.15-16.30 ASSOCIATION OF ASTER YELLOW PHYTOPLASMA WITH A STUNTING
DISEASE OF TOMATO IN SARDINIA
Coghe, F., Sulis, C., d'Aquilio, M., Marzachi, C., Veratti, F. and
Boccardo, G.
- 16.30-16.45 IDENTIFICATION OF STOLBUR-RELATED PHYTOPLASMAS INFECTING
TOMATOES IN PORTUGAL BY NESTED PCR AND TISSUE-PRINT
IMMUNOASSAY
Louro D., Vibio M., Paltrinieri S. and Bertaccini A.
- 16.45-17.00 General discussion

Monday, 24

SESSION II: ECOLOGY AND EPIDEMIOLOGY

- 9.00-9.30 Chair: **H. Lot**
Key lecture - J. Duffus: IMPACT OF VIRUS ECOLOGY AND
EPIDEMIOLOGY STUDIES IN CALIFORNIA AGRICULTURE
- 9.30-9.45 VIRUSES OF HOT PEPPER IN ETHIOPIA
Hiskias Y., Lesemann D.-E. and Vetten H.J.
- 9.45-10.00 POTYVIRUSES IN NEW ZEALAND BUTTERCUP SQUASH (*CUCURBITA*
MAXIMA)
Fletcher J.D., Nott H.M., Wallace A.R., Rogers B.T. and Herman .J.B.
- 10.00-10.15 CHARACTERIZATION OF THE BIOLOGICAL, SEROLOGICAL AND
MOLECULAR VARIABILITY AMONG TURNIP MOSAIC POTYVIRUS
ISOLATES IN CAMPANIA, ITALY
Stavolone, L., Alioto, D., Ragozzino, A. and Laliberté, J.-F.
- 10.15-10.30 EPIDEMIC OUTBREAKS IN TOMATO AND A NOVEL DISEASE OF
COMMON BEAN IN SPAIN ARE CAUSED BY TOMATO YELLOW LEAF
CURL VIRUS-IS
Navas-Castillo J., Sánchez-Campos S., Díaz J. A., Sáez-Alonso E. and
Moriones E.
- 10.30-10.45 EPIDEMIOLOGY AND FIELD MECHANICAL TRANSMISSION OF RADISH
MOSAIC VIRUS IN *ERUCA SATIVA* CROPS
Lovisolò O., Caciagli P., Lisa V., Guglielmone L. and Conti M.

- 10.45-11.15 Coffee break
- 11.15-11.45 Key lecture - H. Lecog
- 11.45-12.00 MUTATIONS WITHIN THE PTK MOTIF OF THE HELPER COMPONENT PROTEIN GENE AFFECT THE PROTEIN ABILITY TO BIND TO VIRIONS AND TO MEDIATE ZYMV TRANSMISSION BY APHIDS
Racchah B., Peng Y.-H., Kadouri D., Huet, H. and Gal-On A.
- 12.00-12.15 HISTOCHEMICAL AND CYTOCHEMICAL INVESTIGATIONS ON THE VIRUS-VECTOR SYSTEM TOMATO YELLOW LEAF CURL GEMINIVIRUS-*BEMISIA TABACI*.
Appiano A., Caciagli P., Dore B., Bonelli S. and Faoro F.
- 12.15-12.30 RISKS ASSESSMENT OF GENETICALLY MODIFIED TOMATO
Ilardi V., Tomassoli L. and Barba M.
- 12.30-12.45 General discussion
- 12.45-14.30 Lunch
- 14.30-16.30 **POSTER SESSION**
(see page 102 for list of posters)
- 16.30-17.00 Coffee break
- 17.00-18.30 Visit to the Istituto di Fitovirologia Applicata

Tuesday, 25

- 7.30 - 20.30 Technical visit to the CeRSAA and Cooperativa L'Ortofrutticola at Albenga (SV), Italian Riviera

Wednesday 26

SESSION III: CONTROL, INCLUDING ENGINEERED RESISTANCE

- 9.00-9.30 Chair: ^{Abat.} **A. Gera**
Key lecture - B. Racchah: CONTROL OF VECTOR-BORNE VIRUSES: MANAGING HOST SUSCEPTIBILITY AND VECTOR ACTIVITY
- 9.30-9.45 RESISTANCE TO ONION YELLOW DWARF VIRUS AND LEEK YELLOW STRIPE VIRUS FOUND IN A "FERTILE" GARLIC CLONE
Lot H., Chovelon V., Souche S., Leroux J.P. and Delecalle B.
- 9.45-10.00 IDENTIFICATION OF NOVEL GENES FOR RESISTANCE TO BEAN COMMON MOSAIC VIRUS IN *PHASEOLUS VULGARIS*
Donovan G.M., Spence N.J., Pink D.A.C. and Wood K.R.
- 10.00-10.15 RADISH (*RAPHANUS SATIVUS* L.) AS A RESISTANCE RESOURCE TO TURNIP MOSAIC VIRUS
Krämer R., Marthe F., Klocke E., Ryschka U., Schumann G. and Clauss E.

- 10.15-10.30 INTERACTIONS BETWEEN BRASSICAS AND TURNIP MOSAIC VIRUS (TuMV)
Walsh J.A., Jenner C. E., Hughes S.L., Lehmann P., Petrzik K., Derek Lydiate J., Sharpe A.J. and Rusholme R.L.
- 10.30-11.00 Coffee break
- 11.00-11.15 EVALUATION OF TOLERANCE TO TOMATO YELLOW LEAF CURL VIRUS DERIVED FROM DIFFERENT WILD *LYCOPERSICON* SPECIES
Ioannou N., Ioannou M., and Hadjinicolis A.
- 11.15-11.30 THE EFFECT OF TYLCV ON NEW BREEDING LINES WITH HIGH LEVEL OF RESISTANCE TO THE VIRUS
Lapidot M., Friedmann M., Cohen S. and Pilowsky M.
- 11.30-12.00 Chair: **R. van der Vlugt**
Key lecture - B. Gronenborn
- 12.00-12.15 ENGINEERING RESISTANCE TO TOMATO YELLOW LEAF CURL VIRUS BY EXPRESSING A TRUNCATED REP GENE
Accotto G.P., Tavazza M., Noris E., Brunetti A., Crespi S, Caciagli P. and Tavazza R.
- 12.15-12.30 USE OF INFECTIOUS cDNA TO STUDY THE PATHOGENICITY OF LETTUCE MOSAIC POTYVIRUS (LMV).
Le Gall O., Candresse T., Redondo E., German-Retana S., Alias E., Yang S.-J., Revers F., Lot H., Souche S. and Dunez J.
- 12.30-14.30 Lunch
- 14.30-14.45 COAT PROTEIN MEDIATED RESISTANCE TO PROTECT TOMATO CROP AGAINST CUCUMBER MOSAIC VIRUS
Tomassoli L. and Barba M.
- 14.45-15.00 TRANSGENIC PEPPER PLANTS CONTAINING CUCUMBER MOSAIC VIRUS satRNA cDNA
Feng L.-X., Dong C.-Z., Jiang C.-X., Guo J.-Z.
- 15.00-15.15 PROTECTION AGAINST CUCUMBER MOSAIC VIRUS SUPPORTING A NECROGENIC satRNA IN TRANSGENIC TOMATO PLANTS EXPRESSING AN ANTISENSE RNA
Grieco P.D., Cillo F., Arpaia S., Cellin F. and Gallitelli D.
- 15.15-15.45 General discussion
- 15.45-16.15 Coffee break
- 16.45-17.30 Business meeting
- 20.00-23.00 Social dinner

Thursday, 27

SESSION IV : HOST-PATHOGENS INTERACTIONS

- 9.30-10.00 Chair: **N. Spence**
Key lecture - P. Palukaitis: STRATEGIES, ROUTES & BARRIERS TO VIRUS MOVEMENT WITHIN PLANTS
Palukaitis P., MacFarlane S.A., Oparka K.J. and Santa Cruz S.
- 10.00-10.15 LOCALIZATION OF T-REP OF TOMATO YELLOW LEAF CURL VIRUS IN TRANSGENIC PLANTS
Noris E., Masenga V., Tavazza M., Milne R.G. and Accotto G.P.
- 10.15-10.30 POSSIBLE ROLE OF OXIDATIVE STRESS AND ANTIOXIDANT ENZYMES IN SYSTEMIC VIRUS-HOST PLANT INTERACTIONS
Riedle-Bauer M.
- 10.30-10.45 ENZYMATIC ACTIVITY AND SUBCELLULAR LOCALIZATION OF POTATO VIRUS X 25 kDa MOVEMENT PROTEIN AND ITS DELETION MUTANTS. ATTEMPT TO STUDY FUNCTIONAL ROLE OF PROTEIN DOMAINS
Kalinina N.O., Fedorkin O.N., Samuilova O.V., Solovyev A.G. and Morozov S.Yu.
- 10.45-11.30 Coffee break
- 11.30-12.00 General discussion
- 12.00-12.30 Closing of the Conference

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- I.1) IDENTIFICATION OF PHYTOPLASMA INFECTING WINTER OILSEED RAPE IN THE CZECH REPUBLIC AND ITS COMPARISON WITH ITALIAN BRASSICA PHYTOPLASMAS
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- I.10) RAPID DIFFERENTIATION OF CLOSELY RELATED ISOLATES OF ZUCCHINI YELLOW MOSAIC VIRUS BY POLYMERASE CHAIN REACTION AND RESTRICTION FRAGMENT LENGTH POLYMORPHISM ANALYSIS
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- I.12) THE IMPORTANCE OF A PLANT VIRUS COLLECTION
van der Vlugt, R.A.A., Cuperus, C. and Vink, J. 83
- I.13) AN UNDESCRIBED SEED-BORNE VIRUS ON VOLUNTEER CHICORY
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