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Monitoring aphid flights to forecast virus outbreaks in squash crops – end of year 3 report

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A report prepared for
AGMARDT

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1 Executive summary

This report outlines the third and final year of the AGMARDT Progressive Farming project monitoring aphid flights to forecast virus outbreaks in squash crops in Hawke's Bay as well as results from the previous three seasons. We summarise the statistical analyses of the information on aphid activity and virus incidence accumulated over these four seasons at four monitored sites.

Our weekly observations on aphid activity have been successfully communicated to growers through fax, email, mail and website. As a result, Hawke's Bay squash growers have been able to make informed decisions on the management of aphid-borne virus diseases. We found that there was no lag period between aphids trapped in the wind or high level suction traps and the occurrence of aphid colonies in squash crops. Aphids will establish in squash crops quite quickly and, after successful colonisation, flights from within the crop will commence. We confirmed that seed treatment significantly controlled the establishment of aphid colonies in squash. We found that the number of colonies within a crop were not closely related to mosaic incidence, and that increased proportions of plants with aphids did not always lead to an increased incidence of mosaic disease. Inconsistencies between sites and seasonal variation have made it impossible to adequately relate aphid activity to mosaic development in crops or to construct a satisfactory virus prediction model. Factors such as temperature, moisture and crop management in addition to aphid pressure are also likely to play a significant role in virus spread. It is clear though that even a minor aphid infestation is sufficient to produce damaging virus levels if other conditions are conducive to virus establishment. Routine monitoring for aphids is very necessary to protect squash crops from virus disease outbreaks.

We conclude that the project has been worthwhile and hope to continue the aphid monitoring service in the future. However, this will depend on financial support from growers.

2 Introduction

A research programme on virus diseases of squash was initiated after an outbreak of zucchini yellow mosaic virus (ZYMV) and watermelon mosaic virus 2 (WMV2) in Hawke's Bay during 1994/95. Observations showed that early or mid season infection with either of the viruses could severely reduce the quantity and quality of squash harvested. Yield losses were not common in crops infected late in their growth.

were determined by randomly sampling 30 plants and counting aphids on up to 10 leaves/plant. Virus incidence was estimated both visually (weekly) by examining 100 plants, and by random sampling and ELISA testing 50 leaves (fortnightly).

A suction trap 7.5 m above ground was erected at Ngatarawa to monitor aphid flight patterns at high levels in the district in order to give early warnings of aphid activity from September through to late April. The trap was serviced weekly and the aphids caught were counted and identified. The data recorded from this trap formed the basis of the information faxed to growers every week and made available on our website.

4 Results

A full research report (Herman & Fletcher 2001) was presented to the growers involved in the project and to the NZBSC's Annual Meeting at Wairakei on 27 July 2001. The executive summary from this report is attached (Appendix).

4.1 *Aphid flights, virus incidence and crop monitoring*

As in the 1999/00 season, virus incidence increased throughout the 2000/01 season, leading to a higher than average incidence of mosaic symptoms in late sown crops. This year virus incidence related to a later commencement of the autumn aphid flights, from small flights in mid-February extending to main flights in April-May. Crop damage from mosaic virus was also compounded by mechanical spread and frost stress. These results demonstrated the need to monitor flights of aphid vectors and conditions favourable for the development of virus disease throughout each growing season.

Suction trap catches of aphid vectors at the start of the 2001/02 season indicated that flights had commenced at a similar time to in most previous seasons (Fig. 1 and 2). A large peak of vector numbers occurred in October, but spells of cold wet weather probably caused fluctuations in aphid numbers throughout the remaining spring and early summer. Very little mosaic virus was observed in the squash crops prior to Christmas.

A flight of aphids was recorded in late January-early February, and while some mosaic symptoms were observed in the foliage they did not lead to levels of fruit damage seen in some crops in the 1999/00 season. In that season, some crops under drought stress developed serious symptoms (reduced fruit size and blistering), but the lack of drought stress in the 2001/2002 season probably precluded the development of serious symptoms of the viral disease in the fruit.

The autumn flight of aphids was greater than previously recorded.

4.2 Faxes to growers

The procedure for sorting, counting and identifying aphids and then interpreting and relaying this information to the project growers ran smoothly during the 2000/01 season and has continued to do so in 2001/02. In the 2001/02 season 30 faxes were sent out weekly to participating growers. In addition, NZBSC has continued to receive the weekly summary and to convey this information to another 49 Hawke's Bay growers. Information on aphid catches was also made available on the aphid watch web site (www.aphidwatch.com/squash).

4.3 Field day

It has been difficult to get growers to attend a field day on the aphid monitoring/virus forecast project during the growing season. Individual discussions with participants have taken place in order to explain or convey details of the project.

Technology transfer has been achieved through presentations to growers at the annual NZBSC conference (Wairakei, July 2001). This meeting was attended by growers, including those from Hawke's Bay involved in the project, along with merchants, exporters and other industry personnel. A written report was also presented to the NZBSC summarising the project and Public Good Science Fund research findings (Fletcher et al. 2001 and Appendix). In addition, discussions with individual members of the project and other growers have been held to explain procedures, convey data and receive comment.

4.4 Disease/vector relationships-model development

Data collected over the four seasons have been analysed to determine the relationships between aphids counted within three crops as well as those trapped flying around the crops (wind traps) and those flying around the district (7.5m suction trap). Aphid activity was related by statistical analysis to the incidence of mosaic virus disease detected within the monitored crops.

4.4.1 Aphid establishment in squash crops

From records of the wind patterns and suction trap catches at Ngatarawa (Fig. 3), we found there was no consistent lag period for each trap between aphid numbers in the traps and numbers of colonies on crops. We hypothesised that the large suction trap might produce data that would allow us to better anticipate aphid activity in the field, improving the precision of the aphid warning programme. However, it appears that both traps equally reflect trends in aphid flight activity at Ngatarawa, although the suction trap caught 5 to 10 times more aphids than the wind trap.

In Figure 3 we have reported catches of known vectors of ZYMV and WMV2 as these are relevant to the study of virus incidence. However, total aphid catches followed similar patterns throughout the study period with vectors forming 68% of the total aphid catch both in the suction trap and in the aggregate of the wind traps over all four study sites. Accordingly, subsequent analyses of aphid incidence and colonisation within the crops were calculated from total aphid catches to ensure that any relationships found would use information which growers could easily collect.

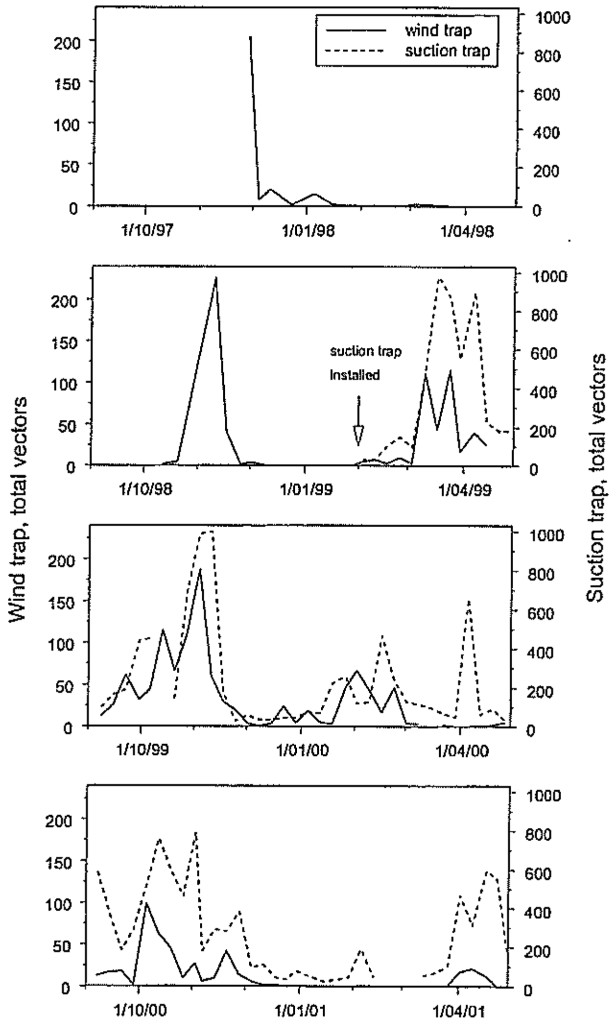
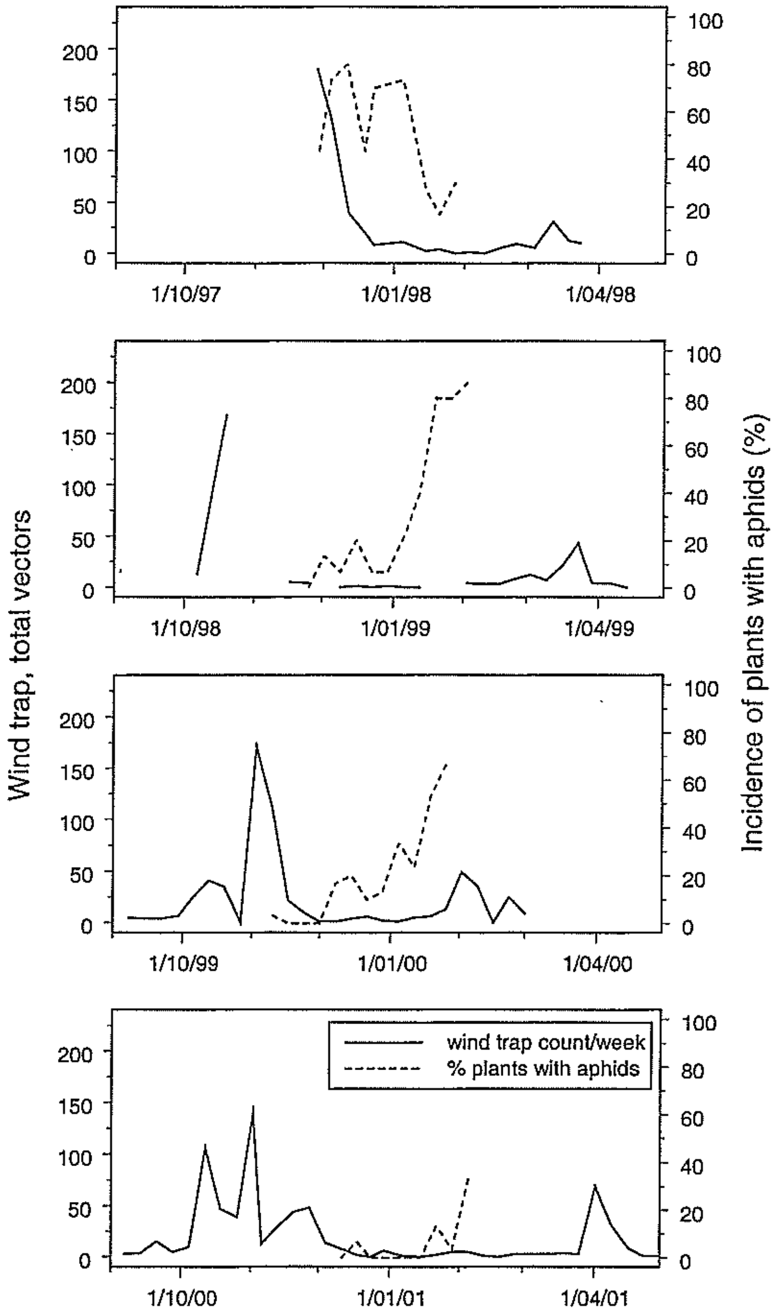


Figure 3: Wind and suction trap catches of aphid vectors at Ngatarawa during four growing seasons (1997/98, 1998/99, 1999/00, 2000/01).

(b) Pakipaki



Wind trap, total vectors
Incidence of plants with aphids (%)
0
50
100
150
200
0
20
40
60
80
100
1/10/97
1/01/98
1/04/98
1/10/98
1/01/99
1/04/99
1/10/99
1/01/00
1/04/00
1/10/00
1/01/01
1/04/01
wind trap count/week
% plants with aphids

4.4.2 *Virus mosaic incidence*

We measured the relationship between visual and serological (ELISA) estimates of virus mosaic infection levels in squash crops (Fig. 6). There was a linear relationship (R^2=0.49) between visual mosaic and serological assays of field samples. This meant that visual estimates of mosaic generally reflected disease incidence in the field. The slope of the regression line was not significantly different from 1, so we therefore used visual estimates in the analyses of aphid/mosaic relationships. Two observations at Pukekura and at Ngatarawa showed poor association (Fig 6), illustrating the difficulty in always obtaining consistent weekly samples from crops.

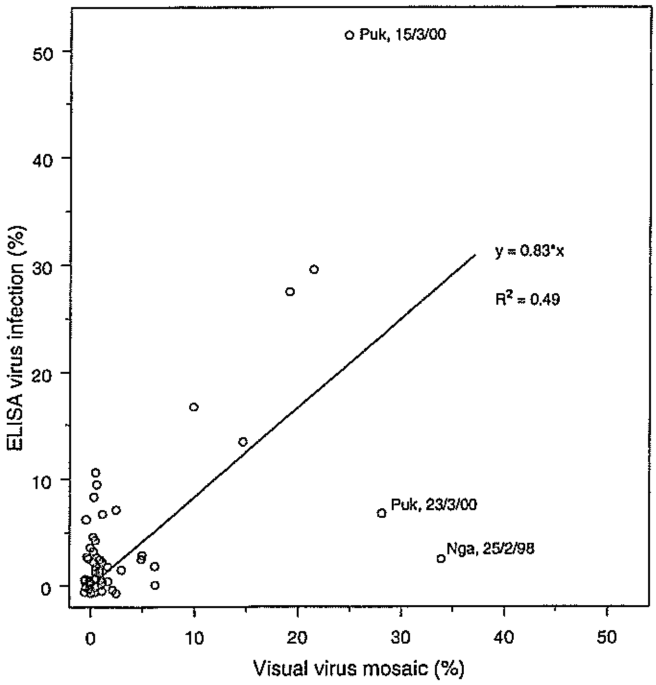


Figure 6: Relationship between visual and serological (ELISA) estimates of virus infection levels in 13 squash crops grown in Hawke's Bay during four growing seasons (n= 65).

We also examined the relationship between the maximum mean number of aphids colonies/plant from the weekly sample during crop growth, and mean visual estimates of the percentage of plants with virus mosaic infection during the final four weeks of the crop (Fig. 7). Mean numbers of colonies/plant were one to five per plant, irrespective of whether the crop had a high incidence of mosaic, suggesting that colony numbers or density alone were not closely related to mosaic incidence.

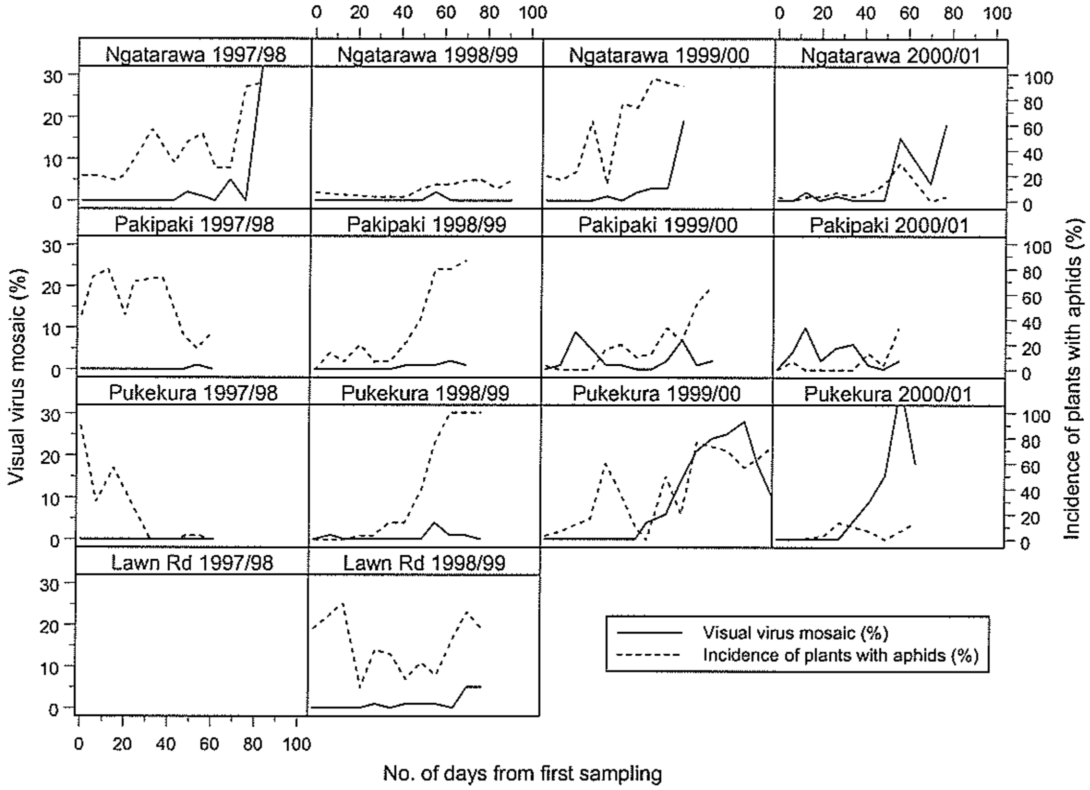


Figure 8: Incidence of plants with aphids present, and visual estimates of percentage of plants with virus mosaic for squash crops at each of three sites in the Hawkes Bay region during four growing seasons.

Figure 8 illustrates the incidence of plants with aphids present and visual estimates of the percentage virus mosaic for each squash crop. This confirmed that in almost all crops, mosaic infection followed once aphids were present on plants. At Pukekura in 1997/98 while no visual mosaic symptoms were observed, virus was detected using ELISA. Increased proportions of plants with aphids did not always lead to an increased incidence of mosaic, although in some seasons (such as 1999/00), increased numbers of aphids did lead to increased mosaic symptoms. Nine of the 13 crops were heavily infested, i.e. more than 50% of plants were infested with aphids at some time. Of these, in four crops more than 5% of plants had incidence of visual mosaic infection and five crops had light levels of infection (less than 5%). Of the four crops that always had aphids on less than 50% of the plants (Ngatarawa 1998/99 and 2000/01, Pakipaki and Pukekura in 2000/01) three had more than 5% visual mosaic infection, and all of these were grown in the 2000/01 season.

5 Discussion

5.1 Communication with growers

This season the aphid flight monitoring and virus forecasting system have worked well. The data were processed, interpreted and conveyed by fax, email, or mail to the growers in a timely manner. However, the development and testing of the model has been hindered by the fact that there has not been a major regional virus epidemic matching those that occurred in the 1995/96 and 1997/98 seasons. During these seasons mosaic developed regionally in crops to levels of 10-30% and up to 70% respectively. Over the monitoring period mosaic occasionally reached high levels at Ngatarawa, Paki Paki and Pukekura, but this occurred late in the growing season. However, growers have been using the data to initiate crop checks and have been able to choose to spray or not to spray for aphids in a timely manner.

The website has been reasonably successful with an average of 23 visitors per month (March 2001 to February 2002, August to November inclusive). International visitors make up more than half the visitors (70%), 30% are from within New Zealand. The squash site is the most requested page of the Aphidwatch site, which also covers cereals and potatoes. More targeted publicity to growers could increase the use of this web page.

Faxing information proved to be an effective way of getting the latest information on aphid flights and our assessment of the risk of virus outbreaks to the growers. It was important that the NZBSC forwarded copies of the fax to all other Hawke's Bay growers. The website, while not heavily accessed, was used by some growers.

An annual field day appears to be an inappropriate form of technology transfer for this research project. The annual grower meeting and individual discussions are more effective, and will be used when opportunities arise. We will continue to report to participants directly and growers generally at the annual NZBSC meetings. When an opportunity to take part in a local grower field day arises we will certainly accept it to further educate growers.

5.2 Suction trap

While the trends in numbers of aphids caught in suction and wind traps were essentially the same, the vastly greater numbers of aphids caught in the suction trap indicated that it has a higher level of sensitivity. Aphid catches in high level (suction) traps are less affected by the surrounding land use patterns than low level (wind) traps. Aphids do respond to cues related to the ground they are flying over. The lower they are to the ground the more responsive they are to the cues and this affects trap catches. Low level traps may also catch more aphids making local, short distance flights while high level traps catch are more likely to catch aphids on long distance migrations.

Research into the management of squash virus diseases, funded by the Public Good Science Fund, is allowing us to develop an understanding of the

Conference Papers

Burgmans, J.; Fletcher, J.D. 1999: Austrian Oilseed pumpkin/Styrian Pumpkins in New Zealand, mosaic virus infection, Hastings, New Zealand. August. 1st International Oilseed Conf., Graz, Austria.

Fletcher, J.D.; Herman, T.J.B. 1999: Weeds are important sources of potyvirus infection in buttercup squash crops (Abst.). p. 271. *Proceedings of the 52nd Annual NZ Plant Protection Society Conference, Auckland, August.*

Fletcher, J.D.; Falloon, R.E.; Herman, T.J.B. 1999: Weeds are important sources of potyvirus infection in buttercup squash crops. 12th Australasian Plant Pathology Society Conference, Canberra, Sept.

Fletcher, J.D.; Herman, T.J.B.; Travis, G.R.; Lister, R.A.; Butler, R.C. 2002: Management of squash mosaic disease in New Zealand. VIII International plant virus epidemiology symposium. Aschusleben, Germany, May.

Fletcher, J.D.; Herman, T.J.B. 2001: Hawke's Bay aphid/virus research. Report to New Zealand Buttercup Squash Annual Conference, Wairakei, June 30th.

Herman, T.J.B.; Fletcher, J.D. 2000: Research and development reprint, Hawke's Bay aphid trapping project. End of season report. *NZBSC 9-15.*

Herman, T.J.B.; Fletcher, J. 1999: Hawke's Bay aphid/virus research. Report to NZBSC Annual Conference. Wairakei, June 1.

A further presentation relating to this work was made at the VIIIth International Plant Virus Epidemiology Symposium in Germany in May 2002.

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Burgmans, J.; Fletcher, J. 2000: Virus infections levels of oil seed pumpkins in New Zealand. *Cucurbit Genetics Cooperative, No. 23:* 112-113.

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Fletcher, J.D. 2001: New plant disease records in New Zealand: further hosts of alfalfa mosaic virus, cucumber mosaic virus, potato virus Y, soybean dwarf virus and tomato spotted wilt virus. *New Zealand Journal of Crop and Horticultural Research 29*: 213-217.

Broadsheet

Fletcher, J.D.; Herman, T.J.B. 200? Mosaic viruses of squash. Crop & Food Research Broadsheet No. 66. June.

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Fletcher, J.D.; Herman, T.J.B.; Coup D.J. 1999: Incidence of buttercup squash virus diseases and experiments in disease forecasting using aphid flights. *CropInfo Confidential Report No. 622.* New Zealand Institute for Crop & Food Research Limited, Christchurch.

Fletcher, J.D.; Herman, T.J.B.; Travis, G-R. 2001: Incidence of virus diseases in buttercup squash and experiments in disease forecasting using aphid flights and disease surveys. *Crop & Food Research Confidential Report No. 435.* New Zealand Institute for Crop & Food Research Limited, Christchurch.

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Herman, T.J.B.; Fletcher, J.D.; Coup, D.J. 2000: Incidence of buttercup squash virus diseases and experiments in disease forecasting using aphid flights - a report on the 1999/2000 season. *Crop & Food Research Confidential Report No. 252.* New Zealand Institute for Crop & Food Research Limited, Christchurch.

Herman, T.J.B.; Fletcher, J.D. 2000: Monitoring aphid flights to forecast viruses in squash crops. *Crop & Food Research Confidential Report No. 134.* New Zealand Institute for Crop & Food Research Limited, Christchurch.

there are areas with repeated, high levels of virus infection as well as areas with a history of lower infection.

The monitoring of a localised late outbreak of mosaic further confirmed the importance of weeds as virus reservoirs in initiating infection. The outbreak also demonstrated the risk from mechanical spread (such as fertiliser spreading, cultivating or spraying) to other sites once a disease is established.

A survey of Gisborne crops failed to confirm virus infection in squash crops although mosaic symptoms were reportedly observed late in the season. Of concern was the detection of seed-borne cucumber mosaic virus in some zucchini crops grown near to squash crops. ZYMV was also detected in samples of zucchini seed sown in Gisborne.

We will continue to monitor regional disease spread throughout the season to study the ecology of virus spread leading to mosaic infection (PGSF funded research). The AGMARDT/NZBSC funded research project will require a commitment from growers for it to continue after December 2001. We will, however, continue to update the website with details of our risk survey and research findings to help growers with their decision making.