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A survey of mosaic viruses in buttercup squash, 1994/95

A report prepared for the
New Zealand Buttercup Squash Council

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CROP & FOOD RESEARCH
Mana Kai Rangahau

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CONTENTS

1 EXECUTIVE SUMMARY

Buttercup squash crops were surveyed in the Hawke's Bay, Gisborne and Manawatu growing areas. Watermelon mosaic virus (WMV) and zucchini yellow mosaic virus (ZYMV) were confirmed to be the major cause of mosaic symptom and fruit damage observed in surveyed crops. In Hawke's Bay all surveyed crops were found to have mosaic virus present with an incidence ranging from one or two isolated plants to a visual estimate of 90%. In Gisborne, WMV was confirmed in isolated squash plants and in a crop of netted melon, although there was no sign of significant mosaic. In Manawatu, one crop had occasional plants infected with squash mosaic virus; again there was no sign of significant mosaic virus. A number of factors, including aphid numbers, drought, frost, and wind conditions probably contributed to the high visibility of disease in Hawke's Bay crops.

At the request of the Squash Council guidelines to limit disease spread were drawn up and distributed to growers through the export manager. These recommendations have been expanded and long-term disease control and education strategies have been prepared for consideration by the Council and growers.

2 INTRODUCTION

Buttercup squash crops grown in New Zealand have been remarkably free of viruses since the early 1970s when squash mosaic (SMV) and watermelon mosaic (WMV) viruses caused disease outbreaks. The recent isolation of zucchini yellow mosaic virus (ZYMV) highlights, however, the vulnerability of this broad-acre crop and the difficulty in controlling such diseases.

Viruses are very small subcellular life forms that consist only of nucleic acids and usually a protein sheath. They cannot reproduce themselves outside a host cell. They take over the host cells (for instance plant cells) and use the cells' metabolic machinery to replicate themselves and multiply. Their activities often damage or disrupt the plant's normal growing pattern, causing visible problems such as leaf mottle, plant stunting, and flower colour break.

The symptoms of zucchini yellow mosaic virus are produced on leaves, plants overall, and, most importantly, on the fruit. Symptoms on the leaves are vein banding, yellow mosaic and distortion of leaves. Some plants show stunting and in particularly fruit show pimpling, blister, and reduced size, or even abortion. The disease was first recorded in France in 1979. Since then it has spread fairly rapidly throughout the world.

ZYMV is primarily transmitted from plant to plant by aphid vectors in a "non-persistent" manner. This means insecticides will usually not prevent transmission, but may reduce it. ZYMV may also be spread through crops by mechanical movement of equipment or people under favourable conditions and seed transmission may occur, but only very rarely. ZYMV has been recorded elsewhere in a range of cucurbit crops and in a few weed species including hen bit, and hairy buttercup, which are often found in New Zealand. Disease spread through the growing season from these sources is important overseas.

The original research objectives were:

- to confirm the identity of the mosaic virus disease affecting buttercup squash in Hawke's Bay,
- to survey and estimate the incidence of zucchini yellow mosaic in at least 10 early and 10 late sown squash crops Hawke's Bay, and to report on this survey to the Council in June 1995, and
- to prepare a popular article informing growers of the virus, its risk to production and possible management strategies.

As the season developed in Hawke's Bay, it became apparent that in addition to the growing effects of drought, late frost, and winds, virus infection was becoming more widespread than had been forecast. In addition to the above objectives, the Council and its advisors decided that additional monitoring of the Gisborne and Manuwatu regions and more extensive publicity on the nature of the disease be undertaken.

This report covers survey activities in Hawke's Bay, Gisborne, and Manawatu. It also reports on control recommendations made during the season and on control strategies for future consideration.

3 SURVEY METHODS

3.1 Hawke's Bay

A total of 20 squash crops, mostly around Hastings, Ngatarawa, Te Hauke, and Havelock North were selected by local Council representatives, growers, or exporters and visited in early February and March. Crops were assessed visually and specimens were taken for disease diagnosis and confirmation. Some additional market garden crops (zucchini) were also included in the survey. In most Hawke's Bay crops seen, disease incidence was visually spectacular, so a simple count of 100 plants (5 x 20 random groups) gave an estimated virus incidence. In less or non-affected crops no counts were made and only specimens of unexplained or unusual symptom were collected. Specimens were returned to Lincoln for inoculation and serological confirmation of virus disease. Diagnosis of disease was confirmed only when there was both mechanical isolation and serological confirmation.

3.2 Gisborne and Manawatu

As in Hawke's Bay, crops were chosen by local contacts but were usually visited only once in February to confirm the likely presence of any virus symptoms. Specimens were taken from any plant with unusual colouring or disease-like symptoms. Some additional market garden crops (zucchini, melon, and pumpkin) were also included in the survey.

4 RESULTS

The symptoms of the two main viruses observed in surveyed squash crops are described below.

- **Zucchini yellow mosaic virus** Yellow vein-banding, chlorotic yellow mosaic, with distortion and blister of leaves, sometimes "fanleaf". Plants sometimes stunted in mature crops; yellow water shoots often stand out above the crop. Fruit symptoms include pimpling, blister, and reduced fruit size.

- **Watermelon mosaic virus** Green vein-band mosaic, two-tone green colour of leaves rather than a yellow mosaic, water shoots may often stand out above the crop. Fruit do not appear to be blistered or distorted in the manner of ZYMV, although size and weight are likely to be affected to some extent.

Symptoms are likely to vary according to cultivar, time of infection, and if there is a mixed infection of both viruses. Symptoms observed this season were probably enhanced by environmental stresses such as frost and water shortage.

Both viruses are transmitted by aphids, usually by the melon aphid and peach potato aphid, but others as well. Aphid vectors were observed only during the March survey in some Hawke's Bay crops, when their populations were building up for their autumn flights.

Mechanical transmission within crops was also noted, particularly along irrigation lines, hand-trained or pruned crops, and in gateways.

The survey results are summarised in Tables 1, 2, and 3.

Crops surveyed in Hawke's Bay were usually selected on the basis of virus-like symptoms. Consequently all were found to be infected with ZYMV or WMV or both. Neither cucumber mosaic virus (CMV) nor squash mosaic virus (SMV) was recorded. ZYMV was the most widespread disease, affecting 17 crops with an incidence ranging from an isolated plant to 90%. WMV appeared to be less widespread, being confirmed in seven crops and in mixed infections in five crops. Widespread leaf yellowing, mosaic, and distortion were observed in most affected Hawke's Bay crops. Fruit distortion, blister, and pimple symptoms were observed in most ZYMV-affected crops.

In Gisborne, only WMV was identified in crops, affecting a netted melon crop and isolated plants in two squash crops. ZYMV was initially suspected to be present in a Tolaga Bay crop but subsequent testing failed to confirm its presence. Mosaic

symptoms of the type observed in Hawke's Bay were not observed in any Gisborne crop.

In Manawatu, only SMV was detected, in occasional plants in one crop. Other virus-like symptoms were observed in occasional plants. These were collected for diagnosis but were found not to be infected. Mosaic symptoms of the type observed in Hawke's Bay were not observed in any Manawatu crop.

5 DISCUSSION

Virus incidence was greatest in Hawke's Bay. It must be emphasised, though, that several factors probably contributed to the high level of virus observed. The important factors contributing to virus survival and spread included:

- large aphid populations overwintering from the previous autumn through a fairly mild winter,
- rapid build-up of spring aphid populations on overwintering cucurbits either as volunteers or in sheltered crops,
- survival of both ZYMV and WMV on squash volunteers, sheltered cucurbits, and in weed species, and
- dry summer conditions leading to drought stress, compounded by two or three very late frosts in December-January and windy conditions.

To assist in controlling of the disease out-break, the Squash Council - in consultation with Crop & Food Research and other specialists - immediately issued guidelines to inform growers and help them minimise disease risks (Appendix). Further to those guidelines, we have grouped our disease control suggestions into seasonal and post-seasonal grower strategies and long-term research-based strategies.

5.1 Grower strategies

The first suggestion is essentially a "do and don't" guide for growers. It is best presented and discussed with them as part of an education seminar. The seminar sets the scene, describes the virus, its vector, and what a grower and his neighbours can do to help themselves.

5.1.1 Seasonal and post-seasonal squash virus management recommendations for growers

(1) During the growing season:

- look for unusual disease symptoms and confirm their identity,
- once identified, if possible, rogue affected plants and destroy them,

- if disease is identified, restrict the movement of equipment and workers through the crop, especially on cool damp days, but crop inspections should continue,
- when inspecting crops, always move from a 'clean' or symptomless crop to a 'dirty' crop to reduce any potential disease spread,
- be alert to aphid invasion of crops,
- monitor adjacent crops for aphid vectors; spray at the same time to limit vector movement, survival, and population build-up,
- when spraying use registered products and observe recommended withholding periods to ensure there are no residue problems,
- ensure that the crop is a weed-free, both in and around the block,
- if moving equipment from an infected crop or district hose clean and sanitise with bleach (0.01% ai/l) or strong detergent, and
- if pruning or training plants, wash hands with soap, and sanitise cutters.

(2) Post-season control

- promptly feed off remaining fruit and vines to stock,
- thoroughly deep-cultivate old crops promptly to break down trash,
- if a crop had virus infection, avoid successive plantings in adjacent blocks where possible,
- initiate and follow sensible crop rotations, and avoid successive cucurbit cropping,
- eliminate all weeds and volunteer squash,
- monitor nearby home garden or glasshouse crops for pre-season infections,
- use reflective mulch in small-scale, high-value crops,
- ensure only high-quality seed with a proven quality assurance is sown, and
- sow disease-resistant varieties where available.

Most points are self explanatory, emphasising field hygiene to eliminate virus and vector hosts before or early in the growing season. Some concern has been expressed over the possibility of ZYMV being seed-borne. There is no evidence of this from the present survey but ZYMV has been transmitted in zucchini seed overseas. It is strongly recommended that all imported seed should have a phyto-sanitary certificate covering freedom from virus disease along with other bacterial and fungal pathogens. Concern from growers, breeders, and MAFQual about the lack of quality control in some seed lines cannot be ignored. Suppliers will almost certainly be able to provide suitable proof of tests undertaken for quality control on request.

5.2 Research strategies

The second suggestion, summarised below, outlines ways in which research organisations, such as Crop & Food Research, can improve prospects for long-term control.

5.2.1 Long-term research based strategies to control squash virus diseases

(1) Breeding virus-resistant squash.

- The use of conventional breeding to incorporate disease resistance.
- **Advantages:** availability of germplasm and expertise in New Zealand, a proven technique; no consumer resistance to this method or legislative constraints to release.
- **Drawbacks:** takes 5+ years, Japanese resistance to New Zealand cultivar.

(2) Trans-genic or molecular disease resistance.
(The use of synthetic processes to incorporate disease resistance).

- **Advantages:** can be fast if genes are available; can modify current cultivars; expertise in New Zealand.
- **Drawbacks:** level of consumer acceptance unknown; legislative constraints on release.

(3) Mild-strain inoculation (cross protection) – the use of a weakened virus strain to compete with and thereby protect the plant from a more destructive strain.

- **Advantages:** there is reasonable evidence that this method works overseas; simple technology, and few constraints for experimental use.

- **Drawbacks:** preliminary experimentation essential; possibly necessary to select a local strain; not proven in broad-acre New Zealand conditions.

(4) Bio-control of aphids.
The use of aphid monitoring, predators, break-cropping and other non-chemical vector control techniques.

- **Advantages:** organically acceptable, giving a market advantage; low grower inputs during growing season.

- **Disadvantages:** need for establishing a monitoring data base; regular field scouting to acquire data; complete vector control unlikely.

(5) Alternative chemicals.
The registration of safer and more effective aphicides.

- **Advantages:** an effective short-term solution; new modes of action e.g., anti-feedant properties and lower user toxicity; elimination of less effective chemicals; established grower practice.

- **Disadvantages:** increasing dependence on chemicals; consumer resistance; potential for build up of insect resistance.

6 RECOMMENDATIONS

The topics detailed in the Discussion should be considered. A list of priorities should be drawn up for action in 1995/6. Further disease surveys will need to continue next season in all regions, to monitor any spread of the diseases.

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Table 1: **Incidence of virus disease in buttercup squash and other cucurbit crops in Hawke's Bay, 1994-5 season. VDE, visual disease estimate; Y/N, presence or absence of fruit symptoms.**

Crop code	Cultivar	Location	VDE	Y/N	Viruses confirmed
Early crop	**18 & 26 January**				
S9501	Delica & Miyako	Flaxmere	50-60%	N	WMV, ZYMV
S9502	Delica	Te Tua	20-25%	N	ZYMV
S9503	Daruma	Pukekura	1%	N	ZYMV, WMV
S9504	Miyako	Pukekura	2%	Y	WMV, ZYMV
S9505	Delica	Te Hauke	50-60%	Y	ZYMV
S9506	Delica	Te Hauke	60%	Y	ZYMV
S9507	Miyako	Ngatarawa	80%	Y	ZYMV, WMV
S9508	Delica	Lawn Rd	5%	Y	ZYMV
S9509	Delica	Wanstead	1%	-	ZYMV
S9510	Delica	Lawn Rd	1 plant	-	WMV
S9511	Miyako	Haumoana	2 plants	-	ZYMV
Late crop	**March 9**				
S9512	Delica	Pukekura	2%	Y	ZYMV
S9513	Delica	Pukekura	10%	Y	ZYMV
S9514	Delica	Ngatarawa	80-90%	Y	ZYMV
S9515	Emiguri	Flaxmere	70%	N	ZYMV
S9516	Delica	Longlands Rd	80-90%	Y	ZYMV
S9517a	Delica	Te Aute Rd	80-90%	N	WMV, ZYMV
b	Delica	Te Aute Rd	20%	Y	ZYMV
S9518	unknown	Pakohai Rd	20%	N	WMV
S9519	zucchini	Pakohai Rd	80%	Y	WMV

Table 2: Incidence of virus disease in buttercup squash and other curcubits surveyed in Gisborne, 1994-5 season. VDE, virus disease estimate.

Crop code	Cultivar	Location	VDE	Viruses confirmed
GS1	Delica	Bell Rd	0	0
GS2	netted melon	Tuckers Rd	0	0
GS3	Delica	Tangihanga Stn.	0	0
GS4	Delica	Tangihanga Stn. Bush	*	WMV
GS5	Delica	Ormond	0	0
GS6	Delica	Waipaoa	0	0
GS7	Kurakuri	Tolaga Bay	0	0
GS8	Delica	Paroa Stn	*	??
GS9	Delica	Pakoirae	+	WMV
GS10	Delica	Puketapu	0	0
GS11	Delica	Puketapu	0	0
GS12	Delica	Willows Rd	0	0
GS13	netted melon	Kemp Rd	5%	WMV

*, occasional plants with a mild leaf yellowing symptom atypical of WMV & ZYMV.
+, single plant, chemical-like, stunt, and distortion.

Table 3: Incidence of virus disease in buttercup squash and other cucurbit crops surveyed in Manawatu , 1994-5 season, VDE, visual disease estimate.

Crop code	Cultivar	Location	VDE	Viruses confirmed
MS1	Delica	Booth Rd	0	0
MS2	Delica	Booth Rd - River	*	SMV
MS3	Delica	Piako Rd	*	0
MS4	Delica	Opiki	0	0
MS5	Delica	Hato Paroa	*	0
MS6	Whangaparoa Crown	Hato Paroa	*	0
MS7	zucchini	Awahuri	*	0
MS8	Ebisu	Awahuri	0	0
MS9	Delica	Settlers Line	0	0
MS10	zucchini	Settlers Line	*	??
MS11	Delica	Manaroa	0	0
MS12	Delica	Manaroa	0	0
MS13	Delica	Manaroa	0	0
MS14	Delica	Rata	0	0
MS15	Delica	Rata	0	0

*, leaf-yellowing or leaf-spotting symptom, atypical of WMV & ZYMV.