Fruit fly: a major threat to New Zealand's fruit and vegetable industries?

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http://www.maf.govt.nz/mafnet/rural-nz/research-and-development/pest-control/fruitfly-threat/httoc.htm

Introduction

On 2 May 1996, Mediterranean fruit fly (*Ceratitis capitata*) was identified in the Mt Roskill suburb in central Auckland, with the trapping of two male flies. By 23 May 1996, this number had increased to 41 adults (31 males and 10 immature females) and 85 larvae extracted from twelve infested fruits (eight feijoas, two tangelos and two grapefruits). The initial find and its identification constituted a fruit fly incursion. In response to the trap captures, an A-zone (200 m radius) and a B-zone (1.5 km radius) around the finds were defined, in which further monitoring and necessary control measures have been undertaken.

The latest fruit fly find was the third in 1996, up to the end of May, and all of them were in urban Auckland. The previous finds were the papaya fruit fly *(Bactrocera papayae)* and the Queensland fruit fly *(Bactrocera tryoni)*. The finds have all been within home gardens in urban Auckland. The control measures adopted by MAF in response to these recent incursions have been exhaustive, with no finds outside the A-zone.

Fruit flies belong to the family Tephritidae, which includes over 4,500 species. About 20 species can be considered as serious pests, even though 60 species are known to infest commercial fruit types. Some of the well-known species are the Queensland, Oriental, Mediterranean, Caribbean and papaya fruit flies. These fruit flies have a wide range of hosts; Queensland fruit fly is one of the most potent pests in that it infests more than 100 species of fruits. Mediterranean fruit fly is very similar, but is able to thrive better in drier conditions than Queensland fruit fly.

This article uses the recent incursion of Mediterranean fruit fly as a benchmark to consider the threat posed to New Zealand's fruit and vegetable industries by the fruit fly pest. In order to carry out this task, the life cycle, the host preferences and the current worldwide distribution of this species of fruit fly are considered. The level of importance of the fruit and vegetable industries in terms of their export values and the levels of direct employment is also analysed, along with their regional production distribution in New Zealand.

Important features of New Zealand's agricultural security system related to fruit fly, which is under the purview of MAF, are covered subsequently. This system consists of border protection measures, monitoring/surveillance systems and control/eradication mechanisms. This is followed by a description of control measures adopted in New Zealand and some other countries in response to fruit fly incursions. The nature of responses by important

trading partners to the recent incursion is outlined next. Finally, certain aspects of potential future incursions such as location, timing, type of fruit fly and the phytosanitary (plant health) responses of trading partners are considered. These are used to provide an overall perspective on the scope of the economic impacts of a fruit fly outbreak in terms of trade losses, control costs and regional employment in New Zealand.

Mediterranean fruit fly

Mediterranean fruit fly (commonly known as Medfly) is one of the world's most destructive pests of a wide range of fruits and vegetables (i.e. it is highly polyphagous). If not controlled, Medfly can cause serious economic losses as heavy infestations lead to complete losses of crops. Losses of 25% to 50% are not uncommon, as experienced in many countries around the world where Medfly is endemic.

Life cycle

Under optimum conditions, Medfly can complete its life cycle, which consists of four stages (adult, egg, larvae, and pupae), within 30 days. At lower temperatures, Medfly requires longer time intervals of up to 100 days to complete its life cycle. The particular season in which Medfly arrives in a country will determine the ease with which it colonises.

Adult Medfly are known to disperse up to distances of 20 km. However, they do not usually disperse beyond 100-200 m when host fruit is present. The female lays eggs in groups, up to 10 eggs usually, depositing them under the surface of the fruit. She may lay up to 1,200 eggs during her life time.

The eggs, laid just under the skin of the susceptible fruits, hatch within a few days and the emerging maggots or larvae feed on the fruit pulp. This is the point at which economic damage occurs. The maggots are fully grown, about one centimetre long, within 7-24 days. When mature, they make their way to the surface of the fruit, drop to the ground, tunnel into the soil and pupate.

The adult fly is formed within the pupa and emerges within 8-46 days forcing its way to the surface of the soil. The extent to which it can survive a complete winter as a pupa in the soil appears to be limited, in that pupal development ceases in temperatures below 9.7^{o} C. The newly emerged adults require about 2-3 days to mature before starting to lay eggs.

Host plants (fruits and vegetables)

Preferred hosts of Medfly include apples, apricot, cherry, feijoa, grapefruit, mandarins, orange, passionfruit, peach, pear, persimmon and plums. All of these are grown commercially and exported from New Zealand. Lesser hosts of Medfly include avocado, capsicum, kiwifruit, lemon, olive and tomatoes. The recent Medfly finds in central Auckland have all been within home gardens, predominantly on feijoas.

Distribution of Mediterranean fruit fly

European countries in which Medfly is present include Austria, France, Greece, Italy, Portugal, Spain and Turkey. Belgium, Denmark, Germany, Luxembourg and the UK are Medfly-free. In the US, there have been local established populations in Florida, Texas and

California, all of which were subsequently eradicated. Among South American countries, Argentina, Brazil, Paraguay and Uruguay have Medfly. Most central American countries also have Medfly.

Importance of the horticultural industry to New Zealand

Value of exports

New Zealand's fruit and vegetable exports were valued at NZ$1.4 billion in the year to June 1995. They accounted for about 14% of agricultural-based exports and about 7% of total exports. Apples ($476 million) and kiwifruit ($321 million) are the major export earners among the fruit category. Minor export fruits include pears ($16 million), avocados ($9 million), persimmons ($7 million), strawberries ($7 million), cherries ($6 million), apricots ($4 million), citrus ($3 million) and nectarines ($2 million).

Among the vegetables which are susceptible to Medfly, squash ($58 million) is an important export earner. Table 1 shows exports to four major markets of fruit and vegetables sensitive to Medfly infestations.

Table 1 - Export Values of Medfly Susceptible Produce by Market Destinations (NZ$000, Year Ended June 1995)

Products	**Australia**	**EU**	**Japan**	**US**	**Sub-Total**	**All-Total**
Fruits						
Apples	22	332, 677	923	71,109	404,732	475,833
Kiwifruit	21,812	172,833	77,642	5,551	277,837	320,817
Pears	83	8,770	-	3,969	12,822	15,528
Avocados	8,968	-	-	11	8,979	9,176
Persimmons	223	213	2,054	-	2,490	7,280
Strawberries	13	119	1,290	3,288	4,710	7,479
Summer fruits	5,690	417	884	1,181	8,172	13,203
Melons	11	237	5,034	537	5,819	5,879
Vegetables						
Squash	-	155	57,424	136	57,715	57,745
Total	36,822	515,421	145,251	85,782	783,277	912,940
Value	(4%)	(57%)	(16%)	(9%)	(86%)	(100%)

Regional trade distribution

The products in Table 1 account for about $900 million of New Zealand's total exports of fresh fruit and vegetables. The remainder comprised mainly processed fruits ($130 million) and vegetables ($177 million), flowers and seeds ($77 million), and fresh fruits and vegetables not susceptible to Medfly ($144 million).

The EU, which takes about $520 million worth of New Zealand's exports of fruit and vegetables, is the key market, followed by Japan ($145 million), the US ($86 million) and Australia ($37 million). Among EU member countries, the UK ($120 million) is a major market, especially for apples ($118 million). The above four countries account for about 86%

of Medfly susceptible fruit and vegetable exports, with the total EU market accounting for 57%.

New Zealand production distribution

Table 2 provides the latest (June 1994) information on fruit growing areas by types of fruits for the main growing regions in the North Island (the Bay of Plenty and Hawke's Bay) and the Auckland Region (due to the recent incursion), along with area totals for North Island, South Island and New Zealand.

The table does not include the grape area as grapes are very marginal hosts for fruit flies. It also does not include separate information for important fruit growing regions in the South Island, since they are less vulnerable to fruit fly colonisation, because of the temperature threshold for pupal development. The main South Island fruit growing areas are Nelson/Tasman (5,622 hectares), Christchurch (1,644 hectares) and Otago (1,783 hectares). In the Nelson/Tasman region, there were about 4,100 hectares of apples and about 800 hectares of kiwifruit in 1994. About 1,560 hectares (95%) of the total area in the Christchurch region was utilised for apple production.

The Auckland region, consisting of areas which are more than 10 hectares per Territorial Land Authority (TLA), accounted for about 2,100 hectares or about 5.7% of the total New Zealand fruit growing area. However, it includes substantial areas of a variety of fruit types which are susceptible to Medfly. Fruit trees in small home gardens, however, are not part of the area reported in table 2, for reasons of confidentiality, if they total less than 10 hectares per TLA. The Auckland region, which is not a major commercial production area for kiwifruit or apples, still accounted for about 5.5% of the kiwifruit and about 11% of the apples produced for the export market in 1995. The Auckland sea port and airport are also important departure points for New Zealand's fruit and vegetable exports.

Table 2: Distribution of Main Fruit Areas[1] by Major Growing Districts (Hectares, Year Ended June 1994)

Fruit Types	Auckland Region	Bay of Plenty	Hawke's Bay	North Island	South Island	New Zealand
Apples	587	176	6,595	8,413	6,844	15,257
Kiwifruit	816	8,261	627	11,331	844	12,174
Pears	36	30	409	770	509	1,278
Nashi	67	90	40	316	102	418
Avocados	61	775	47	1,354	21	1,375
Persimmons	158	70	83	411	1	412
Strawberries	53	24	44	251	80	331
Summer fruits	108	858	224	1,438	1,403	2,841
Tamarillos	41	76	-	286	13	299
Feijoas	24	18	-	148	12	160
Citrus	150	400	570	2,124	-	2,124
Total	2,101	9,920	8,973	26,842	9,828	36,670
	(5.7%)	(27.1%)	(24.5%)	(73.2%)	(26.8%)	(100%)

The Bay of Plenty region with almost 10,000 hectares of fruit grown, accounts for about 27% of the New Zealand fruit area — consisting mainly of kiwifruit (8,300 hectares) with some avocados (775 hectares) and citrus (400 hectares). The Hawke's Bay region, with just under 9,000 hectares or 25% of New Zealand fruit area, consisting mainly of apples (6,600 hectares), is the other main fruit growing area of the North Island. These two major fruit growing regions are most at risk to fruit fly due to:

- their proximity to Auckland and other major ports of entry of overseas passengers coming into North Island; and
- their relatively higher winter temperatures, which do not necessarily hinder the Medfly from completing its life cycle.

The Northland region, with only about 1,900 hectares of fruit area, is less economically significant, though equally vulnerable.

The South Island, which accounts for only about 27% by area of the fruit growing activity in New Zealand, is likely to be less susceptible than the North Island to a Medfly outbreak, and thus less susceptible to any consequent export exclusion zones imposed by trading partners. Given its life cycle characteristics, particularly relating to the temperature threshold for pupal development, Medfly is less likely to survive in regions of New Zealand with cold winters, such as the Otago region.

Permanent and Seasonal Work Force Employed in Fruit Growing

Table 3 provides the latest available data on the employment situation in horticultural production activity by working owners (both full-time and part-time), permanent employees (both full-time and part-time) and casual workers. The total number of workers in table 3, for each fruit growing activity, are the sum of individual categories which provide the level of work force dependency in each activity. They are not full-time equivalents.

In the total fruit sector (not including grape growing), full-time working owners (28%) and full-time employees (27%) make up most of employment. They are followed by casual workers (22%) and part-time working owners (18%). The vegetable types most likely to be affected by Medfly infestations are those belonging to the cucurbit family such as squash and zucchini, and melons (an important export product usually referred to as fruit).

Among the fruit types, not surprisingly, apples (37%), mainly grown in the Hawke's Bay and the Nelson/Tasman regions, and kiwifruit (32%), grown predominantly in the Bay of Plenty region, account for most of the employment. They are followed by citrus (8%), berryfruits (6%) and stonefruits (4%), the latter grown mainly in the Otago region. The 'other fruit' types (13%), consisting mainly of subtropical fruits such as persimmons, melons and tamarillo, make up the rest.

The direct employment effect of a significant fruit fly incursion in a major fruit growing region or in the North and/or the South Island could be considered separately by combining information in tables 2 and 3.

Table 3: Full-time and Part-time Employment Levels on Fruit Orchards (Number of Workers, as at June 1994)

Farm Types	Working Full-time	Owners Part-time	Permanent Full-time	Employees Part-time	Casual Workers	Total Workers
Citrus	267	245	125	44	224	905 (8%)
Pipfruit	1,172	518	1,566	265	698	4,219 (37%)
Stonefruit	162	97	141	12	60	472 (4%)
Kiwifruit	987	638	853	166	959	3,603 (32%)
Berryfruit	207	112	110	48	253	730 (6%)
Other Fruits	403	450	300	78	269	1,500 (13%)
Total Fruits	3,198 (28%)	2,060 (18%)	3,095 (27%)	613 (5%)	2,463 (22%)	11,429 (100%)

For instance, in the extreme scenario of a major fruit fly incursion in the Hawke's Bay region, with the entire region excluded from exporting apples by all our major trading partners, about 43% (i.e. 6,595 of the total 15,257 hectares; Table 2) of the total workforce of about 4,000 involved in on-orchard apple production (table 3) in the Hawke's Bay region or about 1,700 workers could be directly affected. In addition, there are a further 1,000-1,500 workers involved in upstream (e.g. input supply) and downstream (e.g. pack-houses, coolstores, transport and shipping personnel) activities. As the Hawke's Bay region accounts for almost 50% of the total apples produced in New Zealand, potential trade losses could amount to more than $230 million (table 1), if no Hawke's Bay apples could be sold overseas.

However, it should be stressed that such an extreme scenario is very unlikely for a number of reasons:

- the current system of border protection, surveillance and control/eradication mechanisms put in place by MAF, with respect to potential fruit fly incursions, mean that it is unlikely that a localised incursion would spread to an entire region (see following section);
- with respect to kiwifruit and apples, most markets which recently imposed exclusion zones are expected to accept fruits subject to cold storage, even from within excluded regions — controlled atmosphere storage is a standard practice for export kiwifruit;
- the EU, which is the main market for both apples and kiwifruit, did not impose any additional phyto-sanitary measures in response to the recent Auckland Medfly incident; and
- the spraying programmes in most commercial orchards will routinely control fruit fly which escape through the surveillance systems.

For the above reasons, any potential fruit fly incursion in the Hawke's Bay region is unlikely to become a widespread outbreak or lead to major trade and/or employment losses.

MAF's agriculture security system for fruit fly

In order that trade can continue without jeopardising New Zealand's plant health status, MAF enforces an integrated system of technically justified and cost efficient practices aimed at maintaining New Zealand's plant health status. Commercial product coming into New Zealand must meet particular import health standards. For fruit fly host material, this means exporting countries must have in place official control programmes for fruit fly prior to shipment.

Border inspection is used to check compliance with New Zealand's im-port health standards, and applies not only to commercial consignments, but also to passengers, vessels and mail. Indeed, the biggest threat to New Zea-land's horticultural industry comes not from regular commercial imports, but from the illegal introduction of in-fested produce into the country by unthinking or irresponsible passen-gers.

Passengers are encouraged to declare goods which they suspect may pose a risk. Two-thirds of interceptions of fruit fly-infested fruit made at the border this year were from declared goods. The remainder resulted from the inspection of luggage from passengers who had not declared goods.

Quarantine detector dogs are now being trialed, and MAF is investigating using new x-ray technology which can detect organic material. The Biosecurity Act contains penalties of up to five years in prison and/or a $100,000 fine for individuals.

Plant pest surveillance is the next stage of the programme, and is the 'backstop' for New Zealand's border inspection. It is recognised that not all possible means of entry for pests can be controlled, especially in the case of smuggling. Should a major pest such as fruit fly enter the country, it is important that it be detected and eradicated before it becomes well established. The current fruit fly surveillance system is designed as an early warning system. It also provides proof of the absence of fruit fly to our trading partners.

There are two parts to the surveillance system: passive surveillance, which involves using a variety of existing information sources such as agricultural and horticultural sources which, during the normal course of their work, collect surveillance information and are able to report on new pests; and active surveillance programmes such as the trapping system for fruit fly.

This latter system involves 7,385 traps nationwide which are located in populated areas, centres for trade and/or tourism, areas with a climate that particularly suits the fruit fly, and areas of significant horticultural activity. For example, there are about 350 traps in the Tauranga/Mount Maunganui/Whakatane area. In the Auckland area alone, there about 1,992 trimedlure traps, placed at 400 m spacings. Of these, 1,451 traps have been inspected at weekly intervals to ensure accurate monitoring of any spread of the recent Medfly incursion.

All traps nationwide are checked at fortnightly intervals: except those in the lower South Island during the winter. These are designed to detect possible accidental introduction of

fruit fly by passengers/tourists travelling into commercial fruit growing areas from their original point of entry into the country.

The final part of the system is the exotic disease and pest response programme. If a pest such as fruit fly is found in a surveillance trap, an eradication programme based on a pre-defined management strategy is implemented. In the case of fruit fly, specialist teams are immediately mobilised for mapping, fruit monitoring, intensive bait and lure trapping, baiting and fruit disposal. There is also immediate communication with our trading partners who then evaluate how serious they consider the event to be.

Cost of measures to control fruit fly

New Zealand

New Zealand (along with Chile since early this year) is one of the major exporters of fresh fruits and vegetables in the southern hemisphere that do not have economically important species of fruit fly. The annual budget for fruit fly trapping in New Zealand has remained at about $1.1 million since 1989.

The budget for quarantine clearance at airports, for both passengers and aircraft, had risen from $4.5 million in the year ended June 1993 to $4.8 million in 1995, with the introduction of the quarantine detector dog programme. However, the number of overseas passenger arrivals, mainly to the Auckland region, has grown from 1.7 million a year in 1989 to 2.4 million a year in 1995.

The recent Medfly incident in Mt Roskill is expected to cost much more than the $450,000 spent by MAF in total for the previous two responses to papaya and Queensland fruit fly captures earlier this year.

Other countries

Chile has spent about US$50 million over a 30-year period in its battle against Medfly, especially on border controls and the introduction of a rearing facility for sterile fruit flies. Chile is a major southern hemisphere exporter of fruits, valued at about US$963 million in 1994. The exports consisted of apples, kiwifruit, grapes, pears, plums, nectarines and peaches, mainly to North America, Europe and the Far East.

In Australia, the ongoing fruit fly problem has resulted in growers and the State and Federal Governments sometimes paying out more than A$20 million a year for the treatment of crops before and after harvest, for monitoring and eradication programmes, and for measures to prevent the spread of fruit fly. In Queensland, following the papaya fruit fly outbreak in October 1995, the State and Federal Governments are considering a A$40 million programme, over 5 years, to control the problem.

How have overseas markets responded?

Over a period of several days following the Medfly detection in Auckland in early May 1996, many of New Zealand's important trading partners imposed exclusion zones of varying radius around the initial fruit fly find. These exclusion zones for fruits and some vegetable exports, ranged from zero (EU), to the whole of the North Island (China).

Australia initially imposed an 80 km radius exclusion zone around Mt Roskill, which was subsequently reduced to 15 km in early June 1996. This applied to all Australian States, except Western Australia where Medfly is endemic. Insect-proofing is required for all fruit transported through the exclusion zone.

Japan imposed a 15 km radius exclusion zone, with insect-proofing of other fruits transported through the exclusion zone.

The US imposed a 7.2 km radius exclusion zone with similar insect-proofing requirements as Japan and Australia. Auckland airport, a major outlet for the air-freighting of perishable high value fruits and vegetables, is located outside this radius. However, major highways to Auckland airport pass through this smaller exclusion zone.

The EU did not impose any additional phytosanitary measures, even though individual member countries could require safeguards. Belgium, Denmark, Finland, Italy, Luxembourg, Netherlands, Norway, Spain, and the UK confirmed that they did not require any additional measures.

Tonga (15 km), Taiwan (20 km), Philippines (30 km), Korea (80 km), and Fiji (80 km) have also placed partial bans of varying proportions, with the Chinese ban extending to the whole of the North Island, on exports of host commodities from New Zealand.

The responses by most of New Zealand's major trading partners to the recent Medfly incident can be described as restrained. This is probably due to:

- confidence in MAF's phytosanitary regimes and response measures, outlined in the previous section;
- the incident being restricted to 11 of the 78 suburban properties within a 200 m radius (A-zone); and
- the new WTO Sanitary and Phytosanitary (SPS) Agreement, which stipulates that import restrictions have to be technically and scientifically justifiable.

Assessing the implications of a fruit fly incursion

The following factors are important in determining the consequences of a fruit fly incursion in New Zealand.

Location — In a commercial fruit/vegetable growing area such as the Hawke's Bay, an incursion is likely to affect several hundred hectares of export properties. An incursion in an urban area, as occurred in Auckland, has a lower chance of spreading to export properties. However, requirements to insect-proof fruits transported through urban exclusion zones will impose additional cost on exporters;

Timing — An incursion in summer or spring as opposed to autumn, as has been the case with the current incident, allows fruit fly a longer period for successful colonisation;

Type of fruit fly — A Queensland fruit fly incursion is likely to have required similar surveillance and control measures by MAF as the recent Medfly incident and also a similar reaction by the trading partners. The incidence of their accidental introduction is also likely to be greater during the first 4-5 months of the year. An incursion of other fruit fly species, such as the Western or Eastern cherry fruit fly, which are less polyphagous (i.e. more host-selective) than the Medfly and the Queensland fruit fly, would have been met with a lesser response.

Response of trading partners — It is unclear if the exclusion zones applied by various countries in response to the recent Medfly incursion in home gardens might have been any different if the incident had taken place in a commercial fruit growing area. While the likelihood of more extensive colonisation is possible in a commercial area, if unsprayed, current routine spraying programmes on most commercial orchards are expected to provide an effective control of all fruit fly species .

In terms of its economic significance, an outbreak in the Bay of Plenty in autumn or in the Hawke's Bay in late summer could have major impacts on the regional economies (table 2) in terms of potential trade losses (table 1), additional control and phytosanitary costs as well as loss of employment (table 3) and income opportunities. The probability of their occurrence, however, is likely to be smaller than the recent incident in Auckland, principally because international airports are not presently located in these regions.

Summary

This article has attempted to provide an overview of the threat to New Zealand's horticultural industry posed by the fruit fly pest. The horticulture industry is an important export earner, contributing about 14% of agricultural-based exports in the year to June 1995. It is also a significant employer of full-time, part-time and casual labour on orchards and in further processing activities. A major and widespread outbreak of fruit fly could potentially put some of this at risk in the short term, through overseas trade losses, control and phytosanitary costs, and regional employment and income losses.

Because of this potential risk, measures aimed at preventing the introduction and establishment of fruit fly are part of MAF's extensive agricultural security system. MAF's detection and control procedures have proven to be effective in limiting the spread of recent incidents and in gaining the confidence of our trading partners. As such, the disruption to trade resulting from the May finding was minimised.

Other factors mitigating against severe consequences arising from a fruit fly introduction in New Zealand include (i) the current spray programmes on commercial orchards which can control fruit fly; (ii) the present controlled atmosphere storage used for export kiwifruit and apples, which is an acceptable alternative control measure for fruit fly from excluded zones; and (iii) the new WTO SPS regime, which requires countries to base import restrictions on technically and scientifically justifiable grounds.