PEST AND DISEASE DECISION SUPPORT FOR HAWKES BAY APPLE GROWERS - A SURVEY

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SUMMARY

An interview survey was conducted amongst 50 randomly selected Hawkes Bay apple growers to determine their present pest and disease problems, use of existing IPM methodology and requirements for an improved decision-support service. The survey found more than 20% of growers had difficulties with blackspot (*Venturia inaequalis*), Phytophthora crown rot (*Phytophthora cactorum*), mealy bugs (*Pseudococcus* spp.), European red mite (*Panonychus ulmi*) and fireblight (*Erwinia amylovora*). Many growers used existing IPM techniques. Decision-support using fax and computer technology appears feasible. Implementation will require acceptance of the concept by horticultural field representatives and private consultants, as they are major spray decision-makers. Most growers perceived a problem with pesticide residues and pest and disease resistance and expected to reduce and better target pesticide applications through improved technology in the future.

Keywords: apples, pests, diseases, computers, IPM, pesticides, grower-survey.

INTRODUCTION

Apple growing in New Zealand is a sophisticated, high technology industry. Despite its success as a major export earner, future problems are foreseen. One such threat is the probable tightening of access to external markets for pesticide-treated crops (Whalon and Penman 1991). Pesticides are used extensively in New Zealand apple orchards in order to, firstly, produce the high quality fruit necessary for good financial returns and, secondly, to ensure complete absence of key pests and diseases in order to satisfy the phytosanitary requirements of importing countries. Apart from the possible loss of export markets, extensive use of pesticides can lead to other problems. These include pest and disease resistance, effects on non-target organisms and negative public perceptions of the industry.

In New Zealand, a number of IPM techniques are available to assist growers to reduce pesticide applications without significant economic risk. These are either known to growers or recommended by the consultants and field representatives that advise them. Whilst these decision aids have been developed independently of one another, they often use shared environmental parameters, such as temperature. A decision-support system designed to assist in timing pesticide application, as proposed by Manktelow and Laurenson (1990), would seem to be a useful way of combining these stand-alone decision aids in an integrated way.

In all the phases of IPM development, it is often the implementation stage which proves the most difficult. One of the main reasons for this appears to be a lack of understanding by researchers, as to the perceptions and constraints of the grower, and the nature of the industry itself (Wearing 1988; Fenemore and Norton 1985).

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In view of this, a grower survey was conducted with the following aims:

1. to determine which pests and diseases are difficult to control.
2. to determine the use and extent of existing IPM methods.
3. to gauge the receptiveness of growers to integrated decision support and determine the most appropriate delivery system.

Due to time and financial constraints the survey was limited to the Hawkes Bay region.

METHOD

In June 1992 a sample of 50, from a total of 615, export apple orchard owners from the Hawkes Bay region was randomly selected using a registration list from the Apple and Pear Marketing Board. During June - September 1992, these owners were contacted and survey interviews arranged with the "spray manager" of the properties concerned. This was usually the owner but in some cases this role was fulfilled by a salaried manager. Data were subjected to univariate and bivariate analysis, the latter using Pearson's Chi-square (X^2), Spearmann Correlation (sp) and the Mann-Whitney U test (mwu) where appropriate. The margin of sampling error was approximately 7%.

Growers were asked some personal details such as age, experience, size of orchard and status (owner or manager), any formal training in apple growing they may have had and if their parents or grandparents had been involved in the business. They were then questioned on which pests and diseases they found "troublesome" (i.e. the level of control was not to their satisfaction), which ones they found difficult as regards spray timing (i.e. deciding when to spray) and what decision aids (if any) they used. Also included were questions on their desire for an integrated decision support system, the best way of delivering this, how they would rank provided features of a proposed system, and whether they had, and were comfortable with, the appropriate technology. They were also canvassed as to whether they viewed pesticide residues and pest and disease resistance as significant future problems for the industry.

During the survey, growers were asked to rank the main factors (out of seven provided) which contributed to their "spray decision" for six commonly sprayed pests and diseases, i.e., leafrollers (Lepidoptera: Tortricidae), European red mite (*Panonychus ulmi*), mealy bug (*Pseudococcus* spp.), fireblight (*Erwinia amylovora*), black spot (*Venturia inaequalis*) and powdery mildew (*Podosphaera leucotricha*).

One of the factors offered was "monitored data" where growers would take into consideration the results of monitoring or recommendations from a spray decision aid. By allocating a point every time this factor appeared as a consideration in the four highest ranked factors and summing over the six pests and diseases, an "informed spray" score (max. of six points) was calculated for each grower.

Similarly an "advisory" score was calculated as above, depending on whether the factor "advice from someone else" was selected in the top four considerations.

Finally, a "technology score" (max. of 4) was calculated for each grower if they owned (2 points each) or had access to (1 point each) a fax machine or microcomputer.

These scores were used to determine if correlations existed between the various factors and other parameters such as grower experience and orchard size.

RESULTS

Grower and orchard characteristics

The "typical" grower was between 40 and 50 years of age, had been growing for 10 years and did not come from an orchard background (56% of respondents). However, the more experienced growers tended to have parents or grandparents who were also involved in the business (sp=0.39 P=0.04).

A "typical" orchard had 4000 or so trees. This is the median rather than the mean as three "corporate" orchards were selected in the sample, with managers having from 20,000-64,000 trees under their jurisdiction. These outliers had a distorting effect on the mean.

Whilst 80% of those surveyed had no formal training in horticulture, 12% had done courses or gained certificates, 6% had diplomas and 2% (1 respondent) had a

horticultural degree. With the exception of one grower, all those who had formal training did not come from an orchard background.

In the surveyed sample, 86% of the participants were owners and 14% managers. Managers were more likely to be younger (mwu $P < 0.01$) and have had some form of formal training compared to owners ($X^2 P < 0.01$).

Troublesome pests and diseases.

Figure 1 shows the responses to the question “Which pests or diseases have been troublesome in the last 5 years”. Over half the growers (58%) rated black spot as a major problem. Phytophthora (36%), mealy bugs (36%) and European red mite (34%) also rated highly. Most of the pest or disease problems were ongoing with the exception of black spot and fireblight. Most growers found black spot troublesome only in the 1991/92 season (50% vs 8% for seasons previous to that). Most growers who found fireblight troublesome (22%) cited the 1988/89 season as being the only period where this was so. Mealy bug caused problems mostly in larger trees where spray penetration and/or coverage was more difficult. One grower had a 90% rejection rate on one particular variety due to this pest!

Figure 1: Troublesome pests and diseases in the last five seasons (87/88 - 91/92)

European red mite was less of a problem in 1991/92 when only 6% registered difficulties compared with 28% in previous seasons. Seasonal factors may apply, but the reduction may be partly attributed to some growers who suffered problems with this pest in previous years switching to using ovicides or integrated mite control in the 1991/92 season.

Participants were asked if they had difficulty in timing sprays for six regularly sprayed pests and diseases. They were also asked if this “timing indecision” had led to a loss of control. Results appear in Figure 2. As expected, black spot was the most difficult regarding timing, the question often being “Has my protective cover run out?” rather than “Has there been an infection period?” About half of these growers considered incorrect black spot timing decisions had led directly to a loss of control. Thirty two percent of growers considered fireblight spray timing was difficult, although in recent years the disease had not been troublesome.

Sources of information

Growers were asked to rank sources of pest and disease information with regard to their importance. Sixty eight percent of growers cited horticultural merchant field representatives as their most important source of pest and disease information. Fourteen percent used private consultants as their main source of advice whilst 6% used other growers (Fig. 3). Other growers, the Apple and Pear Marketing Board and trade journals were a useful secondary or alternative source of advice to many.

Figure 2: Percentage of growers who found spray timing difficult

Figure 3: Primary sources of advice for pest and disease control

Use of existing IPM technology and methodology

Figure 4 shows the extent to which growers were using existing IPM techniques.

(i) *European red mite management* Most growers (80%) said they had predatory mites in their orchards although only 64% said they always used predator-friendly chemicals. Of the 36% that did not, most cited using ovicides such as clofentezine as the reason. Interestingly, ovicides were used more by those growers who had a low "technology" score (mwu $P=0.01$).

Some form of active-stage mite monitoring was undertaken on 76% of the properties surveyed, although more often with the aid of a field representative or consultant than the grower alone.

The DSIR mite hatch prediction model (Hayes *et al.* 1988) was used by 72% of growers to time early-season miticides. In the main, growers thought this was a very useful service with users scoring it as either good or very good. The main reason for non-use was that ovicides were being used and therefore these growers did not need it. Users of the mite hatch prediction model had a higher "technology" score than non-users (mwu $P<0.01$). A few growers indicated they intended to alternate their mite control techniques, using ovicides one season and "timed" active-mite sprays the next.

Figure 4: Percentage of growers using pesticide saving or timing techniques

(ii) *Black spot infection periods* Black spot infection periods based on Mills periods (Mills and Laplante 1954) or MacHardy periods (MacHardy and Gadoury 1989) were obtained or measured by 94% of growers. These infection periods were often gleaned from more than one source. These included radio broadcasts, the grower's own monitoring, or one of the horticultural merchant firms. Often a representative of the latter would inform their clients if an infection period had occurred.

The daily radio broadcasts were listened to by 62% of growers. In the main, growers found the service useful, the major criticism (by practically all growers that used it) being that monitoring sites were not "local" enough.

Thirty eight percent of growers, particularly those with formal horticultural training ($X^2 P=0.02$), measured their own infection periods either using weather data and an infection period chart (32%) or a specific black spot measuring device (6%).

(iii) *Fireblight infection periods* Only 10% of growers used any kind of quantitative fireblight infection period (mostly watching for temperatures greater than 16°C and relative humidities >70%). Most responded that they did not know enough about such periods (52%) or never felt they needed to monitor for them (30%). As with black spot, fireblight infection periods were more likely to be used by growers with formal horticultural training ($X^2 P=0.02$).

(iv) *Pheromone traps* A number of growers used pheromone traps for monitoring flights of leafroller (22%) and codling moth (14%). Most of those who used leafroller traps found them useful, although three growers (6%) found that they added indecision to spray application. Two growers (4%) had them on the property but did not use the monitored data for management. Thirty two percent of growers considered that there was no need for any leafroller traps and 26% did not know much about them. Eight percent of growers considered they were not practical. However, 12% of growers surveyed, who were not presently using them, indicated they would use them in the following season. Leafroller pheromone traps tended to be used more in the larger orchards (mwu $P=0.01$).

Most growers (60%) considered there was no need for codling moth traps.

(v) *Factors important in the spray decision* As described in methods, growers were shown seven factors which may contribute to the spray decision and asked to rank them for six pests and diseases. Most growers chose at least four factors as being important. Table 1 shows an "average" ranking of these first four most important factors. For leafroller, powdery mildew and mealy bug, most growers followed a regular calendar

program based on a spray chart, applying more or less according to qualitative assessment (gut feeling, intuition, experience etc.). The same calendar treatment was carried out for black spot but with this disease, quantitative data (showing occurrence/non-occurrence of an infection period) and advice from a field representative/consultant etc. was also important regarding timing of protectant and eradican sprays. Spraying for fireblight and mites tended to occur more at specific times of the season, with timing advice often sought or given. Spraying for European red mite was usually determined from either the mite hatch model (early season) or qualitative monitoring (late season), unless ovicides were used. In most growers' opinions, ovicides gave season-long control.

TABLE 1: Factors which contribute to the spray decision ranked in order of importance for six commonly sprayed pests and diseases.

Pest/Disease	Factors ranked in descending order of importance
Leafroller	Timing taken from spray chart Qualitative assessment (gut feeling, intuition etc.) Advice from someone else (field rep., consultant, etc.) Applied in a tank mix when spraying for something else
Mites	Advice from someone else (field rep., consultant, etc.) Monitored data (counts, results of decision-aid etc.) Qualitative assessment (gut feeling, intuition etc.) Timing taken from spray chart
Mealy bugs	Qualitative assessment (gut feeling, intuition etc.) Timing taken from spray chart Advice from someone else (field rep., consultant, etc.) Applied in a tank mix when spraying for something else
Fireblight	Qualitative assessment (gut feeling, intuition etc.) Advice from someone else (field rep., consultant, etc.) Timing taken from spray chart Predicted weather (next 2-3 days)
Black spot	Qualitative assessment (gut feeling, intuition etc.) Monitored data (counts, results of decision-aid etc.) Predicted weather (next 2-3 days) Advice from someone else (field rep., consultant, etc.)
Powdery Mildew	Qualitative assessment (gut feeling, intuition etc.) Timing taken from spray chart Advice from someone else (field rep., consultant, etc.) Applied in a tank mix when spraying for something else

("Average" rankings based on medians)

The percentage of growers who ranked monitored data as one of the four most important factors in spray decisions for six pests and diseases are presented in Table 2. Quantitative data was commonly used in mite and black spot spray considerations. The "informed spray" score derived from these data (see methods) was higher for growers with formal training (mwu $P=0.03$) and was positively correlated with the size of the property ($sp=0.55$ $P<0.01$). Sixteen percent of growers did not use monitored data for spray decisions for any of the six pests or diseases.

Most growers sought advice from someone for at least four pests and diseases out of the six covered (Table 2). There was a weak negative correlation between age of growers and “advisory” score ($sp=-.266$, $P=0.06$) although no correlation existed between grower experience and this score. There was a weak positive correlation between orchard size and “advisory” score ($sp=.28$ $P=0.04$).

TABLE 2: Percentage of growers who ranked monitored data or advice from others as one of the four most important factors in making spray decisions for six common pests and diseases

No. of pests and diseases	% growers	
	Using monitored data	Seeking advice
1	16	10
2	34	4
3	20	20
4	4	16
5	4	18
6	6	28

Pest and disease decision support service?

(i) *Desire for service* Eighty two percent of growers said they would support a service “which automatically monitored pests and diseases in the orchard (or a homogeneous area) and could communicate same-day recommendations to them, along with other orchard-specific information they might want” if such a service was available (Table 3). Of those that said they would not, reasons given were either that the property was too small (4%) or that a consultant/field representative does the same job anyway (12%). One grower said he would not support it on principle unless it was entirely free. In general, the service was supported more by younger growers than older ones (mwu $P=0.01$) and by growers managing larger orchards (mwu $P<0.01$). Also, the service was desired more by those growers that ranked high on the “technology” score (mwu $P=0.02$) and the “informed spray” score (mwu $P=0.01$).

TABLE 3: Decision support statistics

	Fax	% Growers Computer	Telephone
Own	20	46	100
Access only	34	18	0
Preferred delivery mode	68	20	12

(ii) *Existing equipment for delivery* Sixty eight percent of growers felt that a fax machine would be the most appropriate mechanism for delivery of such a service, 20% felt a computer-modem link would be best and 12% opted for the telephone (Table 3). Growers were split about 50:50 on whether the existence of such a service would encourage growers to buy a fax machine. Many growers were contemplating buying them for other uses anyway.

Ownership or access to either a fax machine (54%) or microcomputer (64%) was relatively high, and the “technology” score showed a positive correlation with the size of orchard ($sp=0.39$ $P<0.01$) and a weak but significant correlation with the informed spray score ($sp=0.28$ $P=0.04$). Perhaps surprisingly, age was not a factor in ownership or access to the above technology.

When asked the question "Do you feel comfortable using a microcomputer?" 36% of respondents answered in the negative, mostly those who did not own or have access to one.

(iii) *Importance of selected features for a "hypothetical" pest and disease decision-aid* Growers were asked to rank the importance of five given features of a hypothetical computer-based pest and disease spray decision-support system. From an "average" ranking based on medians, the five most important factors in order of importance were:

1. Reliability
2. Easy to interpret (i.e. at a glance)
3. Automatic monitoring of necessary parameters (insects, weather etc.)
4. Gives control recommendations (control options, list of pesticides etc.)
5. Offers an optional educational aspect (info. on insect life cycles etc.)

Correlations were found between the ranked importance of a particular feature and grower or orchard parameters. "Giving control recommendations (and options)" tended to be ranked lower in larger orchards ($sp=0.36$ $P=0.01$), amongst growers with high "technology" scores ($sp=0.28$ $P=0.05$) and with growers who had formal training (mwu $P=0.04$). Growers with a high "informed spray" score also considered this feature as less important ($sp=0.344$ $P=0.01$).

Experienced growers put less weight on reliability ($sp=0.37$ $P=0.01$) but ranked ease of interpretation as a very important feature ($sp=-0.36$ $P=0.01$). Growers with high "technology" scores valued educational aspects more ($sp=-0.30$ $P=0.04$) and growers with formal training and a high "informed spray" score considered automatic monitoring to be more important than did other growers (mwu $P=0.01$ and $sp=-0.245$ $P=0.08$ respectively.).

Residues and pest and disease resistance - a problem in the future?

Growers were shown two statements saying that pesticide residues and pest and disease resistance would be major problems for the New Zealand apple industry within the next 10 years. Practically all growers agreed (38%) or strongly agreed (58%) residues would be a problem in the future with only 4% of growers unsure. Opinion was more divided on resistance although most growers (78%) felt this would also be a problem. In an open question growers were asked how they saw pest and disease practices changing in the next 5 years. Most said they expected to see less spraying through improved IPM techniques and/or better spray application technology. Many expected to see "greener" pesticides.

DISCUSSION

The survey was conducted in the Hawkes Bay area hence the results and discussion pertain to that region only. Other apple growing regions, such as Nelson and Canterbury, may differ in their problems, perceptions and use of decision-aids.

Grower and orchard characteristics

The survey shows an industry with many "newer" growers as over half those canvassed had less than 10 years experience and did not come from an orchard background. This influx of new growers during the 1980's reflects the present good health and high returns of the industry. It is also an industry where most growers have no formal training in horticulture.

Troublesome pests and diseases

The results indicate more research into the persistence of black spot fungicides on plant surfaces would assist timing. Mealy bug and *Phytophthora crown rot* (*Phytophthora cactorum*) were cited as troublesome by a significant number of growers and could indicate more research into control is perhaps needed with these organisms.

Use of existing IPM technology and methodology

The results show a relatively high use of established IPM technology and strong interest in new techniques (e.g. leafroller pheromone traps) particularly in larger orchards and amongst growers who have received formal training in horticulture. This is not surprising, as larger blocks have greater spray costs and therefore any reduction

in spray applications by improved timing would result in significant financial savings. Growers who have received formal training are likely to have covered the benefits of IPM methodology in the course of their studies and so attempt to apply it to their situation.

Whilst they may save on the cost of chemicals, decision aids often make management harder, when compared to following a conservative spray program or relying heavily on advice from someone else. The difficulties involved with this “active” decision-making and its associated risks is a common problem in apple IPM implementation (Fenimore and Norton 1985). Reducing this risk factor through more accurate techniques and improved decision support should improve uptake of the methodology and lead to overall lower chemical usage.

It is assumed the use of IPM methodology and decision-aids reduces overall pesticide application. Data are being examined at present in an attempt to quantify this, and it is intended the results of this related investigation be the subject of a subsequent paper.

New pesticides can render IPM techniques less important or even redundant. The ovicidal miticides are a case in point, with a number of growers surveyed having only recently switched to them as a mite control option, and therefore considering they have no need for the mite hatch prediction model. To some growers these chemicals appear so effective that late season mite monitoring was regarded as unnecessary. However, many of those using ovicides seemed aware of the benefits of using them only every second year, both to prevent resistance and preserve predatory mites.

Impact of the field representative or consultant

The reasons for the considerable input horticultural merchant field representative and private consultants have on growers’ spray decision-making, apparent from the survey, may include the following. Many growers did not have a long association with the crop and few had tertiary training in horticultural enterprises. Lack of time was a major consideration. Growing apples to export standard is a complex and sophisticated business. Good technical pest and disease knowledge is usually required but often growers are simply too busy to give this area maximum consideration. Leaving part of the decision-making to a trustworthy specialist relieves the burden somewhat. Person to person contact can be frequent as the Hawkes Bay apple growing region is small and most representatives or consultants would only need a 15 minute drive to be on their client’s property.

As these people have a major part to play in reducing spray application in Hawkes Bay apple orchards, their role needs to be considered in any IPM development strategy. Their influence could facilitate (or hamper) the adoption of any new techniques. A similar situation exists with “leading” growers.

Whither pest and disease decision support?

Most growers indicated they would like a “tailored” decision-support service to complement the advice already being obtained from field representatives and private consultants. Such a service would need to be very reliable and very easy to use.

A service with different levels of sophistication may be the most appropriate option. At the most basic level, information and regional IPM advice could be available directly to growers on request through a fax machine, essentially similar to the prototype service operated by MAFTech over the 1991/92 season.

At an advanced level, the service could offer the PC-based information management system and interactive models outlined by Manktelow and Laurenson (1990). This service is more likely to be of interest to growers with large orchards, private consultants and field representatives. The latter two would essentially become “IPM managers” for their clients. Software in the system would need to reflect the different levels of use, i.e. single or multiple management units.

All growers surveyed thought that pesticide residues and, to a lesser degree pesticide resistance, would cause major problems in the future. Nearly all growers felt that techniques to enable reduced pesticide application would continue to develop and improve. The perception exists, therefore, that change in the way pests and diseases

are managed is required, and will occur. This removes one obstacle in the path towards better IPM. The challenge is to provide reliable, effective techniques and the technology-transfer mechanisms to do this.

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