Australian Grapevine Yellows: Source and Spread



RITA FINAL REPORT to

GRAPE AND WINE RESEARCH & DEVELOPMENT CORPORATION

Project Number: **RI 01/15-2**

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Report to GWRDC

This report describes the tasks undertaken in fulfilment of RITA Project # RI 01/15-2 to monitor, investigate and communicate Australian Grapevine Yellows (AGY) in the Riverland during season 2001/02.

The author acknowledges the considerable assistance given by many industry leaders and growers during the course of this work. In particular, Kevin Pfeiffer helped initiate the project while Trevor Wurst, Bruce Proud, Ashley Lipman and a number of others assisted in providing welcome navigation to vineyards during the busy days of the surveys ahead of vintage. These surveys were fundamental to the success of the project.

Orlando Wyndham at Rowland Flat, SA, through the generous assistance of Paul Wright and later Philip Deverell and their team, provided valuable contribution in propagating thousands of cuttings. The Riverland Vine Improvement Committee gave excellent timely support for the establishment of the insect exclusion house at Berri that led to successful local demonstration of factors crucial to a better understanding of AGY.

John Draper, formerly of SARDI, Loxton Centre, gave timely assistance throughout. Justin Dixon, PIRSA Rural Solutions at Loxton was very helpful with the graphics in this report and numerous others assisted in some way or another.

My thanks to you all.

PA Magarey.
Senior Plant Pathologist

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EXECUTIVE SUMMARY:

The work undertaken in this project has led to a better understanding of AGY by Riverland grapegrowers and hopefully brought a clearer understanding of what is AGY and what is not. As a result, it perhaps has led to some reduction in anxiety about the disease.

The monitoring of levels of AGY and subsequent investigations into the disease during 2001/02 revealed some distinguishing aspects of the epidemiology of AGY. This has precipitated a revision of the directions of further investigation.

The strong association between high levels of AGY in vineyards and the proximity of marshlands and permanent still/shallow water is a significant finding. This should reduce the time and cost of resolving the source of AGY and how it spreads into vineyards.

Data from this project provided evidence contrary to the notion that commercially significant quantities of AGY are introduced to vineyards by propagation material.

Additionally, evidence is presented contrary to the idea that AGY spreads from weed hosts or from previously affected vines. In contrast, evidence supports the notion that AGY is native to Australasia, that the pathogen is resident in native plants and these hosts occur in some form more prevalent or grow more favourably at locations external to vineyards. It appears that these locations provide the main source of AGY.

These supposed native hosts of AGY have not yet been identified but the number of likely candidate species has been reduced from 1000's to a few (5-10 species) and their location has been delimited to a zone within a 900m radius of permanent still/shallow water near severely affected vineyards. These zones need immediate exploration in pursuit of infected native plant hosts with view of locating the supposed leafhopper vector(s) of AGY on those plants.

Assessment of the extent and severity of AGY was also made. AGY was found in virtually all vineyards older than three years. The relatively high number of vineyards in which some yield loss was found may lead to a reappraisal (upward) of the importance of the disease to the grape industry. This is especially true for *cv.* Chardonnay in the Riverland.

Communication about means of identifying AGY and information about its source and spread has been made with grapegrowers in the Riverland. It is recognised that this is an ongoing process and that considerable confusion remains in the Riverland (and the Australian) industry as to what is AGY, how is it distinguished from restricted spring growth (RSG), late season leaf curl (LSLC) and another disorder for which the name scaly bark stunt (SBS) is proposed. The confusion needs to be allayed by further investigation (as above) and by effective communication of the outcomes of that work.

The present work provided evidence of specific localities in the Riverland that should be further investigated to locate the source and spread of AGY. It highlighted the need for these investigations before a new wave of the epidemic increases losses in the Riverland or other regions and emphasises the need for further attention to communicating about AGY to grapegrowers the Riverland (and Australia).

BACKGROUND:

The level of Australian Grapevine Yellows (AGY) in Chardonnay and Riesling vineyards of the Riverland has been of concern to the Riverland Wine Industry Development Council (RWIDC). Following first observations of AGY in the region in 1976, levels of the disease increased rapidly and in 1978/79, in many vineyards it caused significant loss. Subsequently, disease levels fell and have since varied up and down.

The source and means of spread of AGY remains unknown. Some investigators have claimed that weeds within the vineyard and propagation material are major sources of AGY. As a result, the supply of propagation material for Chardonnay has been restricted (perhaps needlessly) in Sunraysia/Riverland.

Most investigators concur that an insect is one possible means of AGY spreading from its source reservoirs, wherever they are.

In recent years, surveys of Riverland vineyards have shown an increase in AGY. During 2000/01, the average incidence of AGY in the Riverland was close to 12% *ie* 12% of vines per vineyard show some symptoms of AGY. However, in a number of vineyards the incidence was much higher (>20%). This level is about the threshold for economic loss. As a result, concern was expressed about the disease and the lack of a control strategy.

Because the source and spread of AGY need to be determined before a management approach can be developed, it was considered relevant to determine current levels of disease in the Riverland and to gather local observations about possible sources. It was considered necessary to do this before epidemic levels of AGY recurred and region-wide losses were sustained.

Benefits

Riverland growers had identified AGY as one of the industry's priorities. Understanding the origin of disease was considered important to alleviate concerns. Contrary to the theories above, preliminary investigations from Loxton Centre had indicated that propagation material and vineyard ground cover plants are not likely sources of inoculum. This tentative finding needed validation at an industry level.

AGY is a problem in the Riverland and Sunraysia and in vineyards of the warmer inland regions but it occurs at lower levels in other regions of Australia. Surveys of vineyards in the Riverland were planned to enable levels of disease to be monitored during 2001/02 and so allow on-going assessment of the severity of the disease in the warmer areas. It was also planned to communicate simple means of recognising symptoms and latest evidence about AGY to give local industry a better understanding of the disease.

A brief survey of local vegetation was also considered in attempt to reduce the number of plant species to be investigated in the search for an alternate host of AGY. It was then hoped to find a possible insect vector of the disease on alternate hosts that might be located.

An important aspect of this project was that it coincided with field investigations being conducted with financial support from the Riverland Vine Improvement Committee. In that project, an insect-excluding shade house was erected over two rows of vines in a commercial vineyard at Berri, SA. The present project was timed to combine with this industry-based evaluation of the role of insects in the spread of AGY in the Riverland.

OBJECTIVES:

The present project commenced in November 2001. It had the following aims:

1. **To monitor levels of AGY in Riverland vineyards.**

2. **To clarify if propagation material is a source of AGY.**

3. **To communicate about AGY to Riverland grapegrowers and so reduce confusion about the disease in the region.**

4. **To assist research in the Riverland by clarifying the role of insects in disease spread and by undertaking vegetation surveys in near-vineyard regions.**

METHOD:

Objective 1: To monitor levels of AGY in Riverland vineyards

The aim of this work was to 'keep a finger to the pulse' in monitoring the levels of disease in the Riverland. Given the epidemic nature of the disease with increases and decreases in levels from season to season, it is important to know the risk of vineyard and regional loss from AGY.

1. Mapping Vineyard Incidence of AGY

Detailed local maps of the spatial incidence of AGY in six Chardonnay and two Riesling vineyards were made in the Riverland during December 2001 to March 2002. The incidence of AGY was assessed for each arm on both sides of each vine for a block of vines within each vineyard. This was done by walking down each row of the block of vines while scanning the foliage of one side of the canopy. The presence or absence of AGY on each arm of each vine was then scored and recorded.

Vineyard maps of both the incidence and spatial distribution of AGY were made by plotting disease incidence for each arm of each vine. This continued surveys undertaken by the author over recent seasons.

Each plot comprised between 10 - 40 rows x 30 - 90 vines/row. On average, each arm of each vine was surveyed for a minimum of 800 vines per vineyard block.

2. Mapping Regional Incidence of AGY

A regional survey of the incidence of AGY in 272 vineyards was made during December 2001 to March 2002.

The incidence of AGY was assessed by walking down 2 - 6 randomly selected rows of vines per vineyard while scanning the foliage on both sides of the row and recording the presence or absence of AGY on each vine. The presence of disease was scored if any AGY symptoms were seen on a vine.

The percentage incidence of AGY in each vineyard was then calculated [(# vines with AGY/# vines assessed)x100] and plotted on a map of the Riverland to determine patterns of occurrence of AGY in the region.

Objective 2: To clarify if propagation material is a source of AGY

The aim of this work was to use commercial methods to propagate cuttings taken from AGY diseased vines to determine if the disease can be transmitted in this way.

During the growing seasons 1999/00 and 2000/01, the presence or absence of AGY was surveyed on each arm of each vine in several vineyards of the Riverland and one in Sunraysia. From this, vineyard maps of disease were drawn up and used to locate the presence of arms of vines that showed symptoms of AGY for two consecutive seasons. In the dormant period of 2000, ~1,000 cuttings were taken from these arms and during 2001, ~7,000 cuttings were collected. The resources and usual propagation techniques of Orlando Wyndham, Rowland Flat, SA, were used for the rooting and propagation of the cuttings.

The rooted and potted (and still leafless) cuttings were placed in the rows between mature Riesling vines in an insect exclusion house constructed over two rows of a commercial vineyard at Berri, SA. The exclusion house was financed by the Riverland Vine Improvement Committee, Monash, SA, to investigate the role of insects in the spread of AGY in Riverland vineyards.

During the growing seasons, the potted vines were surveyed for symptoms of AGY identified by yellow and downward curled leaves on shoots that may not have hardened off.

Objective 3: To communicate about AGY to Riverland grapegrowers.

Extension activities were designed to deliver a better understanding of AGY to Riverland grapegrowers and to reduce confusion about what is AGY and what are unrelated disorders.

A number of presentations were made to Riverland grapegrowers through the print media, radio and television and through grower meetings with view to providing descriptions of the symptoms of AGY and of look-alike diseases and disorders. Personal presentations and discussion was had with individual growers.

Two field days were held. The first was a small field day held at the location of the propagation trial in the insect exclusion house at Berri.

The second was held in September 2002, when a major display was presented as part of PIRSA's tent at the 2002 Riverland Field Days. That display presented the detailed symptoms of AGY, summarised recent research progress in seeking the source(s) of AGY in the Riverland including showing maps of disease distribution across the region and provided a coloured brochure detailing the symptoms of AGY and look-alike disorders.

Objective 4: To clarify the role of insects in disease spread and undertake vegetation surveys in near-vineyard regions.

This work was aimed at visually assessing the vegetation types in and near vineyards with view to narrowing down the list of probable host plants that might house the primary reservoir of AGY in the Riverland. From this it was hoped to determine if insects can be implicated with AGY.

The region-wide vineyard surveys for AGY as undertaken in Objective 1 (see above) were used to locate possible localities where the disease occurred with higher that usual severity. From this demarcation, surveys were made for the presence of native plants within those zones to provide a better understanding of the number of possible hosts of AGY.

RESULTS/DISCUSSION:

Objective 1 To monitor levels of AGY in Riverland vineyards

[For completeness, the following discussion incorporates the results of Objective 4 *viz* to assist research in the Riverland to clarify the role of insects in disease spread and through vegetation surveys near vineyards.]

1. Mapping the Vineyard Incidence of AGY

Symptoms
Typically, AGY appeared only on 1 - 3 shoots on each affected vine. Rarely were whole arms diseased. The main cultivars affected are Chardonnay and Riesling.

The most diagnostic features of AGY show from flowering onward. Leaves roll downward and turn yellow in blotches. The yellowing often becomes brown (necrotic) after hot weather. Leaves on affected shoots sometimes feel rougher and fall prematurely.

Shoots are stunted because shoot apices die. Affected shoots fail to harden-off (lignify) and remain a bluish colour and rubbery but snap easily if bent too far. Affected shoots die back from the tips and break off at the nodes.

Bunches on affected Riesling shoots shrivel and die at or just after flowering while on affected Chardonnay, the flower cluster usually survives but berries shrivel prior to harvest.

An unusual and diagnostic feature of AGY is the remission of symptoms. Even on severely affected shoots, after very hot weather *viz* 1-2 days with maxima above 40^0C, stunted, dying shoots with fallen leaves, begin to grow again. Axillary buds activate and within 10 days produce shoots that remain symptomless or again show leaf symptoms typical of AGY.

Possible Variants of AGY
In some vineyards, the following symptoms were observed. The casual observer is likely to confuse these with AGY.

On some vines, typical AGY symptoms were interspersed with leaves that showed interveinal and sometimes marginal burning (necrosis) while shoots sometimes showed zig-zag growth and partial hardening off (incomplete lignification). Affected shoots appeared to die more quickly and sometimes the cordon also died. The latter is rare in vines with symptoms typical of AGY.

Perhaps the above symptoms are an expression of vines affected by another pathogen *eg* the tomato big bud (TBB) phytoplasma, or a combination of the AGY and TBB pathogens or one or both of these in combination with another pathogen(s).

'Scaly Bark Stunt' – a Preliminary Description of a Possible New Disorder Confused With AGY
While surveying for AGY, a consistent set of symptoms of unknown origin was seen in some vines in many vineyards. This may be a distinct disorder or it may be the separate expression of another disease or disorder or it may be a clonal variation *etc.* A preliminary description follows; more detailed observation is needed for a better description.

It is probable that the symptoms of this disorder have been confused with AGY. They were seen on both *cvs* Chardonnay and Riesling and may occur on other varieties.

Compared with healthy vines, the following symptoms were noted.
Leaves were:

- smaller, darker green and sometimes rolled downward at the margins;
- later, especially when vines were under stress, yellow blotches developed across the blade of some;
- marginal burning (necrosis) sometimes followed.

Shoots were:

- short (stunted) though hardened off (lignified) and with functional tips;
- affected uniformly *ie* usually most shoots on a vine were affected;
- some showed zig-zag growth.

Bunches were:

- smaller and with smaller berries;
- sometimes also with hen and chicken effect (berries of different size).

Two-year old wood showed:

- horizontal cracking (fissures) in the thin layer of surface bark. This led to,
- up-turning of the bark at these cracks to give a scaly appearance like the bark on silver birch trees.

Affected vines occurred singly or clumped. The clumping may simply be a reflection of the frequency of occurrence of the disorder rather than indicative of any possible mode of transmission.

Yield Loss
Shoots affected with AGY are barren or have reduced yield because the inflorescences shrivel and die at flowering (mostly *cv* Riesling) or later, the developing berries shrivel and die (mostly *cv* Chardonnay). Also, affected shoots die, either in the season of symptom expression or during the subsequent winter.

In contrast to the expression of AGY in the late 1970's when sometimes whole vines were diseased, in recent years, usually only 1 – 3 (– 5) shoots on one arm per vine are affected. As a result, yield loss in the season of symptom expression is often negligible. On most vines, the symptomless shoots apparently increase bunch size sufficiently to compensate for the lost production from the (relatively few) AGY affected shoots on that vine. If the number of affected arms and or shoots per vine is higher, yield loss occurs.

An additional aspect of AGY influences yield. Because diseased shoots die, either in the season of expression or over the subsequent winter, most vines in a second season show an apparent remission of disease. As a result, where AGY was present last season the vines are symptomless except that a portion of the cordon is barren. At these sites, the shoots are very stunted or absent. These sites are obvious from a distance as a zone of reduced canopy height indicating where AGY occurred in a previous season.

On vines where AGY has occurred at several different times, yield reductions occur because of the fewer number of productive shoots on affected cordons.

Disease Patterns Tell A Story
The detailed spatial surveys of six Chardonnay and two Riesling vineyards allowed the compilation of a map of the spread patterns for AGY in each vineyard. A typical example of

these maps is attached for reference (see map of *cv* Riesling vineyard at Berri, SA. Appendix 1).

The spread (spatial pattern) of AGY in these vineyards and comparisons with those from surveys in previous consecutive seasons confirmed some important characteristics of the epidemiology of AGY.

Significantly, the surveys gave no evidence that AGY spreads from vine to vine because:

- vines adjacent to previously affected vines showed no higher risk of expressing AGY in the next season than any vine more distant from that affected vine.

As a result of this and other observations, it is likely that:

- grapevines affected with AGY do not provide a source of inoculum either for the disease to move to other vines within the vineyard or to move from vineyards; but rather,
- AGY spreads from a different (alternate) host into the vineyard.

From elsewhere we know that the phytoplasma pathogen which is consistently implicated as causal agent of AGY has not yet been found outside Australasia. This would suggest that the causal organism of AGY is native to that region and as a result:

- the pathogen causing AGY is most likely to be native to Australasia; and thus
- most likely to occur naturally in native plant host(s); and because of this,
- AGY is probably without (major) symptoms on its native plant host(s).

Thus, because:

- **grapevines appear to be a terminal host of AGY (*ie* AGY does not spread from affected vines);**
- **the source of AGY is from another (alternate) host; and**
- **that host is likely to be a plant native to Australasia.**

Given the above evidence, the vine maps drawn from the present project confirmed previous evidence as to which of several options best explains where the source of AGY is located. In other words, the vineyard mapping gave good evidence as to the location of an alternate host plant(s) which is the likely primary source(s) of AGY.

With the findings about similar phytoplasma diseases in other crop situations around the world, it is also likely that:

- **an insect is the main means by which AGY spreads, *ie* is the vector;**
- **the insect is likely to be a leafhopper of one or more species; and**
- **the leafhopper(s) feeds and breeds on an alternate host; and then**
- **that/these leafhoppers fly(ies) at random to vineyards and casually feeds and so infects, at least some of the vines upon which it feeds.**

Locating the Source of AGY

Differing locations of the alternate host(s) would present different outcomes in terms of the spatial patterns of disease within the vineyard. Because the reverse is true too, the spatial patterns of disease give us evidence as to the location of the alternate host and the source of AGY.

For instance,

- If the alternate host and so the vector of AGY were coming from within the vineyards, we would expect a focussed pattern of disease and radiating circles or a similar clustering of diseased vines in the vineyard. This is consistent with a supposed vector(s) spreading AGY from diseased vines or weeds in the vineyard to feed on and inoculate adjacent vines.

- If the vector were coming from alternate hosts(s) on vineyard boundaries, the pattern of disease would be expected to show a clustering along the edges of vineyards. This is consistent with a supposed vector(s) spreading AGY from diseased alternate hosts growing adjacent to the vineyard.

- However, focussed and clustered patterns were not seen. To the contrary, the vineyard maps showed that AGY occurs in a random scatter of small clumps within the vineyard. This is the same spatial distribution as was seen in previous seasons and is consistent with the idea that AGY spreads via a presumed insect vector(s) that flies long distances to the vineyard from its primary host plant (on which it feeds and perhaps breeds).

Thus, it can be assumed that:

- **the supposed leafhopper vector(s) flies distances of at least 100 – 300 m to the vineyard *ie* from beyond the near-edges of the vineyard, and brings AGY into the vineyard from native vegetation.**

Grapevines are not a Preferred Host for the Vector

The observed random pattern of spread is also consistent with the idea that grapevines are not a preferred host for the insect(s). Suppose the leafhopper(s) happens to land upon a vine somewhere in the vineyard. As it tries feeding from the sugar conducting tissue (the phloem), it transfers the AGY pathogen to that tissue. However, not finding the vine to its liking, it hops to another nearby in an attempt to find more favourable food. Having fed there briefly and inoculated that vine, the vector(s) perhaps then flies some distance in continuing its search. The result is a small clump of disease here and there in the vineyard.

It appears that the symptoms take at least one season to incubate and so appear only in the season after inoculation., *ie* in the following season.

In keeping with this, in the vineyards surveyed, it was not unusual to find a diseased vine more-or-less at random in the vine row and then close by, in what might be termed an **'echo effect'**, symptoms appearing on a vine perhaps a few (one to four) metres distant. These vines showed less severe symptoms of AGY. It was as though the supposed vector(s) had fed for a while on the first vine and inoculated AGY before moving to the vine nearby where it fed for a lesser time and introduced a lesser amount (titre) of the AGY pathogen. As a result, there was a lesser expression of AGY on that second vine.

Interestingly, symptoms of AGY frequently appeared in shoots on upper portions of the vine canopy. This was perhaps indicative of an insect vector that is airborne and descends to feed on the foliage rather than flies from low vegetation within the vineyard. This is perhaps further tentative evidence of long distant movement of the supposed vector(s).

The above observations affirm the thinking that the vector of AGY is arising at a location distant from the vineyards; perhaps often more than 300 – 500 m from affected vineyards.

Some Deductions about the Alternate Hosts
If, as was concluded from the vineyard surveys, the alternate host of AGY and so the source of AGY originates in a zone outside an area ~300 – 500 m from the edge of vineyards, it seems reasonable to suppose that the native alternate host does not exist normally in the vegetation of highland (or Mallee) ecosystems. If it did, then we would expect to see edge effects (higher levels of AGY near the edges of vineyards) because many vineyards of the region are interspersed with the Mallee vegetation.

Given the above observations, it seems reasonable to suppose that:

- **the source of AGY lies within non-Mallee vegetation ecosystems of the Riverland.**

If so, where is the source?

Because Mallee vegetation is almost ubiquitous on highland terrain, the most obvious non-Mallee ecosystems are riverine *ie* located on the flood plain of the River Murray.

Thus is seems reasonable to suppose that

- **the source of AGY lies in one or more native plant species growing in riverine or modified riverine ecosystems, or modified Mallee ecosystems.**

In attempts to seek further evidence of this hypothesis, extensive surveys were made within vineyards of different regions in the Riverland with a diversity of vegetation systems.

2. Mapping Regional Incidence of AGY

From January to March 2002, some 270 vineyards were surveyed for incidence of AGY. The extensive mapping across the Riverland included the different geographical regions of the area and the different vegetation types. The maps (see Appendices) show the incidence of AGY in the vineyards in each district surveyed.

Some interesting points arise.

Average incidence of AGY across all vineyards surveyed in 2001/02 was ~12%. As a result, many vineyards had less than 10% of vines with AGY, *ie* levels were below the (presumed) threshold for economic loss *viz* 20% affected vines/vineyard.

In contrast, vineyards in some localities showed high levels of AGY (>20% incidence) and were suffering reduced yields as a result.

Maximum levels of AGY were seen in the Glossop area near the swamp at Puddletown Road. There levels of AGY exceeded 50% vines/vineyard. High levels of AGY were also seen in a number of vineyards at Berri and at Loxton North.

Severity of AGY
For completeness, the findings of a survey of Riverland vineyards undertaken during 2000/01 are presented below along with the findings from the surveys of 2001/02 (see Tables 1-4).

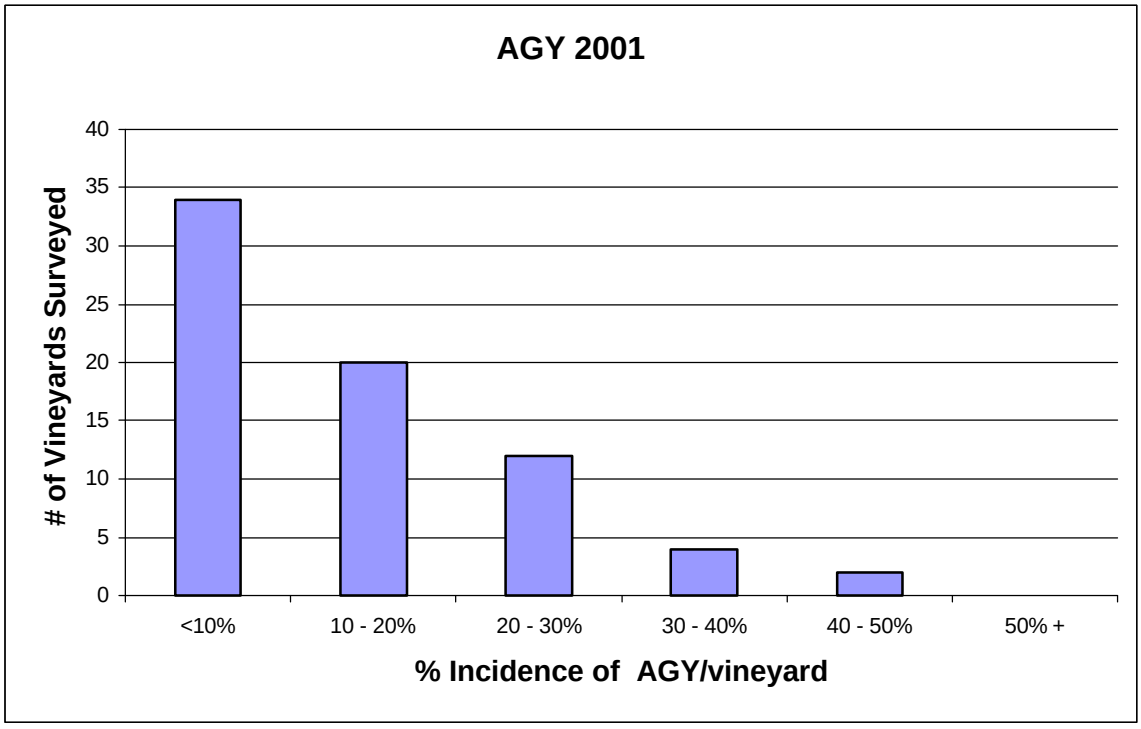
Since vines less than three years old rarely if ever show symptoms of AGY, only older vineyards were included in the data set below.

Survey of 2000/01.

Table 1. Distribution of the incidence of AGY in 72 Riverland vineyards surveyed during late summer 2000/01.

% Incidence of AGY/vineyard	<10%	10 – 20%	20 - 30%	30 – 40%	40 – 50%	50% +	Total
# Vineyards Surveyed	34	20	**12**	**4**	**2**	**0**	72
% Vineyards Surveyed	47.2	27.7	**16.7**	**5.6**	**2.8**	**0**	100

Note: Assuming yield losses occur when levels of AGY exceed 20% incidence in the vineyard, crop loss occurred in **18 vineyards** representing **26.1%** of surveyed vineyards.

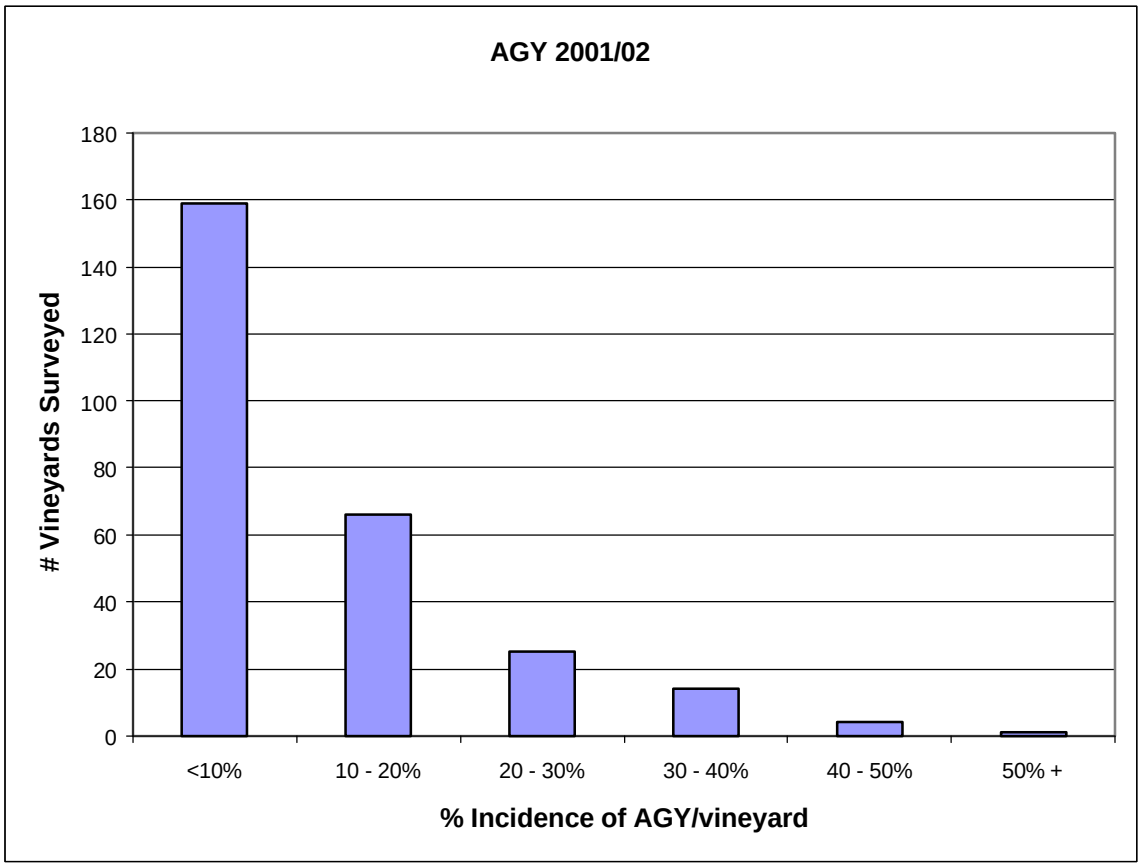


Survey of 2001/02

Table 2. Distribution of the incidence of AGY in 269 Riverland vineyards surveyed during late summer 2001/02 – including *cvs* Chardonnay and Riesling.

% Incidence of AGY/vineyard	<10%	10 - 20%	20 - 30%	30 - 40%	40 - 50%	50% +	Total
# Vineyards Surveyed	159	66	**25**	**14**	**4**	**1**	269
% Vineyards Surveyed	59.1%	24.5%	**9.3%**	**5.2%**	**1.5%**	**0.4%**	100%

Note: Assuming yield losses occur when levels of AGY exceed 20% incidence in the vineyard, crop loss occurred in **44 vineyards** representing **16.4%** of surveyed vineyards.

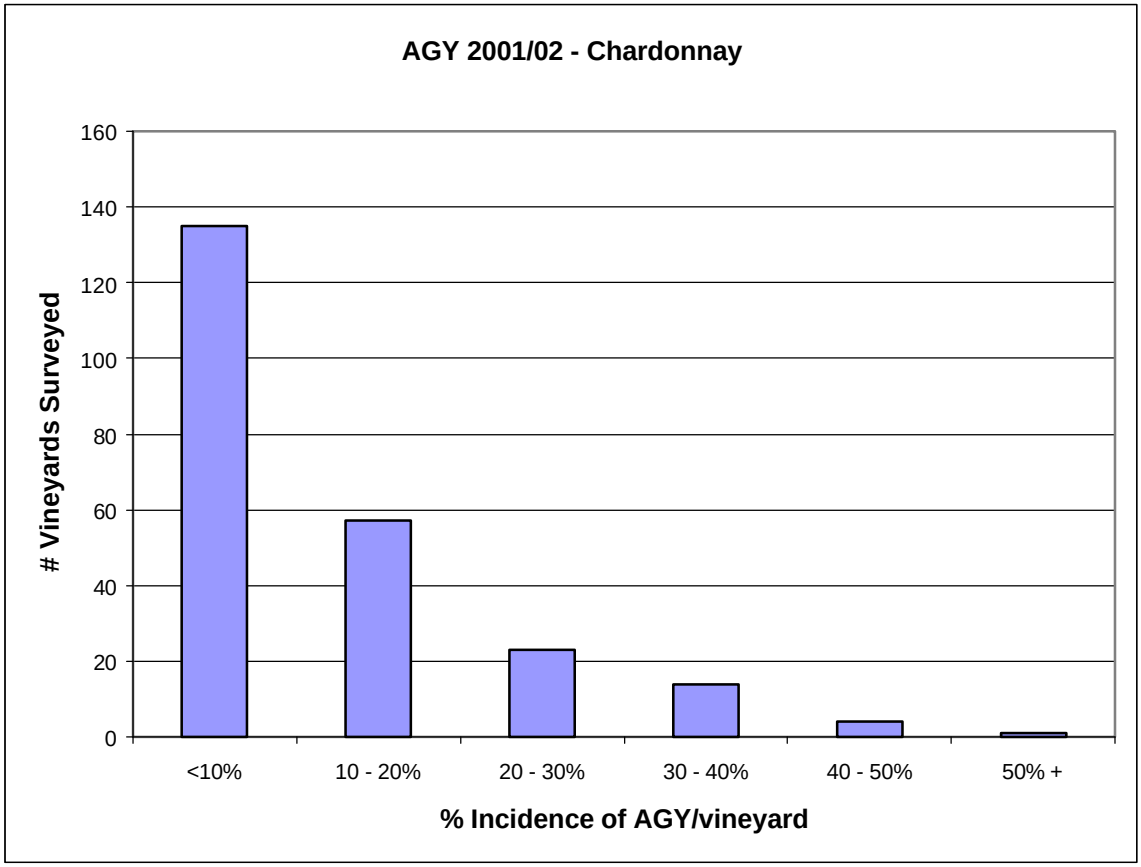


Survey of 2001/02 (cont)

Table 3. Distribution of the incidence of AGY in 234 Riverland Chardonnay vineyards surveyed during late summer 2001/02.

% Incidence of AGY/vineyard	<10%	10 - 20%	20 - 30%	30 - 40%	40 - 50%	50% +	Total
# Chardonnay Vineyards Surveyed	135	57	**23**	**14**	**4**	**1**	234
% Chardonnay Vineyards Surveyed	57.7%	24.4%	**9.8%**	**6.0%**	**1.7%**	**0.4%**	100.0%

Note: Assuming yield losses occur when levels of AGY exceed 20% incidence in the vineyard, crop loss occurred in **42 vineyards** representing **17.9%** of the surveyed Chardonnay vineyards.

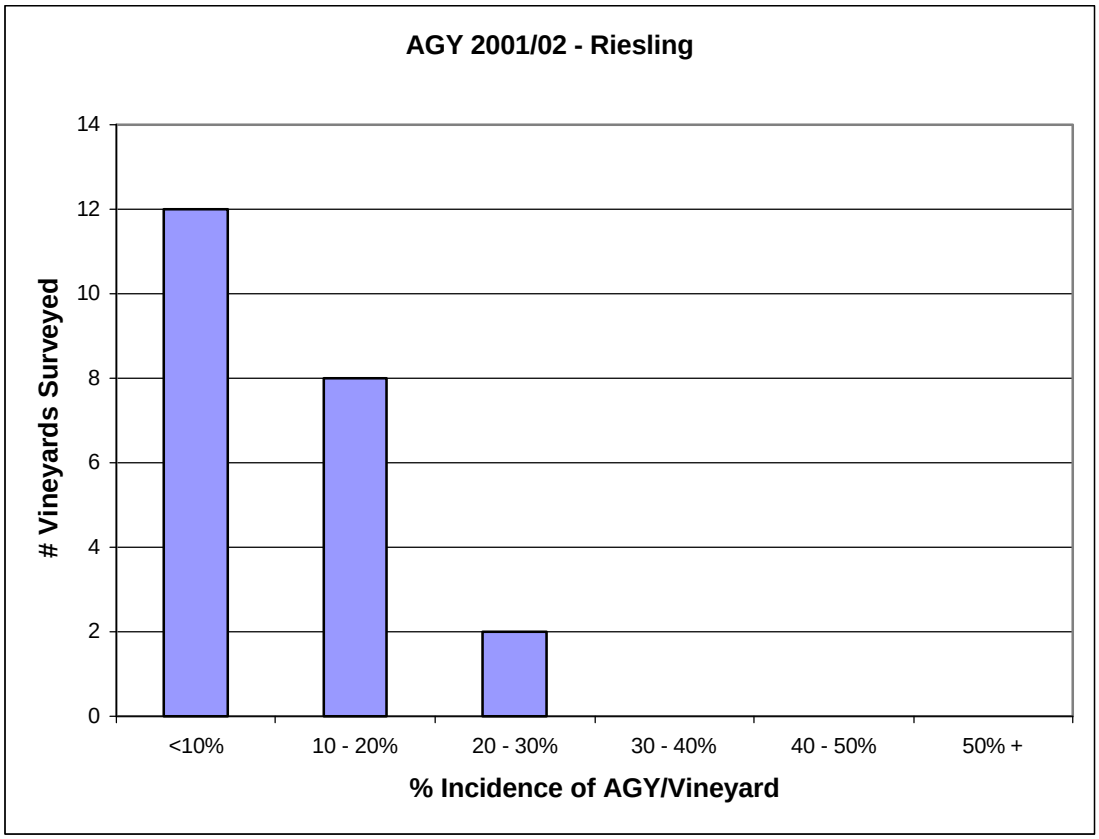


Survey of 2001/02 (cont)

Table 4. Distribution of the incidence of AGY in 22 Riverland Riesling vineyards surveyed during late summer 2001/02.

% Incidence of AGY/vineyard	<10%	10 - 20%	20 - 30%	30 - 40%	40 - 50%	50% +	Total
# Riesling Vineyards Surveyed	12	8	**2**	**0**	**0**	**0**	22
% Riesling Vineyards Surveyed	54.5%	36.4%	**9.1%**	**0.0%**	**0.0%**	**0.0%**	100.0%

Note: Assuming yield losses occur when levels of AGY exceed 20% incidence in the vineyard, crop loss occurred in **2 vineyards** representing **0.1%** of the surveyed Riesling vineyards.



Geographic Spread
The regional maps of the incidence of AGY (see Appendices) indicate the levels and distribution of the disease in each region. In a significant finding, in each region high levels of AGY were observed in some localities but not others.

The reason for this is not yet known but observations made at those localities provided interesting evidence for comment.

Wherever high levels of AGY were found, *ie* where vineyard incidence of AGY exceeded 20% of vines, the vineyards lay within a zone ~ 900m maximum radius from marshy areas. These areas contained permanent still and/or shallow water either in a lagoon or backwater of the Murray River, in a seepage pond or in an overflow from irrigation channels.

In contrast, where vineyards were located either adjacent to a stretch of the Murray River or to an irrigation channel with free-flowing water, the level of AGY was low.

For examples of these, see the regional survey maps in the Appendices and look for the red and purple dots which represent high vineyard incidence of AGY (20-29% and >30% respectively). Look especially at the surveys on the Berri Barmera Survey Area (near Glossop), in the Loxton Survey Area (Loxton North), and the Waikerie Survey Area (just west of the town) where clear associations with the presence of permanent still/shallow water are evident.

Thus,

- **there is a strong positive association with high levels of AGY and the proximity of permanent still/shallow water.**

Possible Alternate Hosts
Upon closer inspection it was noted that localities associated with high levels of AGY usually represented a typical marshland ecosystem with a limited array of plant species.

Association implicates these as a possible alternate host(s) of AGY. Brief assessment indicated that **only a few native species were present. They were:**

- **the common reed** *(Phragmites australis)* – a summer growing, perennial grass 1.5 – 3 m tall that frequents intermittently flooded drainage lines but does best in marshes and lagoons and areas of free-standing, shallow water usually on heavy clay soils;
- **the bulrush (cumbungi)** *(Typha domingensis & T. orientale).* – these are semi-aquatic perennials to 2m tall or more along streams, lakes and local water-filled depressions to 1.5m deep; and
- **several species of the yanga bush (short-leafed bluebush)** *(Marieana brevifolia* & *M. campanulate)* (tentatively identified) – a straggly, woody shrub to 1m widely distributed throughout the Riverland but in dense local stands in some localities.

These species need closer scrutiny and PCR testing for presence of the AGY phytoplasma and for evidence of hosting leafhopper species that could be the vector(s) of the disease.

Objective 2 To clarify if propagation material is a source of AGY

A total of ~ 7,000 cuttings comprising both *cv* Chardonnay and Riesling collected from locations in SA, Victoria and NSW, were taken from vines bearing symptoms for two consecutive seasons. Usual nursery procedures were used to propagate the cuttings but only ~6,000 survived the callusing and rooting process. Of the survivors, all were potted then grown in an insect-free environment for two additional seasons (2001/02, 2002/03) but during this time, none showed symptoms typical of AGY.

This was not surprising since AGY affected shoots die either in the season of symptom expression or in the subsequent winter period. The risk of carrying AGY via cuttings lies in the possibility of selecting a cutting with adequate titre of the phytoplasma pathogen so as to be low enough not to kill the shoot but high enough to survive till the next growing season.

This confirmed earlier separate experiments by the author when ~400 cuttings and ~700 cuttings respectively were taken from AGY affected vines and grown without symptoms in the field for at least one season.

In the work undertaken in the present project, it is possible that the potted vines will only express symptoms in a third season since AGY is rarely if ever seen on vines younger than three years.

Symptoms on Young Vines
The most likely explanation for the lack of symptoms on young vines (< 3 years old) is that **for a newly planted vine to express AGY**, several events need to occur:

- first an insect vector is required to feed on the foliage of the vine – this may take one or two seasons depending on there being a flight of the supposed insect vector into the vineyard; and
- then that vector must both discover and feed on the relatively small canopy of the young vine; and
- then the pathogen must incubate within the young vine to multiply to sufficient titre for symptoms to express – evidence from other experiments and observations suggests that this appears to take at least until the season following initial infection.

Also, the extent of symptom expression is perhaps dependent on the prevailing temperatures in late dormancy to early spring *ie* from August to September. Given all this, it might well take three seasons for a vine to be inoculated, incubate the pathogen and express AGY symptoms.

Alternatively, the lack of symptom expression in the potted vines could be ascribed to the culture of the vine rootlings in a potted environment. To test this argument, in season 2002/03, some of the potted vines have been planted out in commercial vineyards. These will be monitored for expression of AGY.

It is anticipated that at most, ~1 in 1,000 cutting will serve as carrier of AGY. If so, this falls far short of the average levels of AGY in commercial vineyards of the Riverland. As a result from evidence to date, it is concluded that:

- **propagation material is likely to carry little or no AGY; and**
- **is most likely not the primary means by which AGY is transferred to vineyards;**
- **there must be another source of spread for AGY.**

Leafhopper insect vectors are the most likely alternative – see above.

Objective 3 To communicate about AGY to Riverland grapegrowers.

A display was prepared for the Riverland Field Days on September 11-12th 2002. A series of posters and items presented AGY to the grapegrowers of the Riverland. See the Appendices for summaries of the display-posters.

The display proved popular for Field Day visitors and a large number of growers visited the display and many questions were fielded. While no record was kept of the number of visitors the display was considered a success.

During the term of the present project a number of presentations have been made to grower groups and discussions have been had with individual growers. A presentation was made to the Loxton Horticultural Bureau on 2nd July 2002 entitled 'Australian Grapevine Yellows: An overview of progress since 1976'.

A mini-Field Day was held at the site of the insect exclusion house at Berri to show industry leaders from the newly formed Riverland Wine Industry Council and the Riverland Vine Improvement Committee, of progress with that trial *viz* tests of the propagation material as source of AGY and of the role of a possible insect as vector of AGY. This presented the first hard evidence of the role of an insect as vector and the lack of the role of propagation material.

Objective 4 To clarify the role of insects in disease spread and undertake vegetation surveys in near-vineyard regions.

The outcomes of this objective are incorporated under Objective 1 above.

OUTCOME/CONCLUSION:

Objective 1 To monitor levels of AGY in Riverland vineyards

The monitoring of levels of AGY in the Riverland during 2001/02 indicated that the disease maintained a similar level of severity as in the previous season. Over 40 vineyards of 255 Chardonnay and Riesling vineyards surveyed had more than 20% incidence of AGY and were likely to have suffered at least some yield loss from the disease.

Most significantly, the monitoring confirmed one of the most important findings of the 26 year investigation into AGY *ie* where high levels of AGY occurred, there were always areas with permanent still water nearby.

In terms of locating the source of AGY and determining how it is spread, this finding has major ramifications for future investigations. It would appear likely that an insect (leafhopper) vector probably lives on an alternate native host(s) that grows in the 'swampy' areas and flies usually less than 900 m to infect nearby vineyards.

The task is now to use PCR and other tests to find that alternate host plant(s) and hopefully locate the insect vector at its feeding site on that host. To find a useful management strategy for AGY, the biology of the vector will need to be investigated in the hope that an understanding of the population dynamics of the vector may lead to the development of some form of control for the disease.

Objective 2 To clarify if propagation material is a source of AGY

The tests undertaken during the course of this project gave evidence which refutes a previously well-held view that AGY is spread through propagation material. While another season of observation is needed, present outcomes suggest that at most, only a very low level of AGY (<0.1%) is transmitted by propagation.

Thus, the main means of spread of AGY appears to be associated with a probable insect vector which probably arises mostly from confined areas with shallow water and native plants.

As a result, there is opportunity to allay fears that AGY is a disease that requires hot water treatment of cuttings. While it is considered good plant health practice to treat propagation material, issues relating to the increased cost and the risk of reduced viability of treated cuttings, needs to be assessed in the light of the above evidence.

Objective 3 To communicate about AGY to Riverland grapegrowers

The present project facilitated communication about AGY with many Riverland grapegrowers. While good progress was made in this regard, it is recognised that the confusion about AGY in this and other regions of Australia will continue as long as uncertainty as to what is AGY and how it spreads continues. To the contrary, if future research determines the source and spread of disease, confusion will be allayed and from an AGY view point, the industry uncertainty about planting Chardonnay and Riesling can be relieved.

At least in part as a result of this project, concern about AGY has declined significantly. This is good because a more realistic view of AGY is beginning to prevail. However, the relatively high number of vineyards (more than 40) that are at risk or are already losing yield from AGY is a matter that needs better communication.

It is proposed to work in association with the Riverland Wine Industry Development Council to hold another field day on AGY to communicate these findings further.

Objective 4 To clarify the role of insects in disease spread and undertake vegetation surveys in near-vineyard regions

The present project made significant progress in identifying and clarifying the localities where the severity of AGY was high and the localities where the disease was not a mater of concern. The project also identified where further research needed to be focussed *viz.* an intensive search for an alternate host and an insect vector in the marshy areas of the Riverland.

Partly as a result of findings from this RITA project, a GWRDC project was successfully applied for by SARDI at Loxton. This project has a three-year term and is currently underway in pursuit of those investigations.

The present work also clarified the need for the assistance of an entomologist with technical support to resolve aspects of AGY concerning how AGY spreads in the Riverland *eg* how the disease is sourced and how it spreads to vineyards. This information is considered crucial if a control for AGY is to be developed.

BUDGET RECONCILIATION:

Budget	Funding required from GWRDC		Actual Expenditure
Vehicle Hire			
(20 days @ $80/day)	$1,600		$1,600
Vineyard survey and data entry	$3,000		$3,000
Vegetation survey - Riverland	$2,400		$2,400
Field Day			
(Preparation of posters and displays, site rent etc)	$2,500		$2,500
Total	**$9,500**	**Total Expended**	**$9,500**
		Remitted to GWRDC	**NIL**

APPENDICES

The appendices comprise the following:

1. Vineyard spatial distribution map for Fenwick, Berri. Blue cells indicate the presence of AGY on an arm of a vine. Purple area defines the insect exclusion house.
2. Map of Waikerie survey area
3. Map of New Residence survey area
4. Map of Loxton survey area
5. Aerial photo overlay over map of Loxton survey area
6. AGY zone map for Loxton survey area showing interpolations of regions of high and low levels of disease
7. Map of Berri-Barmera survey area
8. Map of Paringa survey area
9. Displays of AGY posters as presented at the Riverland Field Days September 11-12th 2002.

Australian Grapevine Yellows Survey
Fenwick, Berri, SA - Arm map

Riesling - Survey -PA & AMM Rows 1-5, 6/2/02; PAM Row 6- Nth Block + All Sth Block 12/3/02 3:15 -5:30 pm
PAMagarey Rows 7-19 Nth Block 13/3/02 2:45 - 4:20 pm.

		Row																		
Vine	Arm	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
1	1	0	1	0	0	0	0	1	0	1	0	1	0	1	0	0	1			
	2	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0			
2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
6	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0			
	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0			
7	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1			
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0			
8	1	1	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0			
	2	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0			
9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	2	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0			
10	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	1
	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
11	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
12	1	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0	0	0	0
	2	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
13	1	0	0	0	1	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	1
14	1	0	1	0	0	1	0	0	0	0	1	1	0	1	0	0	1	0	0	0
	2	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
15	1	1	0	0	0	0	0	1	0	1	0	0	1	1	0	0	0	0	0	0
	2	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
16	1	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0	0	0	0
17	1	0	0	1	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	1	0	1	1	0	1	0	1	0	1	0	0	0
18	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	1	0	1	0	1	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0
	2	1	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0
20	1	1	0	0	0	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0
	2	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0
21	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	2	1	1	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
22	1	0	1	0	0	1	0	0	1	1	0	0	0	1	0	0	0	0	1	1
	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
23	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
	2	0	1	0	0	0	0	0	0	1	1	0	0	1	1	0	1	0	0	1
24	1	0	0	0	0	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
25	1	1	0	0	0	0	1	0	0	0	1	0	1	0	0	0	1	0	0	0
	2	1	0	0	0	0	0	0	1	0	1	1	0	0	0	0	1	0	0	0
26	1	0	0	1	0	1	1	1	0	1	1	1	0	0	0	0	0	0	0	1
	2	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
27	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0
	2	0	1	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0
28	1	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0
	2	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	1
29	1	0	0	0	0	0	0	0	0	1	*	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	1	0	1	0	1	*	0	0	0	0	0	0	0	0	0

KEY	
Symptoms	
no AGY	0
AGY	1
missing	*
AGY arms	240
Total arms	1334
% AGY	18.0

includes excl. house

Orientation
1 = N
2 = S
North

Insect Exclusion House

Pruning trial
June-00

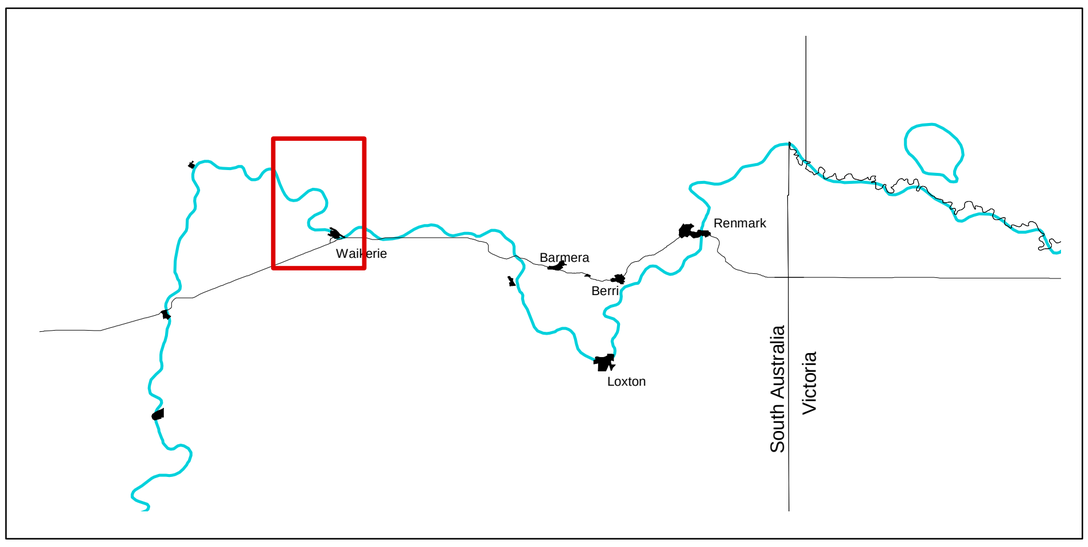
Pink tags=AGY in 2001

Pruning trial of 2000, scored in 01/02	
1. Pruned vines in rows 6-8	
AGY arms in 6-7	#REF!
AGY arms in 8	#REF!
Total arms	68
% AGY	#REF!
2. Untreated vines (Rows 9-11)	
AGY arms	57
Total arms	220
% AGY	25.9

Exclusion House of 2000/01 in 01/02	
AGY arms	4
Total arms	100
% AGY	4.0
Exclusion House of Rows 4-8	
AGY arms	52
Total arms	248
% AGY	21.0

Rows 4-8 full length	
AGY arms	71
Total arms	366
% AGY	19.4

Untreated vines (Rows 9-19)	
AGY arms	156
Total arms	812
% AGY	19.2



Australian Grapevine Yellows - 2002

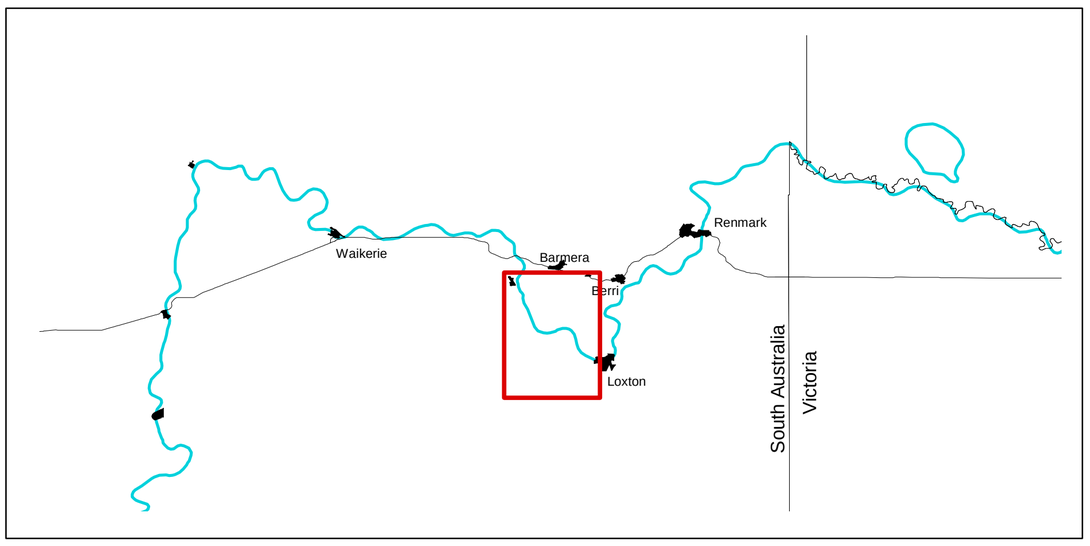
WAIKERIE SURVEY AREA

Agy 2002
- 0 - 2.99 %
- 3 - 9.99 %
- 10- 19.99 %
- 20 - 29.99 %
- 30 +
- No Data

Waterbody
- Lake
- Subject to Inundation
- Swamp
- River

DCDB

1 0 1 2 Kilometers



Australian Grapevine Yellows - 2002

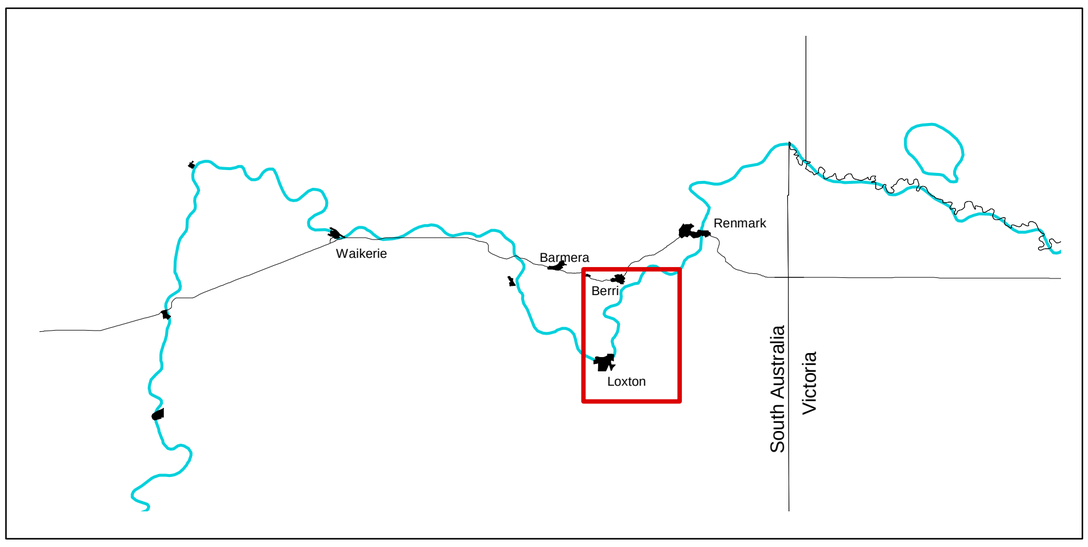
NEW RESIDENCE SURVEY AREA

Agy 2002
- 0 - 2.99 %
- 3 - 9.99 %
- 10- 19.99 %
- 20 - 29.99 %
- 30 +
- No Data

Waterbody
- Lake
- Subject to Inundation
- Swamp
- River

DCDB

1 0 1 2 Kilometers



Australian Grapevine Yellows - 2002

LOXTON SURVEY AREA

Agy 2002

- S 0 - 2.99 %
- S 3 - 9.99 %
- S 10- 19.99 %
- S 20 - 29.99 %
- S 30 +
- S No Data

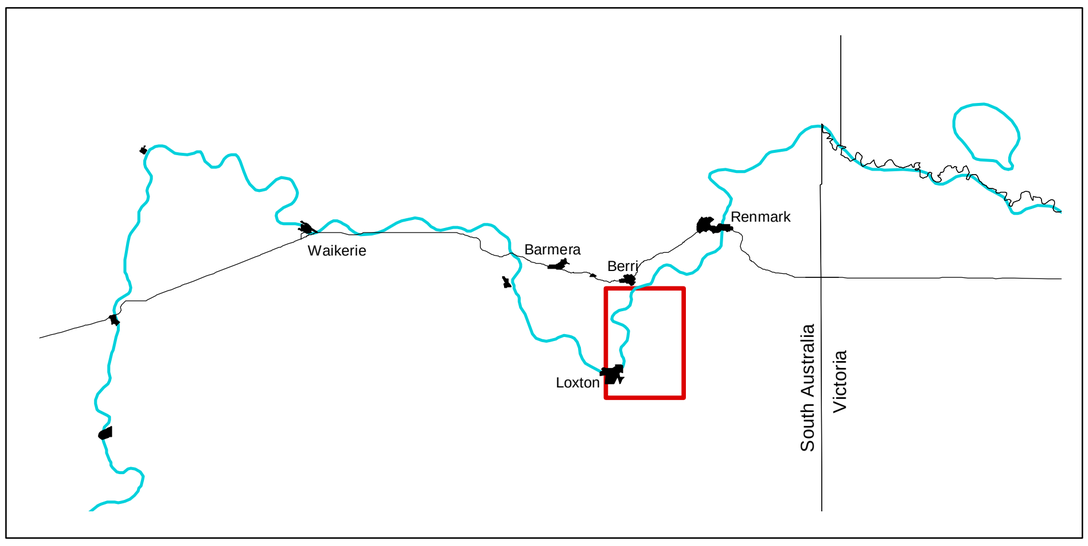
Waterbody

- Lake
- Subject to Inundation
- Swamp
- River

DCDB

1 0 1 2 Kilometers

N



Australian Grapevine Yellows - 2002

LOXTON SURVEY AREA

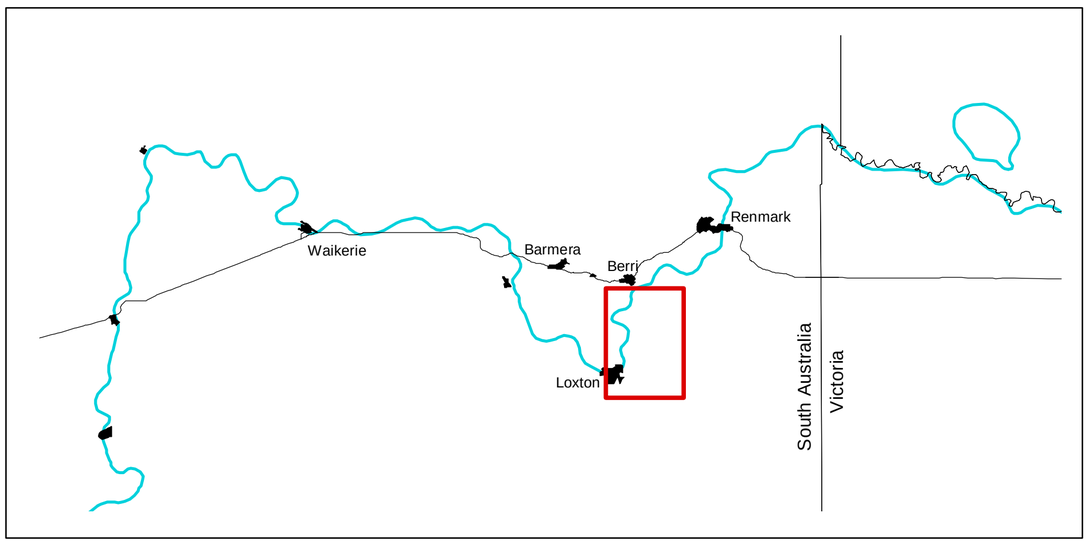
0 0.5 1 1.5 Kilometers

Agy 2002
- 0 - 2.99 %
- 3 - 9.99 %
- 10- 19.99 %
- 20 - 29.99 %
- 30 +
- No Data

Agy Feature

DCDB (Property Boundary)

Waterbody
- Lake
- Subject to Inundation
- Swamp
- River



Australian Grapevine Yellows - 2002

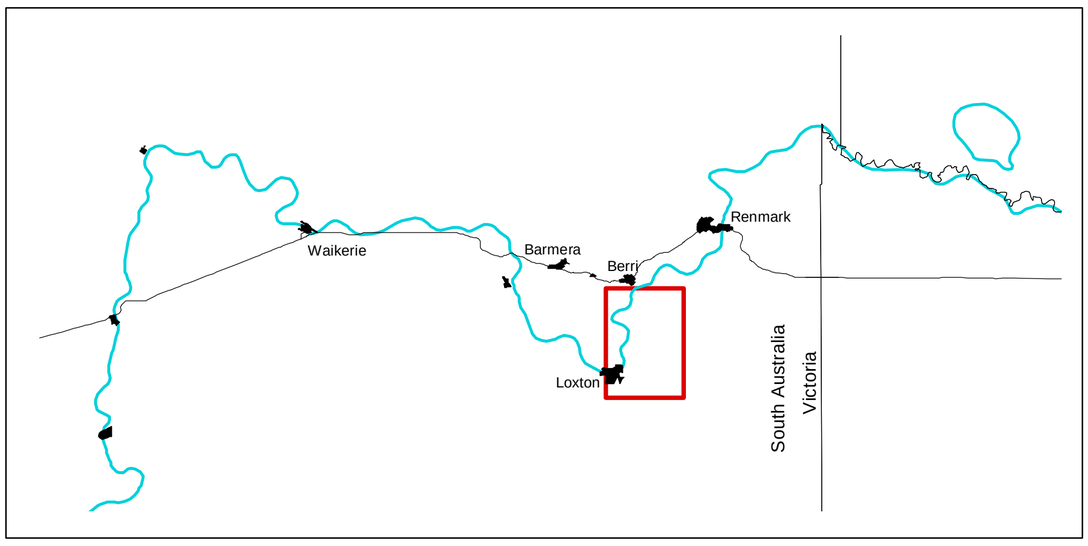
LOXTON SURVEY AREA

Agy 2002
- 0 - 2.99 %
- 3 - 9.99 %
- 10- 19.99 %
- 20 - 29.99 %
- 30 +
- No Data

Agy Feature

Waterbody
- Lake
- Subject to Inundation
- Swamp
- River
- DCDB (Property Boundary)

0 0.5 1 1.5 Kilometers



Australian Grapevine Yellows - 2002

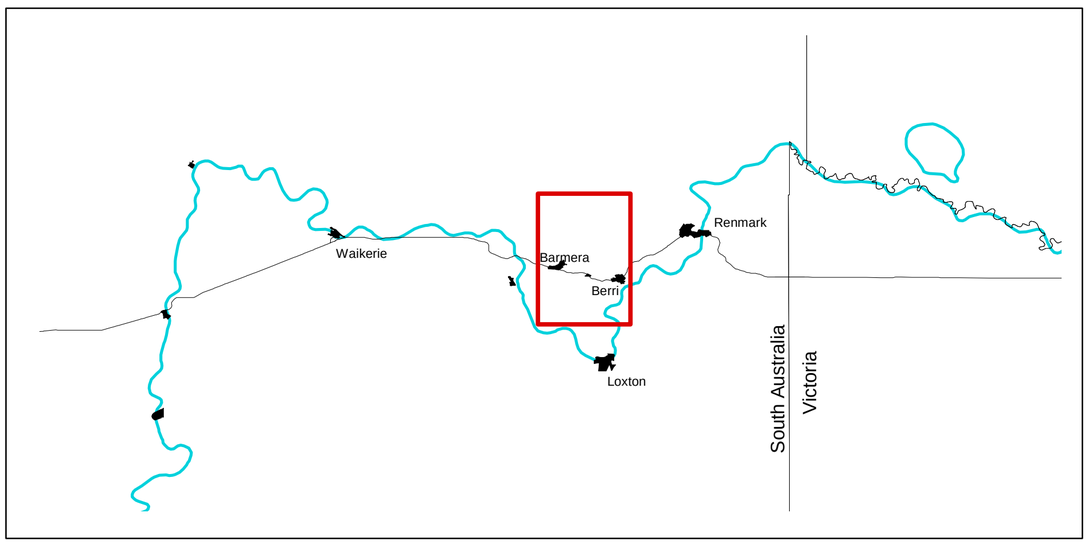
LOXTON SURVEY AREA

0 0.5 1 1.5 Kilometers

Surface from Agy 2002
- 0 - 2.99 %
- 3 - 9.99 %
- 10 - 19.99 %
- 20 - 29.99 %
- 30 +

DCDB (Property Boundary)

Waterbody
- Lake
- Subject to Inundation
- Swamp
- River



Australian Grapevine Yellows - 2002

BERRI BARMERA SURVEY AREA

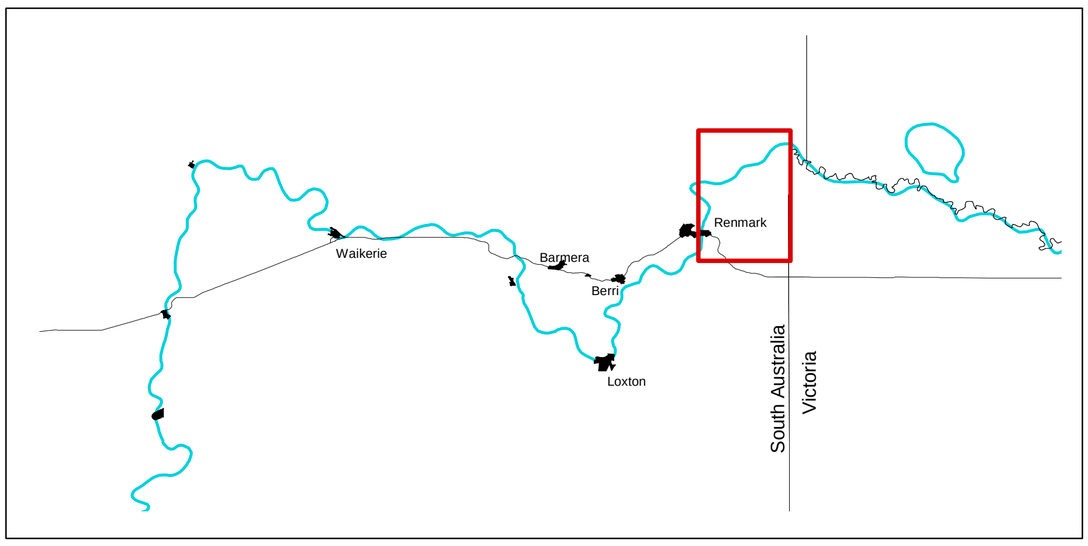
1 0 1 2 3 Kilometers

Main

Agy Survey 2002
- 0 - 2.99 %
- 3 - 7.99 %
- 8 - 19.99 %
- 20 - 50 %
- No Data

Waterbody
- Lake
- Subject to Inundation
- Swamp
- River

DCDB



Australian Grapevine Yellows - 2002

PARINGA SURVEY AREA

1 0 1 2 Kilometers

Agy 2002
- 0 - 2.99 %
- 3 - 9.99 %
- 10- 19.99 %
- 20 - 29.99 %
- 30 +
- No Data

Waterbody
- Lake
- Subject to Inundation
- Swamp
- River

DCDB

Going Bush: Searching for the Source of Australian Grapevine Yellows

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[2.] BBLF, 54470 Bernkastel-Kues, Germany

Vineyard Surveys

Australian Grapevine Yellows Survey
Riesling, Berri, SA March 2001

Vine	Arm	Row 19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
10	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1
	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1
11	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0
	2	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	1	1
12	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	2	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0
	2	0	1	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	1	1
14	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	1
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	1	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0
	2	1	0	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0
16	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
	2	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
17	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0	1	1
18	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
19	1	0	0	0	0	1	1	0	0	0	0	0	1	0	1	0	0	0	0	0
	2	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	2	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
21	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	2	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0
23	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
24	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

KEY	
Symptoms	
no AGY	0
AGY	1
missing	*
AGY arms	106
Total arms	834
% AGY	12.7
Orientation	
1 = N	
2 = S	
North	
Insect Exclusion House	
AGY =12%	



Findings

- **Analysis of vineyard maps showed AGY in random clusters in 28 vineyard (sites x years) combinations**
- **Surveys of 91 vineyard sites in March 2001 showed higher incidence of AGY in some localities**
- **Areas with 'hot spots' appeared associated with vegetation growing along the river and/or in overflows from irrigation channels**

Conclusion

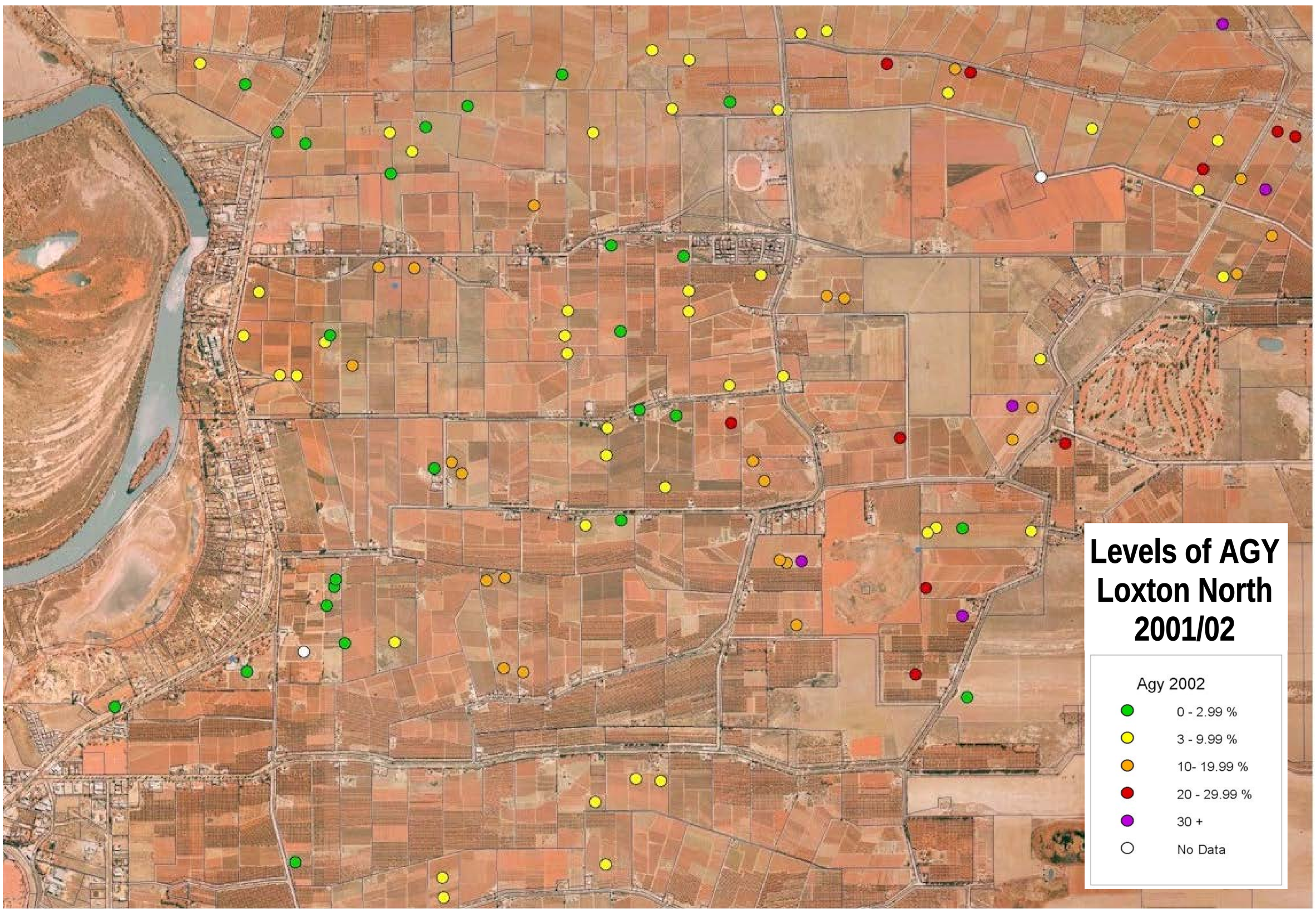
AGY is <u>not</u> coming from in or near vineyards,
But may be coming from native wetland vegetation.
It's time to go bush, to find the source of AGY!

Going Bush 2:

Searching for the Source of Australian Grapevine Yellows

Peter Magarey [1] and Michael Maixner [2]

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Findings

- **<u>Surveys</u> of 240 Riverland vineyards in 2001/02 showed:**
  - **High levels of AGY in vineyards < 1500 m from irrigation overflows or permanent still water**
  - **Low levels of AGY in vineyards further away**
- **<u>Monitoring</u> of vines in an insect exclusion-house showed:**
  - **x 3 less disease inside than in an adjacent vineyard**
  - **No AGY symptoms in ~ 6000 cuttings from diseased vines**

Conclusion

- **AGY is probably**
  - **coming from native plants near permanent still water.**
  - **transmitted by a leafhopper insect**
- **Cuttings from diseased vines are not likely sources of AGY**
- **Investigations are underway to find the leafhopper vector of AGY**

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