NT95003
Irrigation, nutrition & disease
management strategies to maximise yield
& quality of walnuts

Peter Rand
Serve-Ag Pty Ltd
NT95003
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Irrigation, nutrition and disease management strategies to maximise yield and quality of walnuts

HRDC Project NT95003

Conducted on behalf of

Horticultural Research & Development Corporation

by

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Serve-Ag Pty Ltd

November 26, 1998
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Irrigation, nutrition and disease management strategies
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Introduction

Vecon Walnuts (now Webster Horticulture) approached Serve-Ag Pty Ltd in 1994 to help tackle a number of production issues in the emerging walnut industry. After a review of the main problems facing the industry at the time it was decided to tackle these in a project jointly funded by Vecon and HRDC. This project commenced in 1995.

At the time, the industry was very young, with early plantings facing a complex range of production challenges, with a general lack of relevant agronomic information. The main issues to be tackled fell into groupings of irrigation, nutrition and disease.

The scope of the project was very wide, with investigations conducted on the above issues, in very different production areas. The aim of the project was to gather pertinent background information from relevant literature on all of these issues, and then begin the process of gathering and applying this knowledge in order to aim towards practical management decisions appropriate for local situations.

Overseas literature suggests that providing walnut trees with adequate water is crucial to maximise development of the trees, yield and quality of the nuts. As the trees have high rates of growth and water use under good growing conditions, yet low tolerance of waterlogging and salinity, it was seen as vital to collect basic information on how and when walnuts used water. Monitoring of commercial orchards was conducted over three years to gather data as to general water requirements and specific monitoring practices required to apply this data to individual sites.

There is little information available worldwide on the nutrient requirements of walnuts, in particular under Tasmanian conditions. While it was beyond the scope of this project to carry out in-depth investigations between nutrient application and yield / quality (trees do not reach full bearing capacity until at least year 7), it was possible to monitor nutrient status at several different sites with typical soil types used for walnut production. The results could be compared with growth / yield observations and known published values to build a profile of general nutrition management practices needed for optimum production.

In this project, a preliminary survey was conducted for the main type of walnut diseases in Tasmania. Preliminary investigations were conducted to assist in evaluating current and potential control treatments.

The information was extended by a series of articles in the grower magazine, "The Nutter", presentations to field staff and growers at several field days, and presentation of findings at the 1998 Australian Nut Industry Conference.
Orchard Irrigation

Background: Overseas Experience / Research

Most of the available published information relates to Californian conditions. Although the information is not directly applicable, due to many factors including different soil type, climate, varieties, irrigation system (ie flood), etc., it does provide a useful background for tackling issues in Tasmania.

Main relevant points

- Insufficient irrigation results in poor vegetative growth, small nut size and nutrient imbalance.
- Good irrigation management is generally seen as critical in achieving desired growth, yield and quality.
- Irrigation demand of walnuts is generally very high, even in comparison to other tree and vine crops, as they have a large and active root system and canopy.
- Californian walnut producers often irrigate twice weekly with up to 25 mm per application. (The literature suggests that fully developed walnut orchards use up to 10 Megalitre/ha/year in very hot, dry conditions.)
- Few studies have been completed on the irrigation requirements of developing orchards.

Tasmanian Research / Experience

Six sites were monitored on the North West Coast and in the Coal River Valley, with both EnviroSCAN and tensiometers. Soil types and climate vary considerably from site to site (refer Appendix ii, Plate 1).

Readily Available Water (RAW) in the walnut rootzone:

This varied considerably, according to site and soil type, with general findings outlined below.

- Red Krasnozem Clay / Loam (RAW approx. 35 mm)
- Penna Sand (RAW approx. 20 mm)

Most walnut trees have been in establishment stage to date. It is expected that water requirements will increase significantly as orchards mature.
Orchard Irrigation (Cont'd)

Stages of Water Use

Very early (September - Mid October)

Water uptake begins soon after leafing out. The rate of uptake is initially very small. Irrigation may not be required in wet springs.

Early (Late October to End of November)

As the leaf area increases, the rate of uptake also increases. When the rate of daily evaporation increases due to expanding leaf area, and likelihood of rainfall decreases, close monitoring is necessary to provide adequate amounts of water.

Mid (December to late February)

This is the peak water use period, with both growth and rate of water uptake at their highest. Frequent irrigation is required. In some sites, irrigation every three / four days, with light volumes, is needed.

Late (March / April / May)

Rate of water uptake decreases as evaporation rates decrease and season closes.

Depth of Active Root Zone

- Young (1st Year) - Mostly 0-25 cm.
- Medium (2nd / 3rd Year) - Mostly 0-40 cm
- Older (4th Year +) - 0-80 cm+, however the main root activity (i.e. water uptake) occurs in the 0-40 cm zone
Orchard Irrigation (Cont'd)

Recommendations

Irrigation System

- Use micro-sprinklers with enough pump capacity to apply at least 40 mm per week.
- Dan 19 lph mini-sprinklers deliver only approx 2.7 mm/hr over the 7 square meters they cover. Therefore a hot, dry week with 40mm evaporation may require 15 hours of irrigation. This recommendation may vary considerably, depending on weather, tree size / age / vigour, site and soil type.

Irrigation Scheduling

- It is difficult to make general recommendations regarding the most appropriate irrigation scheduling methods due to different orchard sizes (less than 2 hectares through to above 50 hectares). It is recommended that the tensiometers be kept between approximately 15 and 50 kpa in heavy soils, and and between approximately 10 and 30 kpa in sandy soils.
- Small production areas (less than 4 hectares) should use a minimum of two tensiometer sites per block. Each site should consist of two tubes, one positioned at 25cm and one at about 50cm depth. Regular visual checks with spade during season are recommended.
- For larger areas, improved forms of soil moisture monitoring should be considered due to the critical influence irrigation has on walnut growth and yield.
Overseas Research / Recommendation / Experience

The limited information available in literature is not directly applicable to Tasmania due to differences in soil type, climate and production systems. The following general points apply:

- Sufficient organic matter is important for walnut growth.
- The soil pH should be above 6.5.
- Fertiliser application should be light in the first years of production.
- Deficiencies of N, P, K, Ca, Zn and B have been reported in Californian situations.
- Soil copper levels over 10 ppm (mg/kg) may be harmful to walnuts. These may accumulate after several years of high copper application against black blight (Xanthomonas campestris pv. Juglandis). Once this situation has occurred it is almost impossible to reverse. Raising the pH with very high additions of lime can alleviate toxic soil copper levels slightly. Regular monitoring should be conducted.

Local Work / Observations

- Soil testing three sites (Orchards located at Penna, Cranbrook and Forthside).
- Leaf testing three sites (Orchards located at Penna, Cranbrook and Forthside) (refer Appendix ii, Plate 2).
- Sap testing of selected sites.

Key observations from nutrition monitoring program:

- Excess nitrogen applications should be avoided. If using over 140 kg/ha elemental nitrogen per year, walnuts may put on excessive weak growth that appears to be significantly more prone to attack by black blight (Xanthomonas). The recommended level of elemental nitrogen application is approximately 90 kg/ha/yr.

- Potassium, calcium and magnesium levels must be in balance. Sites with excessive magnesium or calcium levels tend to make potassium uptake difficult. High magnesium sites are common in Tasmania. The cation balance must be addressed with appropriate additions of lime, dolomite, hydromag or potassium fertiliser.

- Zinc deficiencies in Tasmania are common. Deficiencies are possible, as walnut trees require ample zinc, and Tasmanian soils often have low zinc status. Application of 40 kg of Zinc Sulphate Monohydrate every two years appears sufficient to avoid problems. Sites with low zinc in soil or leaf should have at least three foliar zinc applications at label rates included in the routine bacterial applications of copper.

- Walnuts are sensitive to salinity. Moderate or high EC levels, occurring as a result of saline water, the soil or fertiliser, can cause burning symptoms or leaf scorching. Fertiliser placement near root zone, use of saline water or excessive mineral fertiliser rates must be avoided.
Walnut Sap Testing

A technique to sample and test walnut sap was developed and basic monitoring was conducted over a range of sites. Preliminary work indicated that this fast-turnaround / low-cost nutrition test was a potentially useful technique for monitoring plant N, P, K, Ca, Mg and Zinc levels. Further testing and trial work is required to develop a commercial application of this technique.

Current Pre-Plant Recommendations

- Conduct pre-plant soil test well before planting.
- If needed, work in lime and super phosphate before planting. (The quantities used must be sufficient. Addressing deficiencies of these elements at a later date is very difficult after planting. Up to 30 t/ha lime and 1 tonne triple super phosphate / ha may be needed in poor soil.)
- Apply pre-plant basal NPK fertiliser + trace elements (as determined by soil test).
- After planting in autumn, apply spring fertiliser (+ fertigation if applicable).

Nutrition Management of Established Orchards

- Conduct soil test at least every second year.
- Conduct leaf test on key varieties every year in mid January.
- Interpret soil, leaf results after leaf analysis and plan fertiliser program.
General Recommendations for Established Orchards
(Note: Actual applications needed may vary considerably, according to leaf and soil tests)

- **Recommended fertiliser application timings (requirements determined by soil test and leaf analysis):**
  - Winter - Lime / super phosphate, low solubility trace elements.
  - Spring - Basal Dressing x 2, early fertilization of N and K, foliar micronutrients.
  - Summer - Fertilization (Mainly N, K and / or Ca).
  - Autumn - Assess need for N and/or micronutrients for next season.

- **Recommended general rates of fertiliser application per year:**
  - Optimal pH - Above 6.0, ideally 6.5
  - Nitrogen - Approx. 90 kg / ha
  - Phosphorus - Approx. 25 - 40 kg/ha
  - Potassium - Approx. 90 kg/ha
  - Calcium / Magnesium - As needed if imbalanced
  - Micronutrients - Zn, B, Cu, Mn, Fe, Mo, others as required (see soil and leaf test)

- **Example of typical programme applied to a mature walnut orchard:**
  - 2 Weeks prior to bud burst apply 450 kg/ha 8-4-10
  - 4 weeks after bud burst apply 450 kg/ha 8-4-10
  - If fertigating, consider total applications of approx 125 kg/ha Calcium Nitrate (5 x 25 kg/ha at approx timings A, B, C, D & E). If not fertigating, consider topdressing total 100 kg/ha (two applications of approx 50 kg/ha) Nitram at timings B and D. Apply trace elements as determined by soil / leaf tests.
    - A. Mid / Late Nov
    - B. Mid Dec
    - C. Early Jan
    - D. Late Jan
    - E. Mid Feb

- **Rate of fertiliser application recommended for young trees (years 1 to 5):**
  The actual rate of fertiliser to be applied to young trees should be as for mature trees, but reduced according to percentage of total orchard area explored by the root zone, as detailed below. Note that as fertigation applications via sprinkler application cannot be preferentially directed towards small trees, rates for mature trees should be applied.

- **Estimated percentage of total orchard area explored by roots:**
  Approximate guide below (an orchard inspection is needed to determine area accurately):
  - Young (1st year) - Approx 20%
  - Medium (2 / 3 years) - Approx 40%
  - Late (4 / 5 years) - Approx 70%
  - Established (6 years) - 100%
Walnut Disease – Black Blight

Introduction

Disease diagnosis of plant specimens has shown that black blight caused by a bacterial pathogen, *Xanthomonas campestris pv. Juglandis*, is the main disease problem of walnuts in the North West Coast of Tasmania.

Background of the Disease

*Xanthomonas campestris pv. Juglandis* is a motile bacterium and the disease it causes, black blight, is a major disease problem in walnut crops worldwide. In severe cases up to 100% crop loss can occur.

Black blight disease symptoms on walnuts are:
- Flower infection leading to young fruit dropping.
- Infection in mature nuts can cause the shell and meat of the nut to blacken and shrivel.
- The bacterium can also kill new shoots.

The bacterium overwinters principally in dormant buds. Populations of the bacteria in these buds off-season can be up to several hundred thousand per bud. Over-wintering can also occur in dormant catkins.

When buds begin to develop in spring the bacterium begins to multiply. Spread of the bacterium can be through water droplets or transmission via infected pollen. Infected pollen can lead to infection developing in the fruit. The bacterium requires water to enter the plant but such water only needs to be present for a few minutes. Extended rainfall periods, warm and wet, windy or frosty conditions can lead to multiple infection cycles as entry sites are created and followed by infection conditions. Lesions can appear on nuts, catkins, shoots and leaves within 12 – 14 days of infection.

No resistant trees have been recorded. Early leafing varieties appear more susceptible to higher infection due to a longer potential infection period.

Disease studies

The objectives of the disease studies in this project were:
- To assess the extent of the black blight disease problem in the North West Coast of Tasmania
- To evaluate the bacterial pathogen population levels with disease symptoms
- To conduct preliminary investigations on the efficacy of copper sprays

Survey of Tasmanian Walnut Orchards for the black blight disease:

A range of suspect samples was collected from various walnut orchards in Tasmania. Bacteria was extracted from the specimens and a serial dilution was carried out and plated onto nutrient agar. The use of nutrient agar medium allows the separation of *Xanthomonas* bacterial colonies from non-*Xanthomonas* bacterial colonies based on the bright yellow colonies of the *Xanthomonas* bacteria. Of these, over 95% from this initial survey indicated presence of *Xanthomonas* bacteria. The serial dilution of the sample materials showed high levels of bacteria associated with sample tissue that have new and developing blackened symptoms.
Walnut Disease – Black Blight (Cont'd)

Effect of Copper on Bacterial Inoculum Level:
A field spray test was carried out by spraying several trees to the point of run-off at Bonney's orchard on 5th November 1996, and samples were taken 5 days later.

<table>
<thead>
<tr>
<th></th>
<th>Xanthomonas CFU's per 10 buds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Untreated control</td>
<td>$4.7 \times 10^4$</td>
</tr>
<tr>
<td>2. 300g Kocide / 100L water</td>
<td>$2.4 \times 10^3$</td>
</tr>
<tr>
<td>3. 600g Kocide / 100L water</td>
<td>$4.0 \times 10^1$</td>
</tr>
</tbody>
</table>

This test showed a reduction in the bacterial levels with increasing concentrations of Kocide. This indicates that the copper spray was effective in reducing the bacteria levels on buds.

Chemical control - Field trial
A field trial was conducted to evaluate the different copper based products and the different rates of copper for the control of black blight in an orchard. Spraying started on the 5/11/97 and ended on the 31/12/97. There were three replicates of each treatment (see appendix i for details). The treatments and spray schedule applied are described in the table below:

First Assessment (23/12/97)

<table>
<thead>
<tr>
<th>No.</th>
<th>Product</th>
<th>Product Rate/100L</th>
<th>% Shoot infected</th>
<th>% Nuts infected</th>
<th>Mean leaf incidence</th>
<th>Mean leaf severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kocide DF</td>
<td>300 g/100L</td>
<td>26.3</td>
<td>44.6</td>
<td>0.92</td>
<td>1.00</td>
</tr>
<tr>
<td>2</td>
<td>Kocide DF</td>
<td>1000 g/100L</td>
<td>15.8</td>
<td>37.7</td>
<td>1.25</td>
<td>1.17</td>
</tr>
<tr>
<td>3</td>
<td>Kocide 2000</td>
<td>250 g/100L</td>
<td>21.4</td>
<td>45.8</td>
<td>0.92</td>
<td>1.00</td>
</tr>
<tr>
<td>4</td>
<td>Mankocide</td>
<td>400 g/100L</td>
<td>14.1</td>
<td>31.4</td>
<td>0.67</td>
<td>0.67</td>
</tr>
<tr>
<td>5</td>
<td>Kocide DF</td>
<td>300 g/100L</td>
<td>25.8</td>
<td>60.4</td>
<td>1.17</td>
<td>1.25</td>
</tr>
<tr>
<td>6</td>
<td>Untreated</td>
<td>N/A</td>
<td>18.1</td>
<td>59.4</td>
<td>1.33</td>
<td>1.42</td>
</tr>
</tbody>
</table>
Harvest Assessments (18/3/98)

<table>
<thead>
<tr>
<th>No.</th>
<th>Product</th>
<th>Product rate /100L</th>
<th>Spray Schedule</th>
<th>% Nuts diseased on tree</th>
<th>% Nuts diseased on ground</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kocide DF</td>
<td>300 g/100L</td>
<td>7 days</td>
<td>72.4</td>
<td>93</td>
</tr>
<tr>
<td>2</td>
<td>Kocide DF</td>
<td>1000 g/100L</td>
<td>14 days</td>
<td>70.0</td>
<td>94</td>
</tr>
<tr>
<td>3</td>
<td>Kocide 2000</td>
<td>250 g/100L</td>
<td>7 days</td>
<td>62.5</td>
<td>91</td>
</tr>
<tr>
<td>4</td>
<td>ManKocide</td>
<td>400 g/100L</td>
<td>7 days</td>
<td>51.8</td>
<td>89</td>
</tr>
<tr>
<td>5</td>
<td>Kocide DF</td>
<td>300 g/100L</td>
<td>10 days</td>
<td>55.7</td>
<td>95</td>
</tr>
<tr>
<td>6</td>
<td>Untreated</td>
<td>N/A</td>
<td>N/A</td>
<td>83.0</td>
<td>98</td>
</tr>
</tbody>
</table>

- Kocide DF - 400g/kg dry flowable formulation of copper hydroxide.
- Kocide 2000 - 350g/kg dry flowable formulation of copper hydroxide
- ManKocide - dry flowable formulation of copper hydroxide and mancozeb in a 2:1 ratio.

ManKocide appears to show lower level of infections on the leaves and nuts compared to other Kocide sprays.
Current & Future Recommendations

The only effective treatment to date has been the use of copper sprays. In recent years the
efficacy of copper has been reduced by the development of resistant strains of the bacteria.
These strains have been reported in California and France. Some work has been done on
inter-row spacing and it would appear that increased spacing can decrease disease pressure.
An inter-row of 1.4 m or greater is recommended.

Recommendations for the application of the copper sprays seem to agree that the first
application should be around the time when catkins reach a length of approximately 2.5 cm. As
the copper sprays are preventative, with little or no curative action of established infection, it is
vital that regular applications are used to cover susceptible tissue. This is most important
during the early part of the season (in particular spring), which generally has more infection
periods. In dry seasons, sprays can be applied on a 10 – 14 day schedule. In wet seasons,
sprays should be applied on a 7 – 10 day schedule. Uniformity of coverage is generally
regarded as critical.

Product:
Currently, only Kocide DF is registered in Tasmania for control of black blight. The label rate is
300 g/100 L. Application on immature trees should be to runoff. Rates of approximately 3600
L/ha are recommended for mature trees. The use of oils or other adjuvants is not
recommended with Kocide DF. Mixing at least 90 minutes prior to application has been shown
to be beneficial to efficacy.

Spray schedule:
It is recommended that spraying commence before catkin length is 2.5 cm. Spraying schedule
is recommended as 7 – 10 days in wet weather, and 10 – 14 days in dry weather.

Potential New Products (currently not registered):
Kocide 2000 is an improved formulation that achieves improved efficacy from a lower rate of
metallic copper. ManKocide is a pre-mixed combination of Kocide and Mancozeb, currently
undergoing registration trials. The formulation is a result of extensive trials in California
showing much-improved efficacy over traditional copper products, even against resistant strains
of bacteria. Both products are undergoing registration trials. Consistent with these findings, the
trial conducted in this project also shows that ManKocide spray applications appear to give
better control of black blight than Kocide DF and Kocide 2000 products. Further investigations
with this product are recommended to develop optimum spray rates and application timings.
Discussion

1. Orchard Irrigation

Irrigation is known to be a very important factor that has a strong influence on tree development and, eventually, yield. It is felt that it is very important to take full advantage of the short growing season in Tasmania by not limiting growth with either too little or too much irrigation.

Under the right growing conditions, walnuts will achieve high growth rates if supplied with sufficient quantities of water, but are very susceptible to damage from overwatering and waterlogging. Due to the vastly different conditions in which walnuts are grown (soil type, climate, etc) in Tasmania it is not possible to make general irrigation recommendations which will be directly applicable to all sites.

Monitoring identified critical periods of walnut rootzone activity, the level of which depends largely on tree age, climate and other factors. Soil moisture monitoring of each site is recommended in order to properly schedule irrigation applications.

It should be noted that monitoring of commercial orchards indicated that on occasions both serious over and under watering occurred to levels which probably resulted in significant long term production losses. There appears to be currently a poor level of understanding amongst growers on irrigation scheduling in general and in particular irrigation requirements of walnuts.

2. Orchard Nutrition

Orchard nutrition is a complex issue which can not be adequately researched over a relatively short time of three years in non-fruited, young orchards. Leaf tissue and sap analysis, in combination with visual assessments and growth levels, were utilised to gather as much information as possible on appropriate nutrition strategies. A list of likely nutritional problems, a sound basic fertiliser strategy and methods to monitor nutrition were developed.

Nutrition monitoring indicated that walnuts are prone to a number of deficiencies, the extent and nature of which varies depending on the soil type and orchard management practices. These deficiencies appear to be usually easily identified and addressed with regular monitoring of soil/plant nutrient status, followed by application of an appropriate balanced fertiliser program. It is strongly recommended that each orchard production area utilise soil and plant nutrient status monitoring on a regular basis.

3. Walnut Disease

Xanthomonas or Walnut black blight will continue to be a particularly significant problem in many areas currently growing walnuts in Tasmania, due to a number of factors. Many areas are prone to be wet and windy, particularly in Spring and early Summer. These environmental conditions favour both disease entry and development.

A field test of different rates of copper application demonstrated the efficacy of copper at lowering the Xanthomonas population level present on buds during the growing season.
Discussion (Cont'd)

ManKocide appears to give improved control of the bacterial disease in the trial conducted to test the efficacy of different copper products in controlling the disease, with lower levels of infection in shoots, leaves and nuts. Further studies are recommended with this new product.

The industry still faces significant challenges ahead in controlling this disease. Although good spray coverage and regular timing is important, the most appropriate spray schedule is yet to be determined. It is felt that, in high disease pressure areas, copper application should probably be continued on a regular basis until later in the season, when the nuts begin to become resistant, possibly being determined by levels of visual infection. As the disease overwinters inside bud tissue and diseased twigs, dormant applications are unlikely to be highly effective.

Continued applications of high rates of copper products against bacteria have been reported to result in toxic soil levels and resistant bacteria (reported in both France and California). No evidence of harmful soil accumulation was discovered from soil testing in any site, although continued monitoring on an annual basis is recommended. It is therefore important to ensure that copper is used strategically in addition to good management practices to reduce the potential for development of resistance.

It is known, however, that the level of potential inoculum will gradually build up in neglected orchards over a period of years, as infection develops in shoot tips. Visual observations indicate that generally high levels of black blight infection are often present in young Tasmanian orchards, suggesting that more effort be directed into controlling this disease at an early stage, in particular in the main nursery, which is the source of all trees destined for commercial orchards.

It should be noted that most areas of significant commercial walnut growing worldwide are situated in generally warm and dry areas, such as central California. This allows faster growth rates with generally low disease pressure (even though control can be a problem in this situation in years with above average rainfall). Careful site selection, therefore, is likely to be the most effective long term method of controlling Xanthomonas disease, and it is not recommended that any further plantings in areas such as the North West Coast of Tasmania are considered.

4. Extension

As the industry continues to expand towards it's production goals and reach an economic critical mass significant challenges to the industry lie ahead. Further extension of information to growers needs to be carried out in order to maximise benefits from this research and development project (and general industry experiences) to date. It is recommended that Webster Walnuts continue to conduct an ongoing extension program and appoint necessary resources to facilitate further information transfer.
Acknowledgments

I would like to thank the Horticultural Research & Development Corporation, Vecon and Webster Horticulture for providing the funding to enable this project to be conducted.

I would like to thank the following Vecon and Webster staff for assistance during the project: Paul Boland, Leigh Titmus, Brendon Bond, Nicole Gibson and Darren Long.

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Appendix i - Disease Trial Details & Methods

Treatments

<table>
<thead>
<tr>
<th>NO.</th>
<th>PRODUCT</th>
<th>RATE g product/100 L</th>
<th>SCHEDULE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kocide DF</td>
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Trial Details

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Trial Plan

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### Appendix i - Disease Trial Details & Methods (Cont'd)

**Application Details**

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Appendix i - Disease Trial Details & Methods (Cont’d)

Assessment Methods

BRANCH ASSESSMENT

DATE - 23/12/97
NO. OF TREES - 10
SAMPLE SIZE - 3 current season shoots per tree
REPLICATES - 3
METHOD - Inspect visually for presence of infection (Severity/Incidence)
RESULTS - Graphs 1 & 2

NUT ASSESSMENT

DATE - 23/12/97
NO. OF TREES - 10
SAMPLE SIZE - 3 current season nuts per tree
REPLICATES - 3
METHOD - Inspect visually for presence of infection (Severity/Incidence)
RESULTS - Graph 1

HARVEST ASSESSMENT

DATE - 18/3/98
SAMPLE SIZE - Whole Plot
NO. OF TREES - 10
REPLICATES - 3
METHOD - Count number of fallen nuts and nuts on tree. Count number of infected nuts in each group.
RESULTS - Graphs 3 & 4
Appendix i - Disease Trial Details & Methods (Cont’d)

Graph 1: Blight infection of walnut shoots and nuts (23/12/97)
(numbers in brackets relate to treatment schedule)

Graph 2: Blight incidence and severity on walnut leaves (23/12/97)
(numbers in brackets relate to treatment schedule)
Appendix i - Disease Trial Details & Methods (Cont'd)

Graph 3: Treatment comparison between tree and ground disease (18/3/98)
(numbers in brackets relate to treatment schedule)

Graph 4: Percentage of blight infected nuts per replicate (block) (18/3/98)
Plate 1 - Paul Boland, Vecon Walnuts, collecting soil moisture information from the EnviroSCAN in the NW Trial Orchard

Plate 2 - Peter Rand, Serve-Ag Pty Ltd, Paul Boland and Nicola Dennet, Vecon Walnuts, taking leaf samples for testing