

VG97064

**Assessment of Tomato and Capsicum Cultivars
and Production Techniques for Export to Japan
and Taiwan and Demonstration of IPM for
Botrytis cinerea for local and export crops**

Ray Hart et al

**Department of Primary Industries Water
and Environment**



Know-how for Horticulture™

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**FINAL REPORT
TO
HORTICULTURE AUSTRALIA LIMITED**

**Horticulture
Australia**



field fresh



Project No. VG 97064

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Purpose:

The purpose of this report is to detail the conduct of this three-year project to Horticulture Australia and to provide new and existing hydroponic greenhouse growers and industry investors with the outcomes of this study. These outcomes are intended to assist the expansion and market options for *Solanaceous* crops in Tasmania by providing new production and investment information gathered, trialed and collated in this report and associated publications.

Acknowledgments:

Project partners

Horticulture Australia Limited (HAL) was the major funding organisation, matching industry contributions dollar for dollar. Horticulture Australia was formerly known as the Horticultural Research and Development Corporation (HRDC).

Department of Primary Industries Water and Environment (DPIWE) provided "in kind" support to the project as project manager and with supply of administration overheads. The project funded one officer for three days a week.

Tasmanian Greenhouse Tomato and Vegetable Growers Association (TGTVGA) representing the interests of greenhouse vegetable growers provided funding and 'in kind' support.

Field Fresh Tasmania contributed financially towards the project and by 'in kind' support through its excellent marketing skills and contacts, Interstate and Overseas.

Project sponsors

J. and A. Brandsema – Seedlings, capsicum greenhouse, maintenance, supply of water, nutrients, management of nutrients and environmental control.

Tasmanian Institute of Agricultural Research (TIAR) – provided “in kind” support to the project principally with plant nutrition advice during the project and collaboration in writing the nutritional topics in the guide.

Aurora Energy – contributed towards the heating bill for the capsicum house and for monitoring the energy input. Heating is one of the main expenses of hot house growing.

Air Liquide – gas and equipment for the capsicum demonstration house.

Ameor Fibre Packaging and Visyboard – packaging for trial marketing.

R. and A. Henderson – U.V. Fogger, tomato demonstration site.

Hills Transplants – Seedlings.

C. Vercoe – Art work design for cartons.

Qantas and A.E.I. Pace Express Pty Ltd – Assistance with freight.

R. Atkins, E. and A. Dykman, N. Mitsakis and B. Laffer – Tomato demonstration sites.

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Serve-Ag and South Pacific Seeds – Seeds

R. Buttermore (Tasmanian Museum and Art Gallery) – Bumblebee demonstrations

Editing

H. Watkias (hwt editing) – Final edit and layout of this report and the production and investors guides.

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Disclaimer:

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Contents

MEDIA SUMMARY	3
TECHNICAL SUMMARY	4
INTRODUCTION, INCLUDING REVIEW OF LITERATURE	6
OBJECTIVES	7
MATERIALS AND METHODS	8
1997-1998	8
1998-1999	9
Tomatoes	9
Capsicums	9
1999-2000	10
Capsicums	10
RESULTS	11
EGGPLANTS	11
1997-98	11
TOMATOES	11
1997-98	12
1998-99	13
CAPSICUMS	13
1997-99	13
1998-99	14
1999-2000	15
AIT in 1999-2000	16
DISCUSSION	19
EGGPLANTS	19
TOMATOES	19
CAPSICUMS	19
IPM CONTROL OF BOTRYTIS CINERA	20
RECOMMENDATIONS – SCIENTIFIC AND INDUSTRY	21
TECHNOLOGY TRANSFER	23
FIFTEEN DAYS	23
MEETINGS	23
PRODUCTION AND INVESTORS GUIDES	23
ACKNOWLEDGMENTS	24
BIBLIOGRAPHY	24

Media Summary

Tasmania has an ideal environment in which to produce greenhouse vegetables. Its cool summers favour the production of high quality produce.

When Tasmania was granted area freedom from Tobacco Blue Mould (TBM) in November 1996, it presented greenhouse growers with an opportunity to export tomatoes, capsicums and eggplants to Japan.

This three-year project investigated a range of greenhouse tomato, capsicum and eggplant cultivars and their production techniques. The project also confirmed the New Zealand experience that *Botrytis cinerea*, which can be a major problem with these crops, can be controlled by managing the environment in greenhouses.

This work has generated knowledge that is a sound basis for decision-making by both existing greenhouse growers who wish to expand production and new entrants to the greenhouse vegetable industry.

Early on the project identified capsicums as the main market opportunity. The project also identified the cultivars Mazurka and Spirit (both red), Fiesta (yellow) and Nassau (orange) as suitable for both Tasmanian greenhouse production and for the Japanese market.

A production guide, "Greenhouse Capsicums: A guide to growing export quality hydroponic greenhouse capsicums in Tasmania", has been published. An investors guide, "Greenhouse Capsicums: Investors guide to export quality hydroponic capsicums in Tasmania", also has been published to help investors decide whether or not to invest in the capsicum industry.

Towards the end of the project, Korean imports of capsicums into Japan had a profound effect on price, making it uneconomic to export this crop to Japan. Fortunately, investigations showed that opportunities existed for high quality capsicums on the Tasmanian and interstate markets.

As a direct outcome, this project has encouraged two industry partners, with support from Horticulture Australia, to begin a semi-commercial joint venture to trial the knowledge learned in this initial study and test the market for capsicums on the local and mainland markets.

Technical Summary

Tasmania was granted area freedom from Tobacco Blue Mould (TBM) in November 1996. This presented Tasmanian greenhouse tomato and vegetable growers with the opportunity to export a range of *Solanaceous* vegetables, such as tomatoes, capsicums and eggplants, to Japan. In 1997, the supply of these crops into Japan was lowest and the prices highest during the peak Tasmanian harvest period from December to late March.

Botrytis cinerea can be a major disease problem with these crops. Experience from New Zealand (NZ) showed that appropriate management of the greenhouse environment would prevent this disease becoming a problem. This Integrated Pest Management (IPM) technique eliminates or minimises the use of fungicides.

The Tasmanian Greenhouse Tomato and Vegetable Growers Association (TGTVGA), Field Fresh Tasmania (FF), and the Department of Primary Industries, Water and Environment (DPIWE) developed a joint industry/Horticulture Australia-funded three-year project to investigate this opportunity and to trial the NZ method of *Botrytis* control in Tasmania.

The initial work involved growers from the TGTVGA and the DPIWE screening a large number of cultivars and FF exploring the export market opportunities. After the first year of broad investigation, the project partners selected the most promising cultivars on agronomic, export quality and market potential for more intensive trials.

The project confirmed early that greenhouse capsicums had the most potential of the *Solanaceous* crops for export. In consequence, world best practice production methods would need to be determined. A small greenhouse containing a computerised environmental control system was leased. In addition, a specialist consultant in capsicum husbandry was contracted to advise on all aspects of crop management.

The project identified that the greenhouse capsicum cultivars Mazurka and Spirit (both red), Fiesta (yellow) and Nassau (orange) were suitable for greenhouse production in Tasmania and for the Japanese market. A production guide, "Greenhouse Capsicums – A guide to growing export quality hydroponic capsicums in Tasmania", was compiled and published as a direct result of this Horticulture Australia project. This publication has been produced for greenhouse growers in Tasmania. However, it could be adapted to suit the needs of any greenhouse growers throughout Australia. A supplementary investors guide also has been written to help potential investors decide whether or not to develop greenhouse capsicum operations.

Unfortunately as the project neared completion, imports of capsicums from Korea had a profound effect on the price received for capsicums in Japan. Fortunately, opportunities exist on the mainland to market high quality Tasmanian capsicums, although it may be necessary to trial different cultivars.

Preliminary trials comparing capsicums grown using Nutrient Film Technique (NFT) with those grown in sawdust bag culture suggested that NFT could be used for early production of coloured fruit without affecting total production. This potential economic advantage is worth verifying.

The work with tomatoes identified two new cultivars, Darita and AX 701-7, that were more adaptable than the cultivars in present use to the wide range of existing greenhouse facilities in Tasmania. The long shelf life (LSL) type Ipsilon, which is widely grown in Tasmania, was found to require the higher temperatures sustained in the more modern greenhouses to produce to its potential.

This work has generated knowledge and information about three *Solanaceous* crops that could provide a sound basis for decision-making by both existing greenhouse growers wishing to expand and new entrants to the greenhouse vegetable industry.

As a direct outcome, this project has encouraged two industry partners, with support from Horticulture Australia, to begin a semi-commercial joint venture to trial the knowledge learned in this initial study and test the market for capsicums on the local and mainland markets.

Introduction, including review of literature

In November 1996, Japan granted Tasmania area freedom from Tobacco Blue Mould (AQIS 1994). This gave Tasmania an opportunity to export *Solanaceous* fruits such as tomatoes, capsicums and eggplants to Japan. In addition, Tasmania's cool temperate climate is ideal for greenhouse production as it favours the production of high quality produce with relatively low incidences of pests and diseases.

DPIWE began a project in 1997 to explore this export opportunity by assessing tomato, capsicum and eggplant cultivars and the best available production techniques for these crops.

Production of greenhouse tomatoes has been extensively researched in Australia and elsewhere. Many cultivars have been tested for their suitability to specific markets that need certain sizes, shapes, colours, tastes, food quality and dates of maturity. Some cultivars, such as Epsilon, show potential for export to Japan. However, they need to be tested to see whether or not tomatoes of acceptable quality for the Japanese market can be produced economically in Tasmanian greenhouses. Hydroponic tomato production methods are well understood by Tasmanian growers.

Capsicums, *Capsicum annuum*, have had a lucrative market in Japan. However, Australia, and especially Tasmania, has little or no previous experience in exporting this vegetable to Japan. In addition, Tasmanian greenhouse growers have not attempted to grow hydroponic capsicums. Technical information is lacking on techniques of production, including solid media versus nutrient film technique (NFT), environmental requirements, nutrient management and economic feasibility of production.

Sawdust as a greenhouse growing medium has been used to grow many vegetable and ornamental crops (Cheng 1987, Adamson and Mass 1976, Morgan and Lennard 2000), but has not been trialed in Tasmania for capsicum.

NFT has been comprehensively reviewed by Graves (1983) and shown to be superior to other media in most cases. Under the same environment and management, tomatoes yielded up to 26% more than when grown on soil or peat media (Spensley *et al.* 1978). However, Norman (1981) observed up to 6% lower tomato yields in two consecutive years with NFT. No comparable results are available in Australia for comparing NFT with alternative media.

Environmental conditions have significant effects on yield, quality and pest and disease management of capsicum crops (Morgan and Lennard 2000, Moreshet *et al.* 1999, Rylski and Spigleman 1982, Bekker 1989). Anecdotal evidence shows that capsicums may need higher temperatures than tomatoes but this has not been verified experimentally.

A wealth of information is available on the composition of nutrient solutions used for growing tomato, lettuce and many other crops. However, little is available for capsicums or eggplants. The recent book on hydroponic capsicum production (Morgan and Lennard 2000) describes nutrient solutions for different stages of growth of capsicum but neither reveals the source of this information nor indicates whether or not the solution has been used successfully in commercial environments.

Blossom-end rot that causes soft watery rots on the fruit of capsicums has been a major problem in Australia and other countries. This disorder is linked to environmental factors and imbalances in nutrient solutions (Wien and Zhang 1991, Tadesse *et al.* 1999).

Eggplants have rarely been grown in Tasmania and little is known of present cultivars, production methods or the economics of this crop.

Botrytis cinerea (grey mould) is a common disease for all greenhouse *Solanaceous* crops. It produces grey to brown coloured fluffy lesions on leaves, fruits and stems and causes severe rot in fruit and flower buds (Kim *et al.* 1996). For the infection to occur, the spores must

germinate and penetrate the plant foliage and fruits. The grey mould spores like hot and humid conditions for germination. When temperatures are above 20°C and humidity above 95%, spores germinate rapidly, especially when free water is present on the plants (Elad *et al.* 1992).

Many fungicide sprays have widely been used to control *Botrytis* infection in greenhouses. Spraying alone is not the answer as this disease can build resistance against many fungicides (Faretta *et al.* 1989) and the method is very costly. In consequence, controlling environmental conditions to make them unsuitable for spore germination is crucial (Elad *et al.* 1992).

An integrated pest management strategy (IPM) for *Botrytis* has been successfully applied in New Zealand by combining minimal pesticide use and taking measures to reduce the presence of free water on crops. There is no information about whether or not the NZ experience could be extended to Tasmania. This project aimed to include a demonstration of this methodology under Tasmanian conditions. An IPM strategy is needed to reduce the economic damage of the disease to the production and quality for export.

This project needed to gain technical production knowledge and document this to ensure potential investors and growers confidently can undertake the production of high quality fruit that meets export standards.

Tasmania has a relatively small domestic market for *Solanaceous* crops. Export would greatly increase the opportunities existing growers to expand production and for new growers to enter the industry.

As Tasmanian growers have no previous experience of exporting *Solanaceous* crops, this would be a major challenge for them without trial shipment experience. Trial exports from this project would allow the many components required for an export program to be assessed.

Objectives

1. To assess greenhouse tomato, capsicum and eggplant cultivars to meet yield, quality and fruit characteristics for export.
2. To gain best practice knowledge on how to economically produce greenhouse crops that meet export requirements.
3. To use this knowledge to produce a comprehensive guide for greenhouse hydroponic production of high quality fruit suitable for export.
4. To demonstrate that IPM control methods will work for *Botrytis* under Tasmanian conditions.

Discussion

Eggplants

Although only a preliminary evaluation was undertaken in tomato greenhouses, it was clear that eggplants would need more heat and specific environmental conditions for this crop to reach its potential for yield and quality.

Market enquires found that the likely export returns for this crop would not warrant the high production costs that would be necessary under Tasmanian conditions at this point in time. The study on eggplants stopped after the first year of trials.

Tomatoes

A small domestic greenhouse tomato industry has operated in Tasmania for many years. At present, there is a wide range of grower experience and levels of sophistication of greenhouse infrastructure, environmental control and production methods.

A local grower association and partner in this project, the TGTVGA, facilitates information exchange. This project has provided the impetus and opportunity for association members to explore the requirements and potential for export through cooperation in trials, field days and meetings.

From the evaluations conducted over two seasons, only two cultivars Darita and AX701-7 performed well at all sites. Although local evaluations of fruit quality were positive for export suitability by visiting importers and exporters, this was not tested by trial shipment.

Export market investigations found that market-suitable cultivars would need to be grown by a number of growers to obtain economic volumes of best quality fruit. In turn, the project partners assessed that more modern or upgraded greenhouses would be required by new or existing growers to produce export volumes.

Enquiries indicated that the likely export returns for this crop might be economic but at some risk because the Japanese market was well supplied and highly competitive.

For these reasons, the project partners considered that further cultivar and market assessment is required before growers make large-scale investments into greenhouse tomatoes for export.

Capsicums

Evaluations of capsicums in the first year were limited. However, the export market investigations were significantly favourable for the project partners to direct the main project effort into this crop.

Although starting from a base of little practical experience, leasing a modern greenhouse specifically to grow this crop and contracting a specialist consultant enabled the project to produce a small commercial crop up to world class standard for yield and quality.

The small trial shipment of about 200 kg sent to Japan to coincide with Foodex 1999 confirmed the quality of the product. Valuable experience was gained in testing the procedures required for packing and exporting capsicums.

Spirit and Mazurka were confirmed in two seasons as red capsicum cultivars suited to both greenhouse production in Tasmania and the Japanese market. The suitability of Fiesta (yellow) and Nassau (orange) also were confirmed. Sirtaki (red) and Emily (yellow) showed similar potential in the final season.

Strict attention to all aspects of crop production was shown to be critical and this knowledge is now available to growers in the production guide developed from the project. Some variations in the production methods in the third season highlighted the sensitivity of capsicums to timely and optimal management methods.

The project showed that, unlike tomatoes, capsicums must be grown with more management and cost inputs and with greater control over temperature and humidity. This can only be achieved in modern greenhouses that have all the ancillary infrastructure needed to achieve this control.

Initial market intelligence suggested that capsicums were a major market opportunity for export to Japan. However, an influx of capsicums from Korea in 2000 lowered prices and no fruit was exported in 2000. The Korean imports reduced prices enough to make export to Japan an uneconomic proposition. However, the potential in the local and interstate markets appears to be promising for Tasmanian greenhouse capsicums.

On the completion of this project, a semi-commercial capsicum trial sponsored by Horticulture Australia and industry partners began to test lessons learned from this initial three-year study. The opportunity exists to update initial findings as the results from this commercial trial come to hand.

As the main focus of the project shifted to capsicums in the second year, the production of a technical guide for this crop became a priority, especially as there was little local experience or expertise in this crop. The use of a specialist consultant was considered the most significant factor in gaining the expert knowledge required. The project partners believe the production guide, "Greenhouse Capsicums: A guide to growing export quality hydroponic greenhouse capsicums in Tasmania", has captured this knowledge in sufficient detail to allow new growers to confidently, and at minimal risk, grow this crop under Tasmanian conditions.

IPM control of *Botrytis cinerea*

With the failure of commercial support, a commercial-sized demonstration was considered too expensive. However, a smaller trial of IPM control of *Botrytis cinerea* confirmed the NZ experience that controlling the greenhouse environment to avoid high humidity and associated surface wetness will control the disease. A number of growers who adopted the environmental control measures achieved considerable success in limiting *Botrytis cinerea* infection in their greenhouses and reduced their use of fungicides.

IPM control measures are keenly sought and taken up by growers as they become more aware and concerned for their own health. Growers see a distinct market benefit in supplying the growing demand for produce grown with less use of pesticides.

Recommendations - Scientific and Industry

This project has confirmed that a number of cultivars of tomatoes and capsicums can be grown in Tasmanian greenhouses to produce export quality fruit. However, further evaluation will be needed for eggplants.

Capsicums have the potential for the highest returns for high quality fruit. To achieve this quality and the consequent economic returns, modern, automated and dedicated greenhouses using best practice management are needed. The production guide developed from the project gives growers most of the knowledge needed to grow hydroponic greenhouse capsicums in Tasmania. The project partners recommend that growers who are unfamiliar with hydroponic cropping should employ consultant agronomists who have experience with growing greenhouse capsicums.

Market intelligence varied over the course of this project. At the time of writing, the prospects for exporting capsicums to Asian markets were less favourable than they were at the beginning of the project. However, interstate markets for high quality, well presented fruit has been found to be strong. The project partners believe that the interstate markets should be evaluated further and that new cultivars should continue to be evaluated. The demand in the Tasmanian market for high quality greenhouse capsicums also is increasing. Both these markets could confidently be pursued, with the option to divert some produce into overseas markets when the demand becomes economic again.

It is recommended that a semi-commercial sized greenhouse be established by industry partners to:

1. carry out a more comprehensive assessment of the market potential for greenhouse capsicums;
2. confirm the methods of production and input costs referred to in the production and investors guides; and
3. further develop a local skills base for growing greenhouse capsicums before any decisions are made to establish a substantial area of greenhouse production that would be needed to generate export volumes.

The small trial using NFT indicated that coloured fruit could be produced earlier than was the case using sawdust bag culture. More comparative trials of both techniques would be worthwhile.

The performance of tomato cultivars varied depending on location, greenhouse environment and grower. Due to this variability, the project partners recommend that growers continue to conduct their own on-site tomato cultivar evaluations.

Some tomato cultivars, such as Ipsilon, an industry standard, only performed in greenhouses that maintained higher base temperatures, whereas some of the new cultivars trialed, such as Darita and AX 701-7, seemed to be adapted to wider temperature ranges. The latter types are worth further evaluation because they would be cheaper to produce than those needing higher temperatures. These types could be grown by more growers, which would be useful if the industry contemplates cooperative supply of larger markets, in the future. In addition, it is now recommended that Ipsilon be grown at temperatures that do not drop below 17°C. This is best achieved economically in heated, twin skin polythene greenhouses.

As found in NZ, managing greenhouse humidity was confirmed as a successful method for controlling *Botrytis cinerea*. In conjunction with good greenhouse hygiene, the project partners recommend that all growers adopt this method of control because *Botrytis* is the most common disease and cause of downgraded fruit. As this IPM method involves precise control of temperature and ventilation, growers who have older facilities should consider upgrading to

at least some form of automated heating. In addition, they would be wise to incorporate some form of automated ventilation. The automated systems must be set to prevent free moisture forming or remaining on plants.

Technology Transfer

The information gained through this three-year project has been passed on to industry through field days, meetings with various industry bodies, articles in the local media and by publishing production and investors guides for capsicums.

A photographic album has been compiled for all the cultivars examined in this project. The album and the results of trials are available for scrutiny at meetings. Posters explaining the project were produced and displayed often.

Field Days

1997-98, Stoney Rise Centre on the 24 February 1998. About 35 growers and industry people viewed and tasted samples, discussed project results and listened to the project marketing partner Joe Gayton, of Field Fresh Tasmania, speak on market prospects.

1998-99, Turners Beach site on 4 December 1998 and 18 February 1999. About 60 growers and industry personnel attended on each occasion.

1999-00, Turners Beach site on 18 February 2000. About 60 growers and industry personnel attended.

Those who attended each of the field days were given handouts that updated progress on the trials and acknowledged the project partners and sponsors.

Each field day was well attended by local media who provided good coverage through radio interviews and newspaper articles. Articles on the project were printed in Tasmanian Country on 27 February 1998, The Advocate on 4 March 1998, Agriculture Tasmania on 14 October 1998, Tasmanian Country on 18 December 1998, The Examiner on 11 February 1999, The Advocate on 17 February 1999, The Advocate on 6 March 1999 and Tasmanian Country on 12 March 1999.

Meetings

Presentations were made at the annual Potato and Vegetable Agricultural Research and Advisory Committee (ARAC) forum to growers and industry processors, exporters, researchers and service providers. The meetings were held on 25 May 1998, 11 March 1999 and 10 August 2000.

Meetings were held twice a year, in March and August for the three years of the project, with members of the TGTVGA and its R&D committee to update progress and review the course of the project. Other meetings were held with key members as required.

Production and Investors Guides

Production and Investors guides have been produced and are available to industry.

The production guide, "Greenhouse Capsicums: A guide to growing export quality hydroponic greenhouse capsicums in Tasmania", contains all the cultural knowledge on capsicum production acquired during the project, covering both the basic and finer details. It has been written as a comprehensive reference manual for experienced hydroponic greenhouse growers and new growers. In addition, the daily details of the environmental and nutrient monitoring have been presented in a separate case study booklet for technically-minded operators. It is called, "Case Study: Technical Information from the 1998-99 and 1999-2000 greenhouse Capsicum Trials".

The investors guide, "Greenhouse Capsicums: Investors guide to hydroponic greenhouse capsicums in Tasmania", is based on typical overhead costs and a gross margin assessment for a new 2,000 square metre twin-skin environmentally controlled greenhouse as a base economic unit for a single owner operator. A 20,000 square metre model also is presented for corporate investors. This scale of enterprise is suited to export on a stand-alone basis.

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Principal fund providers of the project were the **Tasmanian Greenhouse Tomato and Vegetable Growers Association (TGTVGA)** representing the interests of greenhouse vegetable growers, **Field Fresh Tasmania** which has excellent Japanese market contacts, and **Horticulture Australia Limited** (formerly the **HRDC**). Together with **Department of Primary Industries, Water and Environment**, these were the principal joint partners of the project.

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