Production and Marketing of Tasmanian Wasabi
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A report for the Rural Industries Research and Development Corporation

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Foreword

Wasabi (Wasabia japonica) is a high value plant native to Japan where its products are used in traditional meals, but are seldom exported due to limited availability. Wasabi grows in areas that are cool and shaded with plenty of water - a major advantage for its production in Tasmania is the cool temperate climate and proximity to clean water.

Wasabi products from Tasmanian trials have been highly acclaimed on the Australian market and the domestic demand has continued to grow as a result. Supplying wasabi products to neighbouring countries in South–East Asia remains a long-term objective of Tasmanian producers.

This report describes the development of methods for commercial production of wasabi in Tasmania, using techniques for both soil and water-cultivation and markets identified for Tasmanian wasabi products.

This project was funded from RIRDC core funds which are provided by the Australian Government.

This report is an addition to RIRDC’s diverse range of over 1500 research publications. It forms part of our Asian Foods R&D sub-program which aims to foster the development of a viable Asian Foods industry in Australia.

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Peter O’Brien
Managing Director
Rural Industries Research and Development Corporation
## Abbreviations

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<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>DPIWE</td>
<td>Department of Primary Industries, Water and Environment, Tasmania</td>
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<td>WGT</td>
<td>Wasabi Growers of Tasmania Pty Ltd</td>
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Executive Summary

Purpose

The report details the development of commercial production of wasabi in Tasmania. The report describes how traditional cultivation systems have been adapted to suit Tasmanian conditions and research that has been undertaken to improve product quality through the use of selected planting stock and disease management. The report also identifies the increasing interest in Tasmanian wasabi products that has been generated in both domestic and international markets.

The report is targeted at potential growers, investors and research scientists who are keen to be involved in innovative development of a new industry which takes account of the traditional culture of wasabi and aims to extend the range of people who experience the attributes of this unique herb.

Background

Wasabi (Wasabia japonica Matsumara) is a perennial herb, native to Japan, and belongs to the same plant family as broccoli, cabbage and mustards. In Japan, wasabi is cultivated in fields and mountain streams and the fresh product is prepared by grating the stem of the plant to form a hot, spicy, green paste that is served with traditional dishes such as sushi, sashimi and soba noodles. Japan produces about 5,000 tonnes of wasabi per annum.

Wasabi products are in short supply in Japan due to a decline in traditional farm labour, urban encroachment on production sites and pollution of some rivers and streams. Fresh wasabi maintains a value equivalent to AUD150/kg in Tokyo’s fresh vegetable market and is referred to locally as ‘green gold’.

In 1994, Tasmanian wasabi production was developed as an initiative of the former Tasmanian Department of Primary Industries and Fisheries to expand the range of high value industries focusing on Tasmania’s unique environment. Two prior RIRDC funded research and development projects have assisted the development of the wasabi industry in Tasmania with the first soil-cultivated crop market-tested in 2000. Sales of Tasmanian product have continued for five years and in 2003 consumer driven changes initiated the development of water-cultivated wasabi farms. Agronomic advice for soil or water production systems is currently available from the Department of Primary Industries, Water & Environment and the Tasmanian company ‘Wasabi Growers of Tasmania Pty Ltd’. Areas suitable for soil and water grown wasabi have been identified in the north of Tasmania with the number of growers interested in developing this niche industry increasing each year. There are few other areas in Australia that are cool enough for wasabi production.

Objectives

Australian consumers responded with enthusiasm to fresh wasabi produced in Tasmanian trials in 2000 and current market demand is estimated at 50 tonne per annum. One aim of this project was to increase the volume of fresh wasabi produced in Tasmania and to improve product quality and financial viability of the crop by reducing the incidence of black stem lesions. Black streaks observed in the internal stem tissue at harvest were capable of reducing the fresh marketability of a crop by 50%, though much of this material was still suitable for processing as wasabi paste.

The project also aimed to improve product quality by selecting and propagating stems with superior physical and taste characteristics and to expand the existing wasabi gene pool in Tasmania by introducing additional varieties from Japan, USA or Victoria, Australia.
A further aim was to develop production methodology for water-cultivated wasabi as market evaluation indicated that consumers were willing to pay a premium price for fresh wasabi stems cultivated using this technique.

**Methodology**

Trials to determine chemical control measures for disease management were conducted in conjunction with field observations that identified environmental factors that increase susceptibility of wasabi plants to disease.

Individual plants that performed well in field conditions were used as mother plants for micropropagation (tissue-culture) of wasabi to enhance product uniformity and to reduce disease incidence during crop establishment.

Wasabi plant material from Japan, USA and Victoria was collected during the course of this project and mother plants generated from this material will be used for micropropagation purposes.

Traditional methods used in Japan for water cultivation of wasabi, together with methods adopted in USA, were adapted for trial in Tasmania using water sourced from natural springs and streams.

**Key findings**

The demand for Tasmanian wasabi products currently exceeds the supply, as the production area is still small. In addition to the increasing demand for fresh wasabi stems for the premium and food-processing markets, dried wasabi products are also sought. The range of product end-points gives growers a measure of flexibility in regard to production scheduling. Growers recognise the benefits of working together to share knowledge and coordinate orders for purchase of planting material, for planting and harvest schedules, and packaging distribution and marketing of their products.

The results of greenhouse trials indicate that a single application of a chemical control agent pre-planting provides a very high standard of disease protection. With the increasing emphasis on food quality and safety in the market place, this gives Tasmania a further competitive advantage for its wasabi products.

Developing micropropagation techniques for wasabi proved difficult with three commercial laboratories failing in their attempts to develop protocols for this technique. In November 2004, an Australian research laboratory successfully micropropagated Tasmanian wasabi plants and this laboratory will document protocols at the conclusion of its current research project in June 2006. Meanwhile, Tasmanian growers are importing micropropagated plants from Japanese stocks so that new sites can be established with disease-free planting material.

Development of water-cultivation techniques for wasabi continue to progress with water quality and gravel integrity proving to be essential factors in determining the success of this type of cultivation. As a result of this project the practical manual ‘Wasabi- A guide to production of wasabi in Tasmania’ has been updated to include water-cultivation of wasabi. The report recognises that both the topography and access to natural resources at the production site will determine the style of water-cultivation recommended for a particular site.

**Implications**

This project has demonstrated the value of plant hygiene from establishment through to production. Expansion of the industry will be assisted by specific recommendations made for soil and water-cultivation systems.
As a result of this research ‘Wasabi Growers of Tasmania’ has been formed as an incorporated body and the number of growers producing wasabi has doubled. A number of Australian laboratories have expressed interest in pursuing commercial micropropagation of wasabi plantlets. Production methods for soil-grown wasabi continue to improve as do developments with water-grown wasabi. The exclusive growing conditions for wasabi reduces the likelihood of oversupply of this product on the Australian market.

Tasmania’s reputation for producing fine quality food, particularly beef and seafood, will be an additional marketing advantage when product volumes permit entry to the Japanese market. Distribution of a range of wasabi products to other centres in the Asia-Pacific region is also planned. Together with the opportunity for high returns from a relatively small area of land, these factors make the developing Australian wasabi industry a potentially attractive investment opportunity.

Recommendations

The recommendations made at the conclusion of this project reflect the next stage of development of an industry in its infancy and will provide a launching pad for a new self-funding rural industry in Australia.

1. Develop the capacity of an Australian laboratory to produce commercial quantities of tissue-cultured wasabi planting stock.

The availability of tissue–cultured plant stock from a commercial laboratory in Australia will benefit not only the micropropagation laboratory by expanding product and client range, but also Australian wasabi growers by allowing imported planting stocks to be replaced with stocks that have been selected for Australian conditions.

2. Improve product quality through disease management, water-culture and additional varieties.

Chemical control techniques that have proved to be beneficial in greenhouse trials should now be trialled under field conditions for both soil and water cultivated wasabi. The use of Australian selected varieties will be reflected in yield improvements while the elimination of quarantine restrictions will encourage the expansion of the area under wasabi production in Australia.

3. Build the networking capacity of the wasabi grower group.

The development of wasabi production in Australia has been championed by a small group of growers in Tasmania and Victoria who have marketed wasabi products in Australia since 2001. Having formed a small company, the Tasmanian component of this group plans to engage other growers to produce wasabi either in soil or water-culture as the site allows, to mentor new growers and to set benchmarks for wasabi production methodology and wasabi products. As the company develops the capacity to coordinate resources required for production and marketing of Australian wasabi, it will ensure that high quality wasabi products are consistently available to the Australian consumer and to potential export markets.
1 Introduction

Wasabi (*Wasabia japonica* Matsumara) is a perennial herb belonging to the brassica family of plants, which includes broccoli, cabbage and mustards. The plant grows naturally under the shade of deciduous trees, alongside mountain streams in the highlands of Japan.

Wasabi paste is prepared by grating the fresh stem of the wasabi plant to form a hot and spicy, green condiment served with traditional Japanese dishes such as sushi, sashimi and soba noodles. Ready-to-use wasabi pastes are also popular in the catering industry and dried powder made from stems and leaves is used to flavour foods ranging from rice crackers to ice cream.

![Figure 1.1 Sushi (left) and soba noodles (right) with wasabi paste](image)

Wasabi is in short supply in Japan due to a decline in traditional farm labour, urban encroachment on production sites and pollution of some rivers and streams. As they are becoming increasingly scarce, few wasabi products are exported from Japan, even though Asian food is increasing in popularity in countries formally dominated by European cuisine.

From preliminary investigations in 1994, Tasmanian wasabi production developed as an initiative of the former Tasmanian Department of Primary Industries and Fisheries to expand the range of high value industries that focus on Tasmania’s unique environment. Two prior RIRDC funded research and development projects have assisted the development of the wasabi industry in Tasmania, with the first soil-cultivated crop market-tested in 2000. Sales of Tasmanian product have continued for 5 years and in 2003, consumer driven changes initiated the development of production methodology for water-cultivated wasabi farms.

The major advantage of producing wasabi in Australia is the ability to supply product year round as there is no impediment to harvest caused by winter snowfalls. Mild summer and winter temperatures in the cool temperate zones of Tasmania and southern Victoria provide ideal conditions for the growth of wasabi plants, which are particularly sensitive to temperatures in excess of 25°C.

Wasabi is grown commercially in soil, in a manner similar to other brassica crops, or in gravel beds filled with fast-flowing water. For both methods of cultivation, a shade house must be provided and the reliability of cool growing conditions determines the suitability of a site for wasabi production.

The aims of this project were to develop the recommendations made from earlier research trials. Tasmanian wasabi products evaluated on the domestic market in 2000 were highly acclaimed and encouraged growers to change to water-cultivation techniques for premium fresh stems and use soil-cultivated systems to produce wasabi products for processing. During the course of this project, sales of fresh wasabi stems have continued, and processing grade material has been dried for use in value-added products. Wasabi flavoured cheese is a new product developed in Tasmania using locally grown wasabi products.

As a result of this project growers have access to a source of high quality planting stock suitable for water-cultivation and are adapting traditional wasabi production systems for both soil and water culture to Australian agriculture. Product volume is increasing as pests and diseases are better controlled and new growers to join the industry.
2 Objectives

This project had 3 main objectives:

1. **Tasmania to become the major supplier of premium fresh wasabi to the Australian market.**

   Harvest of the first semi-commercial crop of Tasmanian wasabi commenced in July 2000 and test marketing met with an enthusiastic response. Distributors for the fresh and processed products were identified and sales of product from the pilot areas have continued. An increase in product volume was necessary to fill the orders received for both fresh and processed wasabi products.

   Identification and propagation of stems with superior physical and taste characteristics was necessary to improve the quality of planting stock. A 75% increase in yield was considered possible using selected plant lines. The reduced incidence of black lesions would improve the efficiency of the harvesting, grading and packing processes. Additional varieties suited to Tasmanian conditions were also sought from Japan, the USA and Victoria, Australia.

   As seed propagated wasabi plants are variable in habit, plants are traditionally propagated by taking vegetative splits off the mother plants to generate plants for the next crop. This practise is recommended for a maximum of three generations to reduce the likelihood of disease build up. In recent years, Japanese wasabi growers have moved to replanting with tissue-cultured plants to maintain yield for each crop. The project aimed to identify micropropagation (tissue-culture) procedures so that selected disease-free wasabi varieties could be propagated for subsequent crops in Tasmania.

2. **Yield and product quality to be improved by a reduction in disease incidence.**

   Black lesions were reducing the marketability of up to 50% of stems for the fresh market, though much of this material was still suitable for processing as wasabi paste. A reduction in the incidence of stem blackening would significantly improve the financial viability of the crop.

   Black lesions are also common in wasabi stems produced in Japan, and have been attributed to infection by the fungus *Phoma wasabiae*. The incidence of these lesions is greater where plants are subject to poor drainage and warm temperatures. Traditionally, the disease has been controlled using fungicides containing benomyl, but in 2001 the Australian Pesticides and Veterinary Chemicals Association withdrew approval for registration of products containing this active ingredient making alternative chemical control mechanisms necessary.

3. **The ‘Wasabi Production Guide’ to be updated to include aquatic production.**

   While Tasmanian wasabi products evaluated on the domestic market in 2000 were highly acclaimed, experienced consumers suggested that improvements in product quality could be made by changing to water-cultivation techniques for the production of premium fresh stems.

   Interested growers with access to the resources required for water-grown wasabi were approached to conduct trial work for this part of the project. The project officer provided high quality planting material and acted in an advisory role for the duration of the project. Recommendations for aquatic wasabi production are to be included in the updated ‘Wasabi Production Guide’.
3 Methodology

1. Experience from Japan

In 2001, the project officer and wasabi industry representatives met with wasabi research workers in the USA and gained valuable insights as to how traditional Japanese systems for wasabi culture might be adapted to contemporary agricultural systems in Australia.

In 2002, the project officer travelled to Japan and visited a number of wasabi growing areas, research facilities and wholesale and retail vegetable markets. The information gathered from these visits was used in designing water-cultivation systems for wasabi in Tasmania and is summarised in this report.

2. Introduction of alternate plant varieties

Plants with superior growth and taste characteristics were selected from field crops for micropropagation to produce tissue-cultured plants for soil-cultivation. Further varieties were sourced from Victoria, USA and Japan. Decontamination of field selected plants during the micropropagation process proved difficult resulting in severe plant losses at hardening-off stage. Consequently, Tasmanian growers have imported plants from Japanese sources principally for use in water-cultivated production systems. These plants are proved to be of very high quality.

3. Assessment of pest and disease control in wasabi

The influence of cultural practices on the incidence of stem blackening in wasabi was assessed by field observations relating to heat stress, oxygen deficit and physical damage to the plants caused by other pests. These observations are used to make cultural recommendations for current and prospective growers of wasabi.

A greenhouse pot trial was conducted to assess the influence of fungal organisms on stem blackening. In this trial, specific fungal organisms were used to infect genetically identical wasabi plants and fungicides applied to determine control efficacy. Recommendations for control of fungal infection have been made as a result of this research and are included in the updated wasabi production manual.

4. Development of water-cultivated wasabi systems

In consultation with the project officer, the project industry partners took the major responsibility for developing water-cultivated wasabi systems suited to their production sites. Two different methods were trialled, the first diverting water from a natural stream and the second using water generated from a series of natural springs. Both systems used a wasabi variety sourced from Japan that was specifically recommended for water-culture.

Whilst the principle requirements for water-cultivated wasabi production were determined during the course of this project, establishment recommendations for these systems are made prior to the harvest of the first crop of Tasmanian water-cultivated wasabi.
4  Wasabi in Japan

In October 2002, the Principal Investigator for the project travelled to Japan to investigate specific issues identified in the previous research and development project for wasabi. These included adopting water production technology, addressing a black stem lesion problem, identifying rapid propagation techniques and marketing, value-adding and processing opportunities for wasabi. The visit included wasabi farms, markets, research facilities and business outlets.

The Product

In Japan there is a recent move to production of wasabi crops with minimal use of chemical pesticides. Some blackening of fresh stem material is tolerated in both the fresh market and the processing industries. In some areas, growers have invested in greenhouses to produce premium wasabi product for the fresh market throughout the year.

Wasabi stems, leaves and leaf stalks are dried or minced and added to a range of products from savoury crisps, noodles and pickles to mayonnaise, chocolate and ice cream. Traditional Japanese food uses grated wasabi stem served with sushi, sashimi and soba noodles, while fresh flower stalks are used to prepare a green vegetable dish.

Often only specialty restaurants in Japan use fresh wasabi stems, the remainder choosing to stock a ready-to-use frozen product. In many restaurants the ready-to-use product combines wasabi with English horseradish.

Wasabi Production Areas

Wasabi farm visits were made in Shizuoka Prefecture and Nagano Prefecture. Wasabi farms in these prefectures use different cultural specifications for wasabi production. The differences reflect the topography, natural rock types and available water sources in the area.

Water–cultivated wasabi

Shizuoka Prefecture

In Shizuoka Prefecture, wasabi farms are located in deep valleys, which provide shade for most of the day. Due to the sheltered nature of the sites, shade support structures are built with inexpensive construction materials and shade cloth is put in place when required. There is no road access to sites in some steep gullies, so trolley carts are used to bring harvested material up to the road for transport to markets in Tokyo and Kyoto.
Diao wasabi farm comprises 15 hectares of land and is the largest wasabi farm in Japan. Wasabi is harvested in all but the winter months (December to February).

The terrain in this area consists of repeated gravel heaps arranged in fingers with water flowing in depressions between the gravel mounds. Water is diverted from the main river into channels before entering the wasabi farm. The water is then diverted into progressively smaller channels that flow through the wasabi farm. Water temperatures of 13-14°C and air temperatures of 18°C in the shade were recorded in the middle of the day.

At smaller farms, water rises from natural springs and the wasabi plants a planted at the base of gravel mounds close to the water’s edge.
Some growers in this area use greenhouses to produce premium wasabi product for the fresh market throughout the year with minimal use of chemical pesticides. These crops use disease-free tissue-cultured seedlings combined with a chemical-free production system. The temperature inside the greenhouse is about 7-10°C in winter due to the moderating influence of the water, while outside the ground is knee deep in snow. In summer the white surface of the house reflects light, helping to keep the internal temperature below 30°C. Wasabi can be harvested all year round in this protected environment, with the time to maturity being reduced to 12-18 months.
Soil-cultivated wasabi

Soil-cultivated wasabi is grown in small plots in the mountains near the township of Nagano. Some plots use natural shade of persimmon or cedar trees while others use shadecloth. Soil texture ranges from friable clay loam to sandy loam and some plots use straw mulch between rows of crop.

Figure 4.5  Soil-grown wasabi, Japan

Traditionally, soil grown wasabi is in the ground for 2 years. Growers have observed climate changes in recent years, such as increased summer temperatures causing air temperatures in excess of 35°C and soil temperatures exceeding 18°C. Growers reported that soil temperatures exceeding 18°C exacerbate disease problems causing up to 75% loss of plants.

Markets

Wholesale

Recognised fresh vegetable markets sell premium quality, fresh wasabi stems and some wholesale markets distribute fresh stems to supermarkets. Often only specialty restaurants in Japan use fresh wasabi stems, the remainder choosing to stock a ready-to-use frozen product. In many restaurants the ready-to-use product combines wasabi with English horseradish which is produced in most agricultural areas of Japan.

In October 2002, the wholesale vegetable market in Tokyo sold wasabi stems for $130/kg. During December the wholesale price may increase to $153/kg. Fresh wasabi stems are normally brought to the wholesale market every 2 to 3 days.

Retail

Wasabi is dried or minced and added to a range of products from savoury snacks, noodles and pickles to mayonnaise, chocolate and ice cream. In some areas the range is extended to attract the tourist trade and includes wasabi wine and souvenirs such as scarves, tea mugs and postcards featuring wasabi. Processed wasabi products are more readily available than fresh stems, while wasabi stems sold at retail outlets may fetch prices up to 200% higher than at the wholesale market.
Comparison - Wasabi in United States of America

In July 2001, prior to the commencement of this project, the Principal Investigator and industry partners met in the United States and took the opportunity to visit wasabi researchers in Washington State. Below is a brief summary of their findings:

Dr. Carol Miles, from the research facility of Washington State University in Vancouver, Washington, was responsible for promotion of a number of new crops and crop cultivars, one of which is wasabi. The small number of wasabi plants held at the research station were used as a source of vegetative propagation material for growers interested in exploring the possibilities of wasabi production as an alternative cash crop. There is no specific funding for wasabi research. Field trials consisting of approximately 20 plants were used to assess the behaviour of the plants in field conditions.

The Master’s thesis of Catherine Chadwick from Washington State University is the most comprehensive English document on the botany, uses and production of wasabi. The Principal Investigator and industry partners for this project accompanied Ms Chadwick to a farm growing a commercial crop of water-cultivated wasabi. The water source at this site was consistent at 8°C with oxygen concentration of 12.0 mg/L. Discussions with Ms Chadwick included optimum environmental conditions for wasabi production, genetic implications for propagation, disease control and marketing strategies.

The understanding gained from observing the site and finished product first hand cannot be underestimated, however neither Dr. Miles nor Ms Chadwick were able to commit to a visit to Tasmania.

Figure 4.6 Water-grown wasabi, Washington State, USA
Conclusion

The visits to Japan and the United States of America confirmed that there is opportunity to expand wasabi production in Tasmania to supply both domestic and international markets. Sites that can both satisfy the temperature requirements for wasabi and provide adequate resources of clean water have been identified in the central north of the State. Where soil type and climatic conditions are appropriate, further soil-cultured sites should be developed in addition to aquatic sites.

The size of the Australian market is difficult to assess as there is no history of fresh wasabi consumption and the range of processed wasabi products available is very limited. However to date, the interest generated by this project has resulted in orders for fresh wasabi equivalent to 50 tonnes per annum and purchase of dried wasabi powder increased from 6 to 50 kg in the period 2004/05. Manufacturers and distributors from Australia, USA and Japan are keen to access the product and are vigilant in pursuing the progress of the developing wasabi industry in Tasmania.
5 New varieties

Varietal lines in Japan have come about as a result of geographic separation of wasabi cultivation areas. Wasabi plants of variety ‘Mazuma’ are most prevalent in Shizuoka Prefecture while those of variety ‘Daruma’ are more common in Nagano Prefecture. Whilst there has been some mixing of these varietal lines locally, there are no proven wasabi varieties that breed true-to-type nor are there wasabi hybrid varieties. For this reason, vegetative or micropropagation is the preferred means of multiplying planting stock. However, vegetative propagation should be continued for only 2 - 3 generations to prevent build up of disease.

Daruma

The variety ‘Daruma’ was selected for soil-grown wasabi crops in Tasmania based on trials conducted in 1994-96. It is a high yielding variety producing large, green stems with good flavour. Leaves are heart-shaped and deep green in colour. ‘Daruma’ produces many side-shoots, making it particularly suited to processing and vegetative propagation.

Mazuma

Plants of variety ‘Mazuma’ produce short, thick rhizomes with excellent flavour which is enhanced by their slow growth. They are hotter and sweeter in flavour than variety ‘Daruma’ but are lower yielding and more susceptible to disease. Maintenance of root temperature in the optimum range of 12-15°C is the best way of controlling disease symptoms and encouraging optimum flavour production. Mature leaves of variety ‘Mazuma’ are round and dark green while emerging leaves and petioles have a distinct reddish colouration. The use of micropropagated (tissue-cultured) plants of ‘Mazuma’ variety in Tasmania aims to minimise disease risk as tissue-cultured plants are propagated in a sterile environment where bacterial and fungal infection is negligible. As a result of the research conducted in Japan for this project, micropropagated plantlets of wasabi variety ‘Mazuma’ have been imported since June 2003 to establish trials in water-cultivated systems.

Midori

‘Midori’ variety is also suited to semi-aquatic production. By comparison with other cultivars, the rhizome grows quickly and is pale green in colour. The leaves are heart-shaped and bright green. Growers in Victoria have conducted trials with this variety. Heat stress over two summers caused heavy losses in the Victorian crops. Seeds of variety ‘Midori’ were obtained from Victoria in June 2003, but seed quality was poor with only 5% germination. These plants have matured and have been added to the varietal collection of parent stock available in Australia.

Tasmanian selections

During the July 2000 harvest, vegetative side shoots were selected from plants of variety ‘Daruma’ showing superior characteristics and propagated at the field site. Ex-plants from two of these selected lines were micropropagated by a commercial tissue culture laboratory. A 50% loss of plants occurred during the hardening-off phase leaving 2,500 plantlets that were planted in April 2002. Stems of these plants were of a consistently high quality and 500 kg of fresh stems have been harvested and sold on the domestic market at a price of $110/kg.

Vegetative wasabi propagation material imported from Japan and the USA was propagated under quarantine in Tasmania and provides parent material for micropropagation purposes in Australia. While they are not proven varietal lines, these plants have been differentiated according to the geographic region of origin and the quality of the mature stems. A collection
of approximately 20 wasabi varietal lines is housed at DPIWE Mt Pleasant Laboratories. This collection forms the basis of varieties awaiting micropropagation to improve hygiene status and to multiply plant numbers.

The use of tissue-cultured planting stock is essential to minimise disease risk in wasabi production. Although Japan continues to provide the largest gene pool for wasabi varieties, local production of disease–free tissue-cultured plants will ideally replace the need to import commercial quantities of planting stock from Japan for each crop.
6 Production

Wasabi is a semi-aquatic plant and can be grown in either soil or water. In a soil-based medium, anchorage is provided by the soil, while oxygen and nutrients are provided by the soil solution. In a water-based system, coarse gravel provides anchorage, whilst oxygen and nutrients are scavenged by the wasabi plants from the free flowing water passing through the gravel. Consequently, the terms ‘soil-grown’ or ‘water-grown’ wasabi refer to the type of medium that provides the essential requirements for plant growth.

Wasabi is a cool climate crop requiring shaded conditions, plentiful irrigation water and readily available oxygen at the root system. The ideal root temperature range of 12-15°C determines the suitability of a site to grow the crop. While wasabi tolerates air temperatures ranging from mild frosts to 30°C, root temperatures below 12°C cause a decline in growth rate and growth ceases altogether at 5°C. The plants exhibit signs of stress and become more susceptible to disease if the root temperature exceeds 18°C. Areas most suitable to wasabi production in Australia are those with a maximum summer temperature below 30°C, well-drained soil and access to abundant cold water. This confines production to isolated pockets in the southern-most part of the continent.

In Japan, shade is provided from deciduous trees complemented by temporary shade structures during the summer months. In Tasmania, permanent structures, built to withstand windy conditions and using 80% shade cloth, have been constructed.

![Figure 6.1 Shade house for soil-grown wasabi](image)

Soil culture

For soil grown crops, excellent drainage is essential. Soils with an open friable structure, such as sands or light loams, are preferred. Raised beds assist with drainage and soil pH should be in the range 6.5 - 7.5. Soil preparation includes the incorporation of base nutrients similar to those required for other brassica vegetables. Foliar boron and sulphur sprays are beneficial during the second year of growth.
Field grown wasabi

At the field site for soil grown wasabi used in this project, site preparation began in 2001, 12 months prior to planting. A broad spectrum herbicide was followed with the application of a base fertiliser of dolomite and N:P:K. Boron was applied pre-planting and the crop top-dressed with nitrogen after 6 months. Beds were prepared by building mounds 500 mm apart and 300 mm high, along which plants were sown in a zigzag manner. A permanent shade structure providing 80% shade was constructed and irrigation to supplement rainfall provided by overhead sprinklers were included in the shade house framework. Shade cloth extended down the walls to protect the plants from wind and grazing predators and ventilation openings were incorporated at either end.

‘Daruma’ variety was used to produce this soil grown crop of wasabi. From the original seed source imported in 1997, selections had been made from plants showing superior stem growth in field conditions. Micropropagation of two selected lines ‘W6’ and ‘W7’ provided planting material for crops planted in August 2002.

Figure 6.2  Soil–grown wasabi, Tasmania

Tasmania’s temperate climate allows wasabi to be planted and harvested year round, providing a distinct advantage for supplying fresh wasabi to the market. Mature stems are harvested 18 – 24 months after planting.

Of the two lines propagated by tissue-culture, ‘W6’ proved to be more susceptible to disease so its products were suitable only for processing. Stems and leaves from ‘W7’ variety supplied fresh product to the Australian market during the period February 2004 - January 2005.
**Water culture**

For water cultivated crops, the semi-aquatic plants are anchored in gravel beds through which fresh water flows continually. Water must be free of pollutants and have an oxygen concentration of 10-12 mg/L. Plants generally scavenge nutrient requirements from the fast-moving water while foliar sprays provide supplements.

Bed preparation is determined by the topography of the site and the water source available. Bed types for stream and spring fed systems have a finished slope of 1-2% and require 80% shade in the summer.

During the course of this project, independent wasabi growers working in conjunction with DPIWE established two different systems for water-grown wasabi.

**Field sites**

*Stream fed site*

This site was located in the central north of Tasmania on a gently sloping site. An area of 0.25 ha was excavated to a depth of 400 mm and a slope of 2%. The prepared area was fitted with drainage pipes and overlain with gravel to 300 mm depth. Water was introduced through feeder pipes spaced at 15 m intervals across the slope. Perforations along the feeder pipe provided a continuous supply of fresh water to fill the gravel beds. Drainage water was channelled back to the stream. Wasabi plants were spaced at 300 mm intervals with 400 mm access paths left every 10 rows.

![Water-cultivated wasabi, Tasmania](image)

**Figure 6.3** Water-cultivated wasabi, Tasmania

Three major sources of improvement were identified at this site:

1. **Gravel quality**

   The composition of the gravel must be sufficiently robust that it does not breakdown under foot traffic. Settling of gravel beds reduces water flow and the plants consequently show symptoms of oxygen and nutrient deficit. It is essential for the integrity of the gravel to be such that the pore space between the gravel particles remains open so that water can move freely.
2. Rate of removal of drainage water

Drainage water must be quickly removed from the end of the wasabi beds, so that the flowing water has no opportunity to back up. If this does occur, oxygen is depleted and the plants show symptoms of oxygen deficit and may even become submerged.

3. Light intensity

The amount of light reaching the ground through shadecloth is determined by the density of the fabric and its colour. While 80% white shadecloth reduces UV light by 80%, it reduces light intensity by only 48%. Whilst wasabi plants will grow at this light intensity, algal species thrive and at this trial site provided intense competition. Black shadecloth reduces the light intensity sufficiently to eliminate algal growth but retains heat causing internal temperatures of the shadehouse to increase. Using black shadecloth inside white cloth proved beneficial for reducing both light and temperature at this site.

Spring fed site

Spring fed sites are usually identified by the occurrence of coarse gravel or sand at the base of a slope from which spring water seeps. The rate of delivery of the spring water will determine the size of the wasabi beds that can be constructed at these locations. A flattened area is prepared at the spring source with gravel mounded in rows running parallel to the flow of water. Plants are placed at 300 mm intervals along the water’s edge. The water flow rate should be controlled to provide a surface speed of 120 – 150 mm/sec.

Using this model a second site was established in north-eastern Tasmania, using a spring fed dam as its primary water source. However, at this site, unseasonable strong winds caused damage to the shade structure and foraging rabbits caused severe crop losses.

Figure 6.4 Spring fed water-cultivated wasabi, Tasmania
Greenhouse trial

A greenhouse trial was conducted to make a preliminary assessment of the water flow requirement and the nutrient requirement of water-cultivated wasabi. Wasabi plants were grown in PVC pipes filled with gravel into which water containing essential nutrients was delivered at three different rates: by dripper, and at a flow rates of 90L/sec/ha and 180L/sec/ha. A duplicate system was arranged that provided water with half the amount of dissolved nutrients. ‘Daruma’ variety and a ‘Daruma x Mazuma’ cross variety was used in this experiment. There was a minimum of three replicates of each variety in each treatment. The results are summarised in Table 6.1.

Table 6.1  Growth response of two wasabi varieties grown in water culture

<table>
<thead>
<tr>
<th>Variety</th>
<th>Daruma</th>
<th>Mazuma x Daruma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>Plant wt(g)</td>
<td>First grade stem wt (g)</td>
</tr>
<tr>
<td>½ nutrient x dripper</td>
<td>236</td>
<td>70</td>
</tr>
<tr>
<td>½ nutrient x 90L/sec/ha flow</td>
<td>233</td>
<td>79</td>
</tr>
<tr>
<td>½ nutrient x 180L/sec/ha flow</td>
<td>669</td>
<td>186</td>
</tr>
<tr>
<td>Full nutrient x dripper</td>
<td>589</td>
<td>171</td>
</tr>
<tr>
<td>Full nutrient x 90L/sec/ha flow</td>
<td>433</td>
<td>145</td>
</tr>
<tr>
<td>Full nutrient x 180L/sec/ha flow</td>
<td>65</td>
<td>191</td>
</tr>
</tbody>
</table>

Statistical analysis not available for this data

While the consistently better performance of ‘Mazuma x Daruma’ variety in relation to taste may reflect inherent varietal attributes, this data indicates that ‘Mazuma’ varieties are better suited to growth in water culture than is variety ‘Daruma’. Future trials aim to compare the performance of these two varieties in field conditions in both water and soil media.
Figure 6.5  Greenhouse wasabi water-culture trial

Although this was a preliminary study some interesting observations were made:

- At the lower nutrient concentration, the growth response of both varieties increased as the water delivery rate increased. This confirms that wasabi is a good scavenger of nutrients from flowing water.

- Where more nutrient was available, its delivery rate showed little effect on plant growth. In wasabi farm systems, nutrients are supplied from natural water flows such as streams and springs. This data indicates that faster flowing streams promote better growth. The data also indicates that this growth is not attributable solely to the increased amount of nutrient available in faster flowing streams. There were apparent differences in the performances of the two varieties with the ‘Daruma x Mazuma’ variety outperforming the ‘Daruma’ variety in this water-based system, particularly in relation to weight of the primary stem and taste score.
Figure 6.6  Stems of variety ‘Daruma’

Figure 6.7  Stems of variety ‘Daruma x Mazuma’
Pests and Diseases

Maintaining cool temperatures for wasabi culture is a valuable tool for controlling pest and disease problems. Insect pests that attack other brassica vegetables such as diamond-back moth, white cabbage butterfly and aphid are occasional visitors to wasabi production sites, but their incidence is low due to the shaded conditions under which the crop grows.

Pests

Slugs and snails

Slugs and snails are a major pest in the wasabi shade house as they thrive in the moist dark conditions.
Slugs (Deroceras spp.) occur broadly in agricultural systems and move by producing clear silvery, mucus. They hide in cracks in the soil during the day or when moisture levels are low. Snails are similar to slugs but carry a hardened shell preventing them from moving down cracks in the soil. Infestations are heaviest at sites where there has been long-term pasture or minimum tillage. They live under plant debris and are most prevalent near fences and shadehouse framework. If left unchecked, these pests can cause severe damage to leaves and they chew openings in stem tissue, increasing the risk of fungal infection.

Insects

Cabbage white butterfly (Pieris rapae) is a common white butterfly, 40-50 mm long, the larvae of which damage the leaves of the plant. The butterfly lays yellow, conical shaped eggs 1-2 mm long that stand at right angles to the under surface of the leaf. The larvae are velvety green and feed most actively at night eating large holes in the leaves.

Diamondback moth (Plutella xylostella) at maturity is 6 mm long and light brown in colour with white diamond markings along the centre of its back which are visible when the moth is stationary. It moves very quickly when disturbed staying low in the crop. The yellow eggs, 0.5 mm long, are laid in clusters on both sides of the leaf. The green larvae grow to 10mm long and wriggle and hang from a silken thread when disturbed.

Green peach aphid (Myzus persicae) grows to 2-3 mm long and is a pale green sap-sucking insect that feeds on leaves. Active young are born live and appear as white nymphs 2 mm long. Affected leaves curl and the foliage becomes mottled. When aphid colonies become overcrowded, winged aphids migrate to another plant.

Diseases

Disease organisms such as Phoma, Rhizoctonia and Fusarium thrive in the moist shaded conditions of the wasabi shadehouse if the air temperature rises above 25°C. The wasabi plants become heat stressed at these temperatures and consequently have reduced resilience to attack. Symptoms of Phoma and Rhizoctonia infection are difficult to observe in the field but black streaks develop inside the mature stem, reducing their aesthetic quality.

Symptoms of Fusarium infection are permanent wilting of the plant and subsequently rotting of the primary stem at the base. This organism is particularly virulent at temperatures over 25°C, causing sudden loss of whole plants.
Traditionally, Benlate® was used to control fungal organisms in wasabi crops, but as this chemical is no longer registered for use as an agricultural chemical in Australia, alternate strategies must be employed.

**Fungicide trial**

**Purpose**

In the first semi-commercial crop of wasabi produced in Tasmania in 2000, the yield of wasabi stems suitable for the fresh market was reduced by 50% due to a black stem infection detected at harvest (Figure 7.2). Pathological analysis attributed the condition to a number of fungal organisms – *Fusarium, Pythium and Phoma* species. In January 2004, a pot trial was set up to identify a suitable fungicide to treat the organism(s) causing stem blackening.

![Figure 7.1 Healthy wasabi stems](image1)

![Figure 7.2 Black stem symptoms](image2)
Method

One hundred genetically identical tissue-cultured plantlets of wasabi were used for the trial, which consisted of 5 replicates of each treatment arranged in randomized block design. The pots were re-randomized within the blocks at fortnightly intervals. Wasabi plants were either infected with a fungal organism, treated with a fungicide currently registered for use on brassica vegetables or both infected and treated with a fungicide. Treatment details are listed in Table 7.1

Table 7.1 Treatment details for fungicide trial

<table>
<thead>
<tr>
<th>TREATMENT</th>
<th>PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>Plants removed from pots and 2L of potting mix replaced. 1L of water applied to each pot</td>
</tr>
<tr>
<td>Pythium infection</td>
<td>39 plates of inoculum combined with 30L of pot mix. 2L of pot mix replaced in each pot</td>
</tr>
<tr>
<td>Fusarium infection</td>
<td>26 plates of inoculum combined with 20L of pot mix. 2L pot mix replaced in each pot</td>
</tr>
<tr>
<td>Rhizoctonia infection</td>
<td>8L of infected wheat grain: 8L pot mix. 2L of pot mix replaced in each pot</td>
</tr>
<tr>
<td>‘Wasabi’ infection</td>
<td>2L pot mix replaced in each pot. 200g infected wasabi rhizome blended and diluted to 1.5L volume. 700ml water applied to each pot, followed by 100ml ‘wasabi blend’ and additional 200ml water</td>
</tr>
<tr>
<td>THIRAM application</td>
<td>2L pot mix replaced in each pot. 1L of drench applied per pot. Dosage 1g/L</td>
</tr>
<tr>
<td>ZEE-MIL® application</td>
<td>2.5g ZEE-MIL® granules combined with 10L pot mix. 2L pot mix replaced in each pot. Applied 1L of water per pot</td>
</tr>
<tr>
<td>TERRACLOR® application</td>
<td>2L pot mix replaced in each pot. Dosage 1g/L. 1L applied as drench to each pot</td>
</tr>
<tr>
<td>KOCIDE® application</td>
<td>2L pot mix replaced in each pot and 1L water applied. 2g/L KOCIDE + 0.3 ml/L Agral applied as foliar spray to drip wet leaf at fortnightly intervals during the summer infection periods</td>
</tr>
<tr>
<td>SULPHUR DF® application</td>
<td>2L pot mix replaced in each pot and 1L water applied. 2.5g/L SULPHUR +0.3 ml/L Agral applied as foliar spray to drip wet leaf at fortnightly intervals during the summer infection periods</td>
</tr>
</tbody>
</table>
Results

The plants were harvested at 2.5 years of age to assess the development of the black stem condition. The results summarised in Table 7.2 indicate that infection with Rhizoctonia and treatment with Thiram® fungicide together resulted in a significant increase in plant growth. This increase resulted in an increase in the weight of the primary stem, which is the most valuable part of the plant.

Table 7.2  Infection rate and weight of plants treated with fungal infection and/or fungicide

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Whole plant weight (g)</th>
<th>Primary Stem Weight (g)</th>
<th>Infection rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>182.0</td>
<td>38.5</td>
<td>40</td>
</tr>
<tr>
<td>Pythium</td>
<td>170.2</td>
<td>30.0</td>
<td>0</td>
</tr>
<tr>
<td>Thiram®</td>
<td>157.3</td>
<td>31.6</td>
<td>0</td>
</tr>
<tr>
<td>Pythium + Thiram®</td>
<td>165.1</td>
<td>39.8</td>
<td>20</td>
</tr>
<tr>
<td>Zee-mil®</td>
<td>211.8b</td>
<td>40.6</td>
<td>0</td>
</tr>
<tr>
<td>Pythium + Zee-mil®</td>
<td>213.7b</td>
<td>41.3b</td>
<td>20</td>
</tr>
<tr>
<td>Fusarium</td>
<td>158.2</td>
<td>39.2</td>
<td>20</td>
</tr>
<tr>
<td>Fusarium + Thiram®</td>
<td>173.9</td>
<td>28.8</td>
<td>0</td>
</tr>
<tr>
<td>Rhizoctonia</td>
<td>222.6b</td>
<td>53.9b</td>
<td>80</td>
</tr>
<tr>
<td>Rhizoctonia + Thiram®</td>
<td>314.7c</td>
<td>63.8c</td>
<td>0</td>
</tr>
<tr>
<td>Terraclor®</td>
<td>191.8</td>
<td>26.6</td>
<td>40</td>
</tr>
<tr>
<td>Rhizoctonia + Terraclor®</td>
<td>220.1b</td>
<td>41.6b</td>
<td>40</td>
</tr>
<tr>
<td>‘Wasabi Infection’</td>
<td>134.0</td>
<td>33.8</td>
<td>20</td>
</tr>
<tr>
<td>Kocide®</td>
<td>191.5</td>
<td>31.7</td>
<td>20</td>
</tr>
<tr>
<td>‘Wasabi infection’ + Kocide®</td>
<td>126.7</td>
<td>27.2</td>
<td>0</td>
</tr>
<tr>
<td>Sulphur</td>
<td>187.1</td>
<td>36.3</td>
<td>0</td>
</tr>
<tr>
<td>‘Wasabi infection’ + Sulphur</td>
<td>190.3</td>
<td>35.8</td>
<td>20</td>
</tr>
</tbody>
</table>

*aMeans within each column followed by different letters are significantly different at $P = 0.05$*

The results indicate that treatment of plants with Thiram® drench prior to planting is likely to reduce disease incidence and may even provide a growth advantage at sites where the incidence of Rhizoctonia infection is likely. Results for other fungicide treatments used in this trial were not significantly different at 5% level.
**IPM considerations**

One definition of Integrated Pest Management (IPM) is ‘the use of a combination of different control methods to manage crop pests in a safe, economic and sustainable way’ (Wardlaw, 2004). The most effective means of managing crop pests in wasabi is to keep the plants healthy. The primary means of achieving this is through site selection.

Wasabi is particularly sensitive to heat stress and waterlogging. A wasabi crop should not be planted at a site where the air temperature exceeds 30°C or the soil temperature exceeds 18°C. These temperatures represent upper limits and plants should be subject to these extremes for a maximum of 2-3 days during the growing season. Longer exposure to these temperatures makes the plants extremely vulnerable to fungal diseases and damage by insects.

Although wasabi is known as a water-loving plant and can be grown in water-filled gravel beds (see Chapter 6, Section heading ‘Water culture’), the plant is very sensitive to oxygen deficit and will not survive in poorly drained soils or gravel beds in which water moves slowly. Stress caused by oxygen deficiency makes the plants more susceptible to fungal infection.

Crop hygiene is the best means of minimising fungal infections. Tasmanian growers have elected to use tissue-culture transplants to establish new crop sites. Crop rotation should exclude other brassica crops and potatoes. Washing down machinery and tools after use reduces cross infection. Providing a footbath containing a copper fungicide at the entrance to the wasabi shade-house is recommended. Foot traffic in the shade-house should be restricted as the plants are brittle and physical damage to the plants will provide openings for fungal infection.

A black shade house structure acts as a significant deterrent to pests that affect wasabi. White cabbage moth, Diamondback moth and aphids all prefer bright sunshine or white surfaces. The shade house framework provides anchors for spider webs and these act as natural traps for the flying insects that enter the shade house. Overhead irrigation of crops at night helps to wash insect eggs and larvae off the surface of the leaves. Restricting use of chemicals allows frogs to act as natural predators in the wasabi shade-house. Crops should be monitored weekly to determine population density of insect pests and chemical sprays used as a last resort.

Application of Bacillus thuringiensis (Bt) insecticides when larvae are less than 5 days will significantly reduce Diamondback moth and Cabbage white butterfly larvae. Shade structures that are closed to ground level and have entrances that can be closed off, present a physical barrier to insects and animal pests such as rabbits.

Cultivating the soil at the proposed site before planting the crop will reduce the numbers of slugs and snails. Once the shade-house has been constructed, introducing chickens or ducks to the enclosure prior to planting will help to clean up remaining snails and slugs. A defensive physical barrier around the shade-house, such as a metre-wide apron of sand, fine gravel or sawdust will prevent more of these organisms from entering the shade-house from adjacent areas. Chemical control can be obtained using snail and slug baits containing methiocarb or metaldehyde.
### Table 7.3 Summary of management options for wasabi pests and diseases

<table>
<thead>
<tr>
<th>Organism</th>
<th>Biological</th>
<th>Cultural/Mechanical</th>
<th>Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diamondback moth (DBM), cabbage white butterfly</td>
<td>• Parasitic wasps.*</td>
<td>• Shade house fully enclosed.</td>
<td>• <em>Bacillus thuringiensis</em> (Bt) on young larvae.</td>
</tr>
<tr>
<td></td>
<td>• Predators such as damsel bugs*, spiders, birds, frogs.</td>
<td>• Remove brassica weeds.</td>
<td>• Use resistant chemicals only after monitoring.*</td>
</tr>
<tr>
<td></td>
<td>• <em>Bacillus thuringiensis</em> (Bt) on young larvae.</td>
<td>• Monitor crop weekly.</td>
<td>• Choose chemicals that protect predators and beneficial insects.*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Irrigation and rainfall may drown grubs and wash off eggs</td>
<td>• DBM has developed resistance to certain insecticides. Use a rotation of different chemical groups across generations.</td>
</tr>
<tr>
<td>Green peach aphid</td>
<td>• Predators such as hoverfly,* ladybirds.</td>
<td>• Dark shade cloth.</td>
<td>• Registered aphicides such as Confidor®. Fine droplet size is optimal.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Limit plant nitrogen to make to crop less palatable to the aphid.*</td>
<td>• Broad spectrum insecticides may worsen aphid infestations.</td>
</tr>
<tr>
<td>Fungal organisms</td>
<td>• Reduce infection sites caused by slugs and snails.</td>
<td>• Minimise heat stress.</td>
<td>• <em>Thiram</em> drench pre-planting.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Avoid water-logging.</td>
<td>• Regular applications of copper sprays.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Irrigate when air temperatures are cool.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Remove brassica weeds and crop residues.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Wash machinery and tools and use a footbath at entrance to shade house.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Use clean transplants.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Restrict foot traffic to minimise physical damage.</td>
<td></td>
</tr>
<tr>
<td>Slugs and snails</td>
<td>• Introduce ducks or chickens pre-planting</td>
<td>• Cultivate site pre-planting.</td>
<td>• Slug and snail baits.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Establish physical barrier around shade house with sand, fine gravel or sawdust.</td>
<td></td>
</tr>
</tbody>
</table>

*Ref. ‘Vegetable Integrated Pest Management in Tasmania’ DPIWE publication 2004
8 Market

The project officer fields approximately 150 enquiries per year from Australia, Japan and the USA regarding purchase of fresh or processed wasabi products. At current production levels, most of these clients must be put on a waiting list for follow up when more product becomes available.

The area currently under wasabi production in Tasmania is relatively small and comprises both soil (0.3 ha) and water (0.5 ha) cultivation systems. Fresh wasabi products (0.5 tonne valued at $110/kg) was sold directly to restaurants in Hobart, Sydney, Melbourne and Brisbane during the financial year 2004/05 and dried wasabi products were sold in Tasmania. The current market for fresh Australian wasabi is estimated at 50 tonne per annum.

The demand for dried wasabi leaf and stem material increased from 6 kg ($2,400) to 50 kg to ($20,000) in the 2004/05 period. Dried wasabi products are currently used in wasabi flavoured cheese.

Producing 10t/annum (valued at $90,000) of processing grade wasabi stems to use in ready-to-use wasabi paste is the next goal for growers of soil-cultivated wasabi.

Future

In April 2005, 20 participants attended a workshop for current and potential growers from Tasmania and Victoria. At this workshop participants were asked to discuss three questions:

1. What is required for you to participate in the commercialisation of wasabi?
2. What impediments are there to your involvement?
3. What research and development work is required to support the wasabi industry?

The response to these questions identified the following establishment priorities: availability of capital, production expertise/mentoring, contractual details, planting stock, market experience and business coordination.

Research and development priorities included: establishment of a tissue culture laboratory in Tasmania/Australia, pest and disease management strategies, protocols for water culture production, benchmarking, processing technology, variety assessment, information sharing and market research.

A number of the issues raised at the workshop are those which have been addressed during the course of this project. Pest and disease management, identification of an Australian based tissue culture laboratory, production protocols for water-cultivated wasabi and development of production and marketing expertise have been the focus of the current research project and this information is now available to the public.

In 2003, the industry partners that have worked alongside DPIWE for 10 years to conduct trials relating to wasabi production in Tasmania registered their business name ‘Wasabi Growers of Tasmania’ and in 2005 this group became an incorporated company. As a result of the workshop held in April 2005, there is now a process to engage further growers in development of the industry. As the number of wasabi growers in Tasmania increases, strategies to work together on production, packaging, marketing and distribution are being implemented.

Research and development results contained in this report are included in the practical manual ‘Wasabi - A guide to the production of wasabi in Tasmania’ which has been updated to provide information on both soil and water-cultivated wasabi production. This practical manual is available in electronic format from Department of Primary Industries, Water and Environment, Tasmania.
9 Discussion of Results

1. Tasmanian wasabi products are currently available on the Australian market.

The demand for Tasmanian wasabi products currently exceeds the supply, as the production area is very small. Tasmanian wasabi growers recognise the benefits of forming an incorporated company to coordinate the Tasmania industry with the initial aim being to increase the area under wasabi production in Tasmania. Growers recognise the benefits of working together to share knowledge and to coordinate orders for purchase of planting material, planting and harvest schedules, and packaging, distribution and marketing of their products. In addition to the increasing demand for fresh wasabi stems for the both the premium market and food-processing companies, dried wasabi products are also sought. The range of product end-points gives growers a measure of flexibility in regard to production scheduling.

Wasabi growers intend to establish a coordinated approach to the development of the wasabi industry by building relationships with individuals or companies at all points in the supply chain. The formation of an incorporated company with strategies to attract external investors will help to increase the confidence of the innovators in this new industry.

2. Yield and product quality improvements

In 2003, a committee was formed to develop farm hygiene recommendations for wasabi production. The committee consisted of plant pathologists, virologists, entomologists and wasabi growers. The outcome of the considerations of this committee was the publication of ‘Farm hygiene protocols for wasabi’ distributed both in the newsletter ‘Wasabi News’ Issue 2 December 2003 and in ‘Access to Asian Foods’ Newsletter No.67, February 2004. Management options for wasabi pests and diseases are made on the basis of the findings of this committee, field experience and recommendations from ‘Vegetable Integrated Pest Management’ published by DPIWE, Tasmania.

The results of greenhouse trials indicate that a single application of chemical control agent pre-planting could provide a very high level of disease protection. With the increasing emphasis on food quality and safety in the market place, this gives Tasmania a further competitive advantage for its wasabi products.

Developing micropropagation techniques for wasabi proved difficult with three commercial laboratories failing in their attempts to develop protocols for this technique. In November 2004, an Australian research laboratory successfully micropropagated Tasmanian wasabi plants and this laboratory will document protocols at the conclusion of its current research project in June 2006. Wasabi growers have identified tissue-cultured wasabi plants produced by an Australian laboratory as a research priority. Meanwhile Tasmanian growers are importing micropropagated plants from Japanese stocks so that new sites can be established with disease-free planting material.

3. The practical manual ‘Wasabi- A guide to the production of wasabi in Tasmania’ now includes recommendations for both soil and water-cultivated wasabi.

Development of water-cultivation techniques for wasabi are progressing with water movement and gravel integrity proving to be essential factors in determining the success of this type of cultivation. As a result of this project, the practical manual ‘Wasabi- A guide to production of wasabi in Tasmania’ has been updated to include water-cultivation of wasabi. The report recognises that both the topography and access to natural resources at the production site will determine the style of water-cultivation best suited to a particular site.
Techniques for soil-cultivation of wasabi have been refined during the course of this project and recommendations for optimising soil types, fertiliser requirements, water application methods and pest and disease management are included in the revised practical manual.
Implications

This project has demonstrated the value of plant hygiene from establishment through to production. Expansion of the industry will be assisted by specific recommendations made for soil and water-cultivation systems.

As a result of the research undertaken during the course of this project ‘Wasabi Growers of Tasmania’ has been formed as an incorporated body and the number of growers producing wasabi has doubled. Several Australian laboratories have expressed interest in pursuing commercial micropropagation of wasabi plantlets. Reduced disease incidence and use of selected varieties has potential to double the stem yield of soil-grown wasabi crops (Table 10.1). Production methods for water-cultivated wasabi will continue to improve. The exclusive growing conditions for wasabi reduce the likelihood of oversupply of this product on the Australian market.

Table 10.1 Current and projected results for soil-cultivated wasabi

<table>
<thead>
<tr>
<th></th>
<th>Premium stems</th>
<th>Processing stems</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Current Results</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yield (t/ha)</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Gross return ($/ha)</td>
<td>550 000</td>
<td>200 000</td>
<td>400 000</td>
<td>1 150 000</td>
</tr>
<tr>
<td><strong>Projected results</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yield (t/ha)</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>Gross return ($/ha)</td>
<td>1 150 000</td>
<td>400 000</td>
<td>400 000</td>
<td>1 900 000</td>
</tr>
</tbody>
</table>

As premium stems for water-cultivated wasabi have an estimated value of $350/kg (DPIWE market evaluation 2000), the projected gross return from this type of system is $4.1 million/ha.

Tasmania’s reputation for producing fine quality food, particularly beef and seafood, is an additional marketing advantage when wasabi product volumes permit entry to the Japanese market. Distribution of a range of value-added wasabi products to other centres in the Asia-Pacific region is also planned. Already Tasmanian wasabi cheese has gained entry to both Japanese and USA markets. Considering the high return achievable from a relatively small area of land, these factors make the developing Australian wasabi industry an attractive investment opportunity.
11 Recommendations

The recommendations made at the conclusion of this project reflect the next stage of development proposed for an industry in its infancy and will provide a launching pad for a new self-funding rural industry in Australia.

1. Develop the capacity of an Australian laboratory to produce commercial quantities of tissue-cultured wasabi planting stock.

Expansion of the area under production has been limited by lack of high quality planting material. Research demonstrates that tissue-cultured planting stock provides the benefits of plant integrity and low disease status not available from seed lines. Currently wasabi growers in Tasmania use imported Japanese plant stocks. Plant material of several varieties has been collected during the course of this project, but development of locally produced tissue-culture stock from these plants has been frustrated by unresolved decontamination procedures for this species.

In October 2005, tissue-cultured plants successfully generated by an Australian research laboratory were used in hardening-off trials. The availability of micropropagation protocols from this research laboratory will form a valuable part of the intellectual property associated with future research and development projects. Production of tissue-cultured plant stock from a commercial laboratory in Australia will benefit the micropropagation laboratory by expanding its product and client range, and it will benefit Australian wasabi growers by allowing imported planting stocks to be supplemented and ultimately replaced with stocks that have been selected for Australian conditions.

2. Improve product quality through disease management, water-culture and additional varieties.

Fungal diseases are the biggest threat to wasabi crop yields, so the demonstration of disease management practices that protect plants from infection and cause minimal environmental impact are essential to the survival of this niche industry. Techniques that have proved to be beneficial in greenhouse trials should now be trialled under field conditions.

As micropropagation protocols are made available to a commercial micropropagation laboratory in Australia, the use of locally selected varieties will eliminate quarantine requirements currently associated with imported wasabi planting stock and provide yield improvements through specific varietal selection.

3. Build the networking capacity of the wasabi grower group.

The development of techniques for water-cultivated wasabi in Australia has been championed by a small group of growers in Tasmania whose background in the production of soil-cultivated wasabi has seen their products available on the Australian market since 2001. One group in Victoria is also developing a technique for water-cultivated wasabi. Many obstacles in the water-cultivation process have been overcome in the last three years and these growers are in a position to provide technical advice to new growers supported by production experience.
Having formed a small company, the Tasmanian group plans to engage other growers to produce wasabi either in soil or water-culture as the site allows, and to mentor new growers and to set benchmarks for wasabi production methodology and wasabi products. The company plans to coordinate both the production and marketing of Australian wasabi to ensure that high quality wasabi products are consistently available to the Australian consumer and to potential export markets. In order to achieve this, a business plan proposal will be developed by the company and communication technologies updated to keep wasabi growers informed of the latest production and marketing research.
Production and Marketing of Tasmanian Wasabi

by Angela Sparrow

RIRDC Publication No. 06/085

Wasabi (Wasabia japonica) is a high value plant native to Japan where its products are used in traditional meals, but are seldom exported due to limited availability. Wasabi grows in areas that are cool and shaded with plenty of water - a major advantage for its production in Tasmania is the cool temperate climate and proximity to clean water.

Wasabi products from Tasmanian trials have been highly acclaimed on the Australian market and the domestic demand has continued to grow as a result. Supplying wasabi products to neighbouring countries in South-East Asia remains a long-term objective of Tasmanian producers.

This report describes the development of methods for commercial production of wasabi in Tasmania, using techniques for both soil and water-cultivation and markets identified for Tasmanian wasabi products.

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