Production and Marketing of

Japanese Ginger (*Zingiber mioga*) in Australia

A final report for the Rural Industries Research and Development Corporation

by *Professor RJ Clark and Mr RA Warner*

September 2000

RIRDC Publication No 00/117
RIRDC Project No UT-17A

ISBN 0 642 58147 9
ISSN 1440-6845

Production and Marketing of Japanese Ginger (Zingiber mioga) in Australia
Publication No. 00/117
Project No: UT17A

Researcher Contact Details

Professor Robert Clark
School of Agricultural Science/Tasmanian Institute of Agricultural Research
GPO Box 252 –54
Hobart, Tasmania 7001

Phone: 03 6226 2619
Fax: 03 6226 2642
Email: Rob.Clark@utas.edu.au

Mr Richard Warner
Agrilink Asia Pacific Pty Ltd
PO Box 293
New Norfolk, Tasmania 7140

Phone: 03 6261 2031
Fax: 03 6261 2010
Email: rwarner@tassie.net.au

RIRDC Contact Details
Rural Industries Research and Development Corporation
Level 1, AMA House
42 Macquarie Street
BARTON ACT 2600
PO Box 4776
KINGSTON ACT 2604

Phone: 02 6272 4539
Fax: 02 6272 5877
Email: rirdc@rirdc.gov.au.
Website: www.rirdc.gov.au

Published in August 2000
Printed on environmentally friendly paper by Canprint

Foreword

Australian producers have an opportunity to produce high value, specialty Asian vegetables and market these products both within Australia, to the increasing Asian Australian population, and off-season as fresh product into Asia when prices are high and supply from competing Asian production is minimal.

This project, within the RIRDC Asian Foods Sub-Program, focuses on specialty Japanese vegetable produce, builds on past achievements in establishing successful supply chains of fresh product export to Japan and has been developed and implemented with close consultation and input from industry partners, both in Tasmania and Japan.

The project builds on the successful R&D outcomes from RIRDC UT-9A, which investigated the production of Japanese Ginger or myoga (*Zingiber mioga* Roscoe) in Tasmania. Myoga is a traditional Japanese vegetable produced for fresh market consumption. In early spring, pseudostems arising from under ground rhizomes, grow through a 10 to 15cm layer of leaf litter mulch, finally reaching a height of 1.0 to 1.5m. The edible immature flower buds are hand harvested from within the mulch layer during a period of 3 to 4 weeks in late summer. In Japan, 87% of myoga production is produced “in season” during June through September. Australian production will target the”out of season” November to May period.

This publication presents a production guide for myoga in Australia, describes the outcomes of R&D on crop agronomy and outlines the process and results arising from the establishment of semi-commercial production in Australia. Results from trial marketing in both Australia and Japan are also reported. This report should provide baseline information for those wishing to produce, market or invest in myoga production in Australia.

This project was funded from RIRDC Core Funds which are provided by the Federal Government.

This report, a new addition to RIRDC’s diverse range of over 600 research publications, forms part of our Asian Foods R&D program, which aims to provide an R&D program that supports industry in its drive to develop new products and markets and to gain competitive advantage through improving productivity in, and achieving price premiums for, Australian production.

Most of our publications are available for viewing, downloading or purchasing online through our website:

- downloads at www.rirdc.gov.au/reports/Index.htm
- purchases at www.rirdc.gov.au/eshop

Peter Core
Managing Director
Rural Industries Research and Development Corporation

Acknowledgments

The opportunity to establish myoga production in Australia was first introduced to the Australian partners in 1990, by Japanese executives responsible for the importation of Tasmanian farmed fish into Japan. This opportunity was recognised by Mr Richard Warner and Mr Peter Shelley (Agrilink Asia Pacific Pty Ltd) who over the period from 1990 to 2000, have provided the commercial focus and financial commitment. This industry input was combined with R&D input from the University of Tasmania and funding support from RIRDC, and has enabled this project to progress through the many challenging stages of new crop development, through to semi commercial production and trial marketing. The researchers are indebted to this industry commitment.

The industry partners also acknowledge the financial support provided by the Supermarkets to Asia Program, AFFA, Canberra. The Supermarkets to Asia Program funds assisted in taking the R&D findings of the RIRDC project through to semi commercial production.

Contents

Executive Summary

This two year RIRDC project commenced 1 July, 1997 and was an extension of an initial three year RIRDC funded project (UT-9A) which commenced in July 1994. The findings of project UT-9A were reported in October 1997 and are available from RIRDC at www.rirdc.gov.au/reports/Index.htm

A major outcome of the initial three year research project was the identification of a plant "condition" which caused one type of myoga to prematurely senesce after two or three seasons growth. This "condition" was first identified in commercial plantings in New Zealand in 1995. The full debilitating effects of the "condition" were apparent in New Zealand during the 1996 season. Senescence of the affected plants occurs well before flower bud emergence and hence crops displaying the "condition" do not yield flower buds.

Having identified and inspected plants showing the "condition" during research visits to New Zealand, it was possible to identify early symptoms in plants in Tasmania during the 1996 season. Unlike the situation in New Zealand, the "condition" was identified in Tasmania before distribution to commercial growers and before any commercial areas had been planted.

Based on observations and experiences in New Zealand and the identification of the symptoms of the "condition" in plants originally imported into Tasmania from Japan, it was decided to destroy all plants, except a collection sample currently held at the University of Tasmania, originating from the original Japanese material in 1996.

During the research visits to New Zealand in 1995 and 1996, a superior " type" of myoga was identified. The superior type of myoga was found to consistently produce high yields of high quality flower buds over several seasons without displaying any symptoms associated with the "condition" observed in the initially imported material. Planting material of the superior "type" was imported into Tasmania and following quarantine clearance has undergone intensive multiplication using micro-propagation techniques developed within this project.

This new material now forms the basis of the Australian myoga industry.

As a result of the identification of the "condition" within the initial RIRDC funded project (UT-9A) insufficient material was available within the early project to either allow scale up to semi commercial production or to provide sufficient flower buds to enable trial marketing in either Australia or Japan. The current project addressed the need to extend plantings of the superior "type" to semi commercial scale. Having done so the aim of this project was to produce sufficient flower buds to allow trial marketing to proceed in both Japan and Australia, to apply and adapt the production protocols developed in UT-9A to semi commercial plantings and continue plant physiology research towards an understanding of flowering in myoga.

During the course of this project (UT-17A) it became apparent from the performance of myoga in the Derwent Valley area of Tasmania as well as the North West Coast of Tasmania, that growing conditions in Tasmania were potentially rather marginal. Late spring frosts, the short growing season, extended periods of high temperature and low relative humidity when combined with early autumn frosts, were judged by the commercial partners, to present a significant production risk. Accordingly, the commercial partners used information collected during study tours of Japan and New Zealand, combined with limited literature data, in their decision to locate the first semi commercial production unit in the Albion Park region of NSW.

A grower was identified in this region during the course of this project and a trial plot established in the 1998/99 season. The trial was established using Tasmanian grown myoga of the superior "type" and 100 small plantlets (100 to 150 g) which were judged to have received sufficient winter chill under Tasmanian conditions, were transferred and planted at the trial site. The trial was conducted in accordance with the production protocols developed in UT-9A and on several occasions during the growing season was monitored and assessed by both researchers and industry partners in this project. As expected, the plants performed exceptionally well under the climatic conditions at this site and in early 1999 a first small yield of high quality flower buds was harvested. Yield data was collected over the course of the harvest, post harvest handling systems were trialed, grading and quality assessments conducted and small quantities of material were provided to co-operating market outlets in Sydney to test the acceptance of the product within the Australian market.

The results of this trial at Albion Park, NSW were very positive and both yield and quality of flower buds, exceeded all expectations from a first year crop. Flower buds from this trial were air freighted to Japan with the objective of obtaining feedback on the quality of the product and also to develop an export protocol which incorporated a freight forwarding company and the Australian Quarantine Inspection Service. While feedback from the Japanese market was positive, it identified flower bud size as an issue. The quantity of flower buds available for test marketing was very limited due to the delay in production which resulted from the need to re-establish plantings after the defect "condition" was identified. Trial quantities were also marketed in Sydney with around 60kg being sold to wholesalers. Feedback from wholesalers and customers was sought and the services of a Japanese chef were retained to assess the product quality and advise on packaging and labelling. Finally advice was sought on strategies to effectively introduce myoga into the Australian market.

The success of the trial at Albion Park in 1998/99 resulted in a joint decision by the grower and of Agrilink Asia Pacific Pty Ltd to extend the trial to a semi commercial production unit in 1999/00. Again, dormant propagation material generated in the production nursery in the Derwent Valley was transferred to Albion Park and planted. This material was planted in a purpose built shade house adjacent to the trial planting. This semi commercial unit was 2400m^2 and housed 7500 plants. Planting and maintenance was in accordance with techniques developed within this project and production and design of both production systems and post harvest handling systems was supervised by researchers and the industry partners in this project. In anticipation of a commercial quantity of flower buds becoming available in the 1999/00 season, market research visits were made to Japan and Australian markets by the industry partner. The successful outcome of these visits resulted in trail marketing agreements in major Australian markets and in Japan. Packaging was designed and post harvest handling and transport arrangements developed. In March 2000 the semi commercial planting at Albion Park yielded semi commercial quantities of high quality flower buds. These flower buds were trial marketed in Australia and in Japan.

The major outcomes demonstrated in this project was as follows;

- High quality flower buds can be produced from the superior "type" of myoga when grown at Albion Park in NSW, using the production protocols developed in this and an earlier RIRDC funded project (UT-9A). Achieving this outcome effectively validated the production model developed in Tasmania.
- There is significant market interest in Australian grown myoga in the Australian market.
- Australian grown myoga can be exported to Japan using the cool chain/supply chains established during this project and the quality of the product is judged by the Japanese market as equivalent in quality to the best Kochi myoga. Kochi myoga is grown in glasshouses/poly tunnels out of season in Japan, is the only product in the Japanese market at the time Australian myoga is available and is considered a premium product which attracts significant price premiums in the Japanese market.
- There is need to continue research and development in Australia to refine the flowering model developed in this project with the eventual aim of extending the production season beyond the present harvest period. Market research has demonstrated that to be successful, Australian grown myoga must be available in the market for an extended period. This aspect of research is the current focus of a research higher degree program at the University of Tasmania, supported by an Australian Postgraduate Award and of Agrilink Asia Pacific Pty Ltd.
- The outputs from this project include publications in the scientific literature, industry publications and RIRDC reports and publications, which includes a "Growers Manual".

1. Introduction

The proposal to produce myoga in Australia was outlined by executives of the Yamaha Motor Company Limited to the Principals of of Agrilink Asia Pacific Pty Ltd. Australia was identified as having a comparative advantage in myoga production due to the availability of suitable climatic conditions and the ability to supply myoga flower buds to Japan during the "out of season" months.

More recently, Tassal Japan Ltd have replaced the Yamaha Motor Co. Ltd as the importer of fish products produced by Tassal Ltd, Tasmania's largest fish farmer, processor and exporter. Tassal Ltd had an annual turnover of approximately $36 million in 1996/97. Key executives of Tassal Japan Ltd, who first suggested myoga production in Australia when employed by Yamaha, have been involved in the development of Tassal's products and their demonstrated ability to successfully penetrate the Japanese market, will be available to assist this project.

Furthermore, much of the transport and handling of myoga is aligned with established protocols currently used in the fresh fish export industry.

Initially 20 myoga plants were selected from Japanese clonal material and imported to Tasmania in 1990. These plants were cleared from quarantine and were the basis of material used to establish the first field trials in the early 1990's. In 1994, a three year collaborative research project was commenced. The partners to this project were RIRDC, Agrimark - Tasmania (now Agrilink Asia Pacific Pty Ltd) and the School of Agricultural Science, University of Tasmania. The Final Report for this project UT-9A is available from RIRDC (www.rirdc.gov.au/reports/Index.htm) and details much of the science and technology outcomes associated with this project. Further details of the outputs from the project are detailed in a number of publications which have resulted from this work and which are publicly available and referenced in this report.

Along with validation of production protocols, further development of a myoga flowering model, semi commercial production and trial marketing of myoga, an agreed output from this project was the production of a "Grower's Manual". This "Grower's Manual" along with the more detailed research findings which are presented as submitted or published journal articles in this report, form the basis of the Final Report to RIRDC on Project UT-17A.

2. Industry Structure

Industry initiated the investigation into myoga production in Australia. In 1990, Mr Richard Warner and Mr Peter Shelley, Principals of Agrilink Asia Pacific Pty Ltd (ACN 083 147 602) commenced the investigation with the aim to develop myoga production in Australia to a sufficient level to allow profitable export of myoga flower buds to Japan in the “out of season” months of January to April. It was also intended to promote myoga within a niche Australian market. The company Agrilink Asia Pacific Pty Ltd was incorporated to facilitate this research, development and commercialisation opportunity. Since 1990, activities within the project have included important of germplasm and quarantine clearance, agronomic R&D, plant physiological studies, field trials, field inspections, study tours to Japan and New Zealand, evaluation of growing areas, assessment of yield and quality parameters, post harvest handling and storage, and business and marketing.

In the 1999/2000 season, Agrilink Asia Pacific Pty Ltd have established semi commercial production in Tasmania associated with a propagation/nursery unit and a semi commercial production unit in NSW. At this time, ownership of the project and all plant material remained with Agrilink Asia Pacific Pty Ltd, with some sharing of production with grower/investor interests in NSW, and joint ownership in intellectual property with the University of Tasmania, RIRDC and AFFA. Agrilink Asia Pacific Pty Ltd have also established marketing agreements both in Australia and Japan. It is envisaged that as the production moves to fully commercial, there will be a number of growers who will be contracted to produce for Agrilink Asia Pacific Pty Ltd, who in turn will have responsibility for marketing.

3. Opportunity

Japanese ginger (myoga) is a traditional Japanese vegetable grown for the edible flower buds which provide a distinctive flavour and aroma used in traditional Japanese soups, tempura, salads and other Japanese cuisine.

Commercial production of myoga has been largely limited to Japan where the total Japanese production is estimated to be 9000 tonnes/annum with 4800 tonnes sold through the Japanese wholesale market system and 87% produced “in season”. “Out of season supply in January to April, is limited to small quantities being produced using expensive heated glasshouse units. Myoga produced in this way is known in Japan as “house myoga”. The combination of research, development and commercialisation in this project, has enabled Agrilink Asia Pacific Pty Ltd to demonstrate that Australian grown myoga can be supplied to the Japanese market successfully and profitably. While quality has consistently been assessed within the Japanese market as equal to the best “house grown” myoga, there remain some marketing challenges associated with the Japanese marketing chain and pricing. However, experience gained during the 1999/00 season provide confidence that these issues can be resolved and that commercial outcomes will be achieved.

4. Background

Zingiber mioga, commonly called myoga or Japanese ginger, is a traditional Japanese vegetable. Myoga is the most cold tolerant species of the ginger family and is widely cultivated throughout Japan. Myoga has the habit of a typical ginger plant, with a thick rhizomatous but inedible rootstock. Myoga is grown for spring shoots, or more commonly for sterile flower buds produced during summer and autumn.

Myoga is a perennial, woodland plant grown in open fields in Japan. The above grown portion of the plant, are pseudostems, and these are frost sensitive. Consequentially, in cool climates, senescence coincides with the onset of colder winter temperatures. Myoga regenerates in spring from under ground rhizomes. The pseudostem growth rises to about 1.5 to 2m in height prior to the appearance of flower buds. Flower buds are produced underground on rhizhomes and as they grow they emerge through a layer of mulch. Flower buds left to mature, produce delicate, whitish inflorescences. Buds which progress to the stage of inflorescence emergence are considered too mature and of no commercial value. Likewise buds which develop in light conditions without mulch, produce chlorophyll and lack the typical pinkish colour which is required in high quality buds. Under Australian conditions myoga requires shading to prevent excessive pseudostem damage from direct exposure to sunlight. Under commercial conditions shading of 30 to 50% is achieved using artificial shade cloth.

Following the identification of a yield debilitating “condition” plants originating from the planting material imported from Japan, this material was replaced by a small quantity of high performing myoga from New Zealand in 1996. Following release from quarantine, the high performing plants were divided into 10g rhizome pieces and planted in glasshouses at the University of Tasmania. In August 1997, these small plants were again divided into single node rhizome pieces and planted in a shade house at New Norfolk, in the Derwent Valley area of Tasmania. Plants were established in raised beds 1.2m wide and covered with 50mm of pine bark mulch. Plants received basal fertilisers and irrigation from overhead micro sprayers. The overhead irrigation system was designed to provide adequate moisture for crop growth as well as evaporative cooling during the excessively hot and dry summers in the Derwent Valley.

The multiplication process, which commenced with only 1400 single node plants and 256 larger yearling plants in August 1997, has resulted in over 300,000 mature plant (~ 300g) in 2000.

Construction of the first semi commercial shade house (~2000m^2) was completed in NSW in 1999 and plants established in this facility were harvested for the first time in the 1999/00 season. When combined with the establishment and operation of the “foundation plant nursery” in Tasmania, the establishment of this semi commercial area NSW means that there is now, for the first time in Australia, sufficient planting material of known performance, on which to base future commercial plantings.

5. Objectives

The overall research and development objectives of the RIRDC funded research projects on myoga (UT-9A and UT-17A) can be summarised as follows;

UT-9A

- Investigate plant physiological factors controlling flower initiation including vernalisation, juvenility/growth stage, temperature, daylength/photoperiod and planted rhizome size,

- Modify and define growing conditions to optimise growth, flower initiation and flower development; and

- Investigate Japanese techniques of production, harvesting, post harvest handling, transport and marketing with the aim of incorporating or adapting techniques to suit Australian conditions

UT-17A ;

- Apply production technology developed with the RIRDC project (UT-9A) commenced in 1994 to recently imported high performing myoga plants; and

- develop marketing procedures within Australia and develop post harvest practices to enable a viable myoga industry to be established in Tasmania, capable of supplying the Japanese market with “out of season” product thereby increasing export earnings and providing Tasmanian producers with a profitable alternative agricultural enterprise.

6. Production Issues

At the commencement of the project, plant material had been imported from Japan and following release from quarantine, had been multiplied into approximately 10000 small plants. While the plants were observed to grow well in the nursery area, little information was available on cultural requirements and despite reasonable vegetative growth no flower buds were produced prior to the 1994 season.

Since 1994, plants have been observed to produce flower buds that have been assessed as acceptable quality by Japanese importers and local Japanese restaurants.

A protocol has now been established for production of Australian myoga, including some general observations on cultural aspects such as site, soil type and irrigation requirements. More specific data has been collected on shade, mulch, optimum size of rhizome piece to plant, multiplication rate, planting date, planting density and pre-treatment/chilling of rhizomes prior to planting. The project also undertook numerous studies that examined the literature on myoga production techniques as well as investigations into aspects of plant morphology and plant physiology.

Details of research and development outcomes from both RIRDC UT-9A and UT-17Ahave been published and are available through RIRDC (www..rirdc.gov.au/reports/Index.htm) or in refereed journal articles listed in the references section in this report. The focus of this “Grower’s Manual” is not to reproduce detail already published but rather to outline some of the important aspects of production which need to be adhered to in order to successfully produce high quality myoga in Australia.

6.1 The Plant

Myoga is a perennial plant that belongs to the Zingiberaceae family. The leaf margin of myoga overlap, each producing a sheath to form an erect pseudostem measuring between 1 and 1.5m high. The perennial structure is a well developed, thick, palmately branched rhizome borne horizontally near the surface of the soil (Pursglove, 1972).

Flowers occur on separate underground shoots in mid summer. The bracts enveloping the unopened flower bud are thick and fleshy, with a distinctive flavour (Palmer, 1984) Once at the soil or mulch surface, the flowers proceed rapidly through to anthesis, producing an inflorescence with three yellowish lobes (Pursglove, 1972)

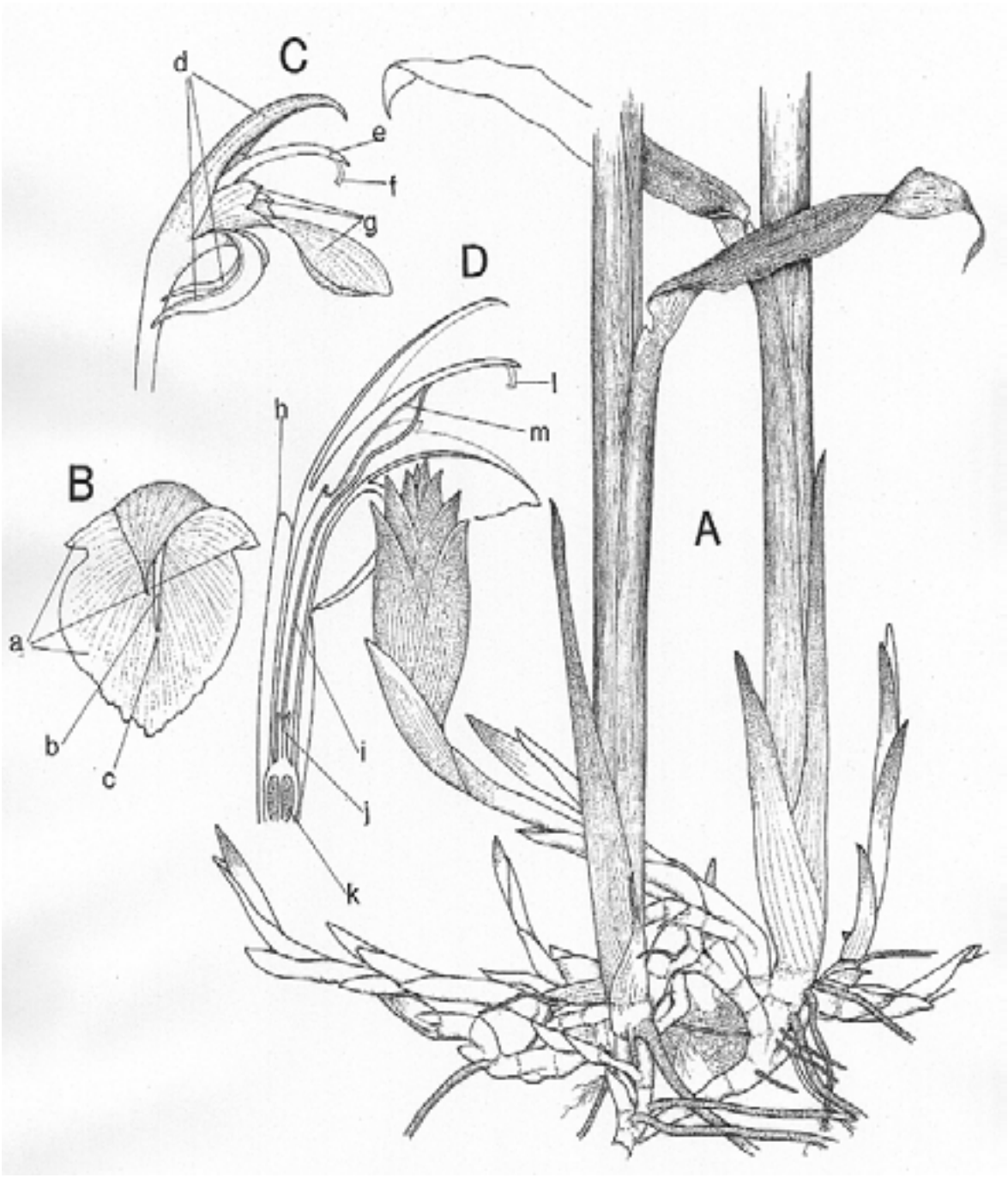


Figure 1 Zingiber mioga (Thunb.) Rosc. (taken from an original sketch by Mr D Morris, Honorary Research Associate, School of Agricultural Science, University of Tasmania – commissioned as part of this RIRDC project)

[A = base of plant showing rhizomes, pseudostems and an inflorescence bud; B = flower, front view, a – modified stamen filaments, b – anther connective, c- stigma; C = flower, side view, d – inner perianth lobes, e – anther connective, f – stigma, g – modified stamen filaments; D = section through flower, h- outer perianth lobe, i – style, j – nectaries, k- ovary, l – stigma, m- anther]

6.2 The Growth Cycle

Myoga is commonly regarded as sterile (Yazawa *et al*, 1985) and is vegetatively propagated using rhizome pieces. It is possible to achieve up to a 20 fold increase in rhizome weight during one season using initial rhizome pieces as small as 20g. Generally larger rhizome pieces or small intact dormant plants (complete with roots, rhizomes and storage roots) weighing about 100g are used to plant commercial areas. While smaller amounts of propagating material will result in good establishment, it is questionable whether economic yields of high quality buds will result from small propagules. As myoga approaches senescence in autumn, high order rhizomes tend to produce dormant buds that are the sites from which either pseudostems or rhizome growth commences in the following year. If taken at this time, these buds tend to be dormant and require a period of chilling at 2 to 5°C for several weeks, in order to break this dormancy (Maeda, 1994). If collected after senescence is complete under Tasmanian conditions, rhizomes have been found not to require a period of vernalisation to allow growth to recommence. However, a vernalisation period was observed to stimulate early and uniform pseudostem growth that in turn promoted vigorous flower bud production. Studies of growth and development completed in the present investigation indicate that flower bud initiation occurs during shortly before flower bud development and emergence, in the same growing season. As such it is not surprising that vernalisation is not require to enable flower bud production and that any reported effects of vernalisation on flower bud production result indirectly from the effect on pseudostem growth. Maeda(1994) reported that early growth could be promoted and rhizome dormancy broken by water infiltration of cut rhizome pieces under pressure.

Observations made from trials in Tasmania and semi commercial production in the Albion Park area of NSW, have shown that myoga is dormant during the winter months. In Tasmania the period of dormancy is longer than in NSW and begins with the first frosts in autumn and growth recommences in late September and early October. The above ground portion of the plant senesces in late autumn and the underground rhizomes produced during the growing season remain dormant until the following spring. Above ground shoots, pseudostems, grow from the rhizomes during the warmer spring months and reach 1.5 to 2m in height. Maeda (1994) reported that while 1 year old plants commonly produced primary, secondary and tertiary order pseudostems, 2 year old plants only produced primary pseudostems. Similarly, 1 year old plants tended to produce a more highly branched rhizome system compared with 2 year old plants. The late spring to early summer period of pseudostem growth and rapid rhizome growth is followed by initiation and development of flower buds in mid summer to early autumn. Depending on size of the initial planted rhizome piece, multiplication rates, on a weight basis, have been observed to exceed a 20-fold increase during one growing season. The flower buds develop from the apical buds on the rhizomes and it is generally the primary and secondary rhizomes that produce flower buds. Higher order rhizomes tend to produce either additional pseudostem growth or dormant buds that become the sites for growth in the following season.

Flower buds develop from rhizomes and rise to about 5cm above the ground prior to the appearance of numerous, typically white to yellowish inflorescences from each flower bud. Quality myoga flower buds are harvested prior to emergence of the inflorescences.

6.3 Site Selection

The choice of a suitable production location is of utmost importance to the successful cultivation of myoga. Since myoga is frost susceptible, the ideal location should be frost free from mid spring through to mid autumn. In choosing a site it is important that conditions are such that myoga is able to grow quickly in spring and develop through to the flower emergence stage. Under Japanese conditions the period from emergence to flowering is reported to vary from 100 to 120 days (Maeda, 1994).

Despite Japanese winters being significantly cooler than those recorded in the areas in which myoga has been grown in Australia and NZ, such cold winters do not seem essential for flowering.Based on data from Japan, and from the limited comparisons of myoga performance in Tasmania, NZ and NSW it would seem that idea conditions for production are those that are typical of a growing region like the Albion Park are south and inland from Sydney, NSW. Typical weather data from this region is as follows;

Weather Data - Albion Park, NSW 1998														
		J	F	M	A	M	J	J	A	S	O	N	D	Annual
Air Temp														
Av. Daily Max ^{o}C		23	24	22	20	11	15	14	15	16	18	20	22	18.2
Av. Daily Min ^{o}C		16	16	15	12	9.3	1.3	6.6	7.5	9.1	11	12	13	11.3
Av Daily Ground Frost						0.2	2	1.1	1.2	0.3				
% RH		73	75	76	78	80	81	80	81	75	72	73	72	76
Mean Rainfall(mm)		66	68	110	103	118	139	122	130	125	98	98	92	1297

(NB Excellent production outcomes were achieved from the Albion Park site in 1998/99 season when small dormant intact plants were transferred from Tasmania to Albion Park and planted in winter 1998. Much smaller rhizome pieces, again transferred from Tasmania to Albion Park during the winter of 1999 failed to produce as higher yields in the 1999/2000 season. While the lower yields in 1999/2000 were attributed to smaller rhizome pieces – it still remains to be seen whether or not there is sufficient winter chill at this site to promote high yields in mature plants which over winter at this site. This information will be available after the 2000/2001 season.)

Exposed windy sites should also be avoided since pseudostems are extremely susceptible to wind damage. Soils should be relatively fertile, have a pH of 5.5 to 7, be free draining, deep and friable, to allow for expansion of the rhizomatous roots and emergence of the delicate flower buds. Water logged sites should be avoided, if for no other reason than that they tend to remain wet and cold in spring and this delays early growth and vigorous pseudostem emergence. Vigorous, early and uniform pseudostem growth has been found essential for viable yields of high quality flower buds.

Maeda (1994) reported that long photoperiods (16 hours) and warm nights (18^{o}C) are conducive to the highest yields of high quality myoga flower buds.

6.4 Planting

Myoga is vegetatively propagated using rhizome cuttings. It is possible to achieve up to twenty fold increases in rhizome weight during one year using initial rhizome pieces as small as 20g. In Tasmania, planting of rhizome cuttings should be completed by the end of August.

To achieve maximum yield of flower buds in the first year, the plants must be at least 100g and preferably intact plants weighing 150 to 200 g should be used. Intact plants tend to contain sufficient reserves to allow uniform and vigorous growth in spring, which is essential if reasonable yields are to be achieved in the first year after planting. Currently, all planting material is owned and supplied to growers by Agrilink Asia Pacific Pty Ltd.

Myoga is best grown on formed beds 1.2m wide and 0.8m between beds. This arrangement with 2 rows of myoga per bed, planted at 400mm intra row spacings has proven to result in high first year yields and a manageable system at harvest, with the alleys providing suitable access to pickers. Plant density may need to be reduced in later years to avoid excessive competition between plants and to provide reasonable access at harvest. Later year plant densities recommendations are currently being formulated.

6.5 Mulching

Mulch has been shown to be essential to ensure optimum colouration of the flower buds and hence flower bud quality. Without mulch, as the flower buds emerge they quickly develop a dark green colour (chlorophyll) and do not exhibit the pinkish blush typically associated with anthocyanin development. Open mulches such as wood shavings and leaf litter at a depth of 10cm has been demonstrated to result in optimum colour development. Finer mulches such as sawdust result in pale buds and mulch particles frequently lodge within the bracts of the emerging buds, making washing very tedious. Aged mulches are preferred and all should be assessed for phytotoxicity prior to applying. Mulch can be spread by hand, blower or by muck spreader.

6.6 Pest and Disease

The most serious fungal diseases, reported in the literature, are *Pythium zingiberum*, causing a root or rhizome rot, and leaf spot or "blast" caused by *Pyricularia zingiberi*. Myoga is also known to be susceptible to Cucumber Mosaic Virus (CMV). The myoga crops being grown in Tasmania, in the foundation nursery, have been tested free from CMV.

Some slug damage is reported in early spring and after periods of extended rain but control has been readily achieved using commercially available repellants and baits. No other pests or diseases have been widely reported in the literature or observed to date in plantings either in Tasmania or NSW.

6.7 Irrigation and Nutrition

Myoga producers a very vigorous and dense canopy of pseudostems early in the growing season and then goes on to produce a vigorous rhizome "mat" and high yields of flower buds. While there are few references in the literature to specific irrigation or nutrient requirements for myoga, from the above observations on growth, it would be expected that a reasonably high input of fertilisers and irrigation/rainfall would be required to support the vigorous growth typical of myoga. However, excess nitrogen may produce overly vigorous vegetative growth, suppress flower bud growth and cause lodging at harvest. While crop nutrition was not the focus of the current project, routine sap analysis was conducted and the following results were typical seemingly "healthy" plants growing in the field at New Norfolk, Tasmania or in glasshouses at the University of Tasmania, Hobart, Tasmania;

Nutrient (ppm)	Glass House	Field	Glass house	Field
	25 Nov	25 Nov	21 Jan	21 Jan
Nitrate	544	1580	693	1210
Phosphorus	237	192	342	332
Potassium	5140	5680	2700	3330
Calcium	35	31	62	40
Magnesium	567	413	1147	763
Zinc	7	4	7	7
Boron	4	4	3	3
Sulphur	147	153	290	327
Copper	1	1	1	1
Manganese	235	194	67	104
Iron	2	3	2	2

[1998/99 Season Myoga, Samples Analysed by Serve-Ag Pty. Ltd., Devonport Tasmania, 7310]

As mentioned above, myoga is grown under a thick layer of mulch. This mulch layer may add a level of complexity with respect to irrigation and nutrition. Firstly, depending on the age and stage of breakdown of the mulch, significant quantities of nitrogen may be tied up in the process of mulch breakdown. Secondly, experience shows that given the soil is covered with a thick layer of mulch, growers have difficulty judging soil moisture levels and irrigation needs. Combining this difficulty of interpretation of irrigation needs with the observation that myoga is very sensitive to soil moisture stress, with stomates closing early in the day even under mild humid climates, growers should be encouraged to install soil moisture monitoring equipment (e.g. tensionmeters, enviroscan, etc)

6.8 Shading

While myoga is typically grown in open fields in Japan, under Australian conditions full light intensity causes severe damage to pseudostems. Therefore, it is essential that myoga be shaded and artificial shadecloth that provides between 30% and 50% shade has proven successful in the production of high yields and quality flower buds. Excessive shading, greater than 50%, has been observed to decrease flower bud yields under glasshouse conditions in Tasmania.

Shade structure used in Tasmania have been constructed up to 5000 m^2 and consist of 50% shade - knitted green sarlon shade cloth, treated poles, strained wire cables and associated wire work. Shade cloth can be machine stitched together or provided from the manufacturer in custom sized sheets.

The semi commercial shade structures in NSW consists of steel frames supporting 50% shade – woven aluminium thermo/shade cloth. The shade structure was custom build and is designed to allow the shade cloth to retract during periods of high wind. The ability to remove shade might be an added advantage for crop growth, under low light conditions.

6.9 Varieties of Myoga

While it is uncertain whether clearly described varieties exist, there is some evidence from the Japanese literature that there are different varieties cultivated in Japan. Maeda (1994) in describing the response of myoga to photoperiod and night temperature refers to an “early” myoga type. While there has been little focus on variety types in the present study, at least two “types” of myoga have been identified. The original importation of plants consisted of a “type” now referred to as an “inferior type” due to early senescence that occurs in mature plants of this “type”. In these plants, senescence begins prematurely in autumn and importantly, prior to completion of flowering. A later importation of myoga, known as the “superior type” does not exhibit this premature senescence under Australian growing conditions. Field observations in NZ where the “inferior type” was also observed and field observations combined with laboratory and glasshouse trials in Tasmania, suggest that the senescence is not a disease factor but rather a “physiological condition” which is not transmitted between “types”. While this issue remains unresolved and is the focus of ongoing research, it is interesting to note that Maeda (1994) reported that the “early” variety used in Japanese trials, senesced much earlier when grown under short day conditions compared to long day conditions and that in some cases 1 year old plants behaved differently to more mature plants. These observations are consistent with observations in the present investigation. Therefore it maybe that there are different “types” of myoga in commercial production and that they may vary in their requirement for photoperiod. Accordingly, it is of utmost importance that any new importations of myoga are assessed for their suitability for sustained production over several seasons as plants mature, prior to being released into commercial production. This is essential if the Australian industry is to avoid the problems encountered with the original importations, and perhaps those problems that have limited development of the industry in NZ.

6.10 Harvesting

Flower buds are picked by hand as soon as they emerge through the mulch layer. If harvesting is delayed much beyond this time, flower buds become deep green on their tips and rapidly progress to anthesis. Green and flower buds with emerged inflorescences are not marketable. Highest quality myoga flower buds are large and plump, with a distinct pink to crimson colour, weighing between 15 and 20g. Harvesting during the peak of the season should take place every 2 to 3 days. A typical yield profile during harvest is as follows;

Harvest Date	Yield A Grade Flower Buds(kg)
23/2/99	2.0
26/2/99	3.0
3/3/99	3.0
6/3/99	5.1
10/3/99	6.75
14/3/99	3.75
18/3/99	5.1
22/3/99	3.1
29/3/99	3.0

[Yield profile over at harvest, Albion Park, Trial Site, 1998/99]

Experienced pickers will harvest 10kg of flower buds per hour and are able to exercise judgement and only harvest the highest quality flower buds – often leaving smaller flower buds to later harvests. At harvest, the flower buds are picked into containers which are easily cleaned and transported and contain about 5kg of flower buds.

6.11 Post Harvest Handling

Freshly harvested flower buds are transferred to cool rooms quickly after harvest and all field heat removed. Flower buds are then washed in cool water to remove any soil or fragments of mulch, especially fragments that often lodge in the opened bracts at the tip of the flower buds. Washed flower buds are stored at 4^{o}C until they are graded using Japanese quality standards. QA is guided by "grade charts" and essential criteria include shape, weight and colour.

Myoga destined for export to Japan is inspected for possible pest contamination by officers of Australian Quarantine Inspection Service prior to the issue of a phytosanitary certificate that is a requirement of the Japanese import authorities. Any premises used for myoga packing and AQIS inspection purposes will require AQIS certification.

Myoga which has been packed and inspected is stored at 4^{o}C prior to shipment.

Figure 2 "A" Grade Flower Buds, Albion Park, 1999/2000

6.12 Packaging

The graded flower buds are packed into clear clip – top retail packs of 75 to 150g each and these packs are packed into protective cardboard outers. Ongoing research and development on post harvest handling and packaging at the University of Tasmania will focus on refining storage temperatures as well as use of wraps to extend shelf life. Preliminary results suggest that optimising storage temperature and applying various permeable wraps may significantly increase shelf life.

Packaging and labelling have been designed to meet market requirements and regulations in both Japan and Australia.

6.13 Flower Yields

While good yields of flower buds have commonly been achieved in glasshouse trials in Tasmania and yields between 10 and 15t/ha are reported in the literature, until the 1998/99 trial in NSW, there were no yield data available for Australian myoga production.

The 1998/99 NSW trial planting consisted of 100 plants each weighing about 100g, planted at Albion Park, NSW on 16 September, 1998. The site was selected following inspection of the soil type, shelter from wind, general aspect and topography, the strong commitment of the owner and farm manager and IMPORTANTLY, the fact that the site has a climate that falls within the range considered ideal.

Trial Plot Yield 16Feb to 2 Mar, 1999	Albion Park, NSW 1998/99
A Grade Flower Buds (kg)	35
% A Grade Flower Buds	89
Total Yield (kg/100 plants)	39
Yield/Plant(g)	390

The yield of 390g/plant if extrapolated to one hectare (25,000 plants/hectare) gives a yield of 9.75t/ha. Obviously there are shortcomings associated in extrapolating from such small plots, however, this yield and the high percentage of A Grade flower buds is considered exceptional for a first year planting. While reliable Australian yield data will only be available after several production cycles/seasons, the 1998/99 trial at Albion Park provided encouraging evidence that good yields can be achieved in Australia.

7. Marketing Issues

7.1 Australian Market

During the course of this project (UT-17A) the industry partner with responsibility for development of marketing (Mr RA Warner, Agrilink Asia Pacific Pty Ltd) visited Brisbane, Sydney and Melbourne to assess the market for myoga and to appoint a distributor and promoter in each city. Australia has approximately 35,000 permanent Japanese residents of which 80% (28,000) live in Sydney, mostly in the northern suburbs. In addition, almost 800,000 Japanese visit Australia each year, most spending time in Sydney, Brisbane and Melbourne. Myoga is not available commercially in Australia and imports of myoga are prohibited without meeting exhaustive quarantine requirements.

Following the emergence of the relatively small quantity of flower buds from the University of Tasmania glasshouses, the Albion Park site and from the Tasmanian shade house in February/March 1998, it was decided to concentrate all marketing activities in Sydney. The test marketing in Sydney had the marketing objectives of testing the acceptability of the product, packaging, market potential, distribution and product awareness, and promotional issues.

As the quantity of myoga flower buds was limited in this season, the specialist market research company a Principal of the company Enterprise Marketing and Research Services, Associate Professor Tony Hocking, was engaged to assist design the marketing plan. A Sydney specialist fruit and vegetable wholesaler was engaged to receive, store and distribute myoga to restaurants in Sydney and to gather marketing information that was used in the development of the marketing plan. A myoga product information booklet was produced and supplied to the wholesaler for dissemination to customers. Also, Mr Hideo Dekura of Japanese Functions of Sydney was engaged to provide advice on myoga packaging, labelling and to carry out visual and taste tests of Australian grown myoga. Mr Dekura was provided with myoga for use in cooking schools he regularly conducts in Sydney.

Test Market Specifications for Myoga in Sydney

The most important criteria in assessing myoga quality are flavour, colour, aroma, bud size and shape and maturity. Mr Dekura has reported on the excellent flavour, which is not as strong as some Japanese myoga, attractive colour with good cover of bright pink, fresh, ‘young’ aroma, similar to Kochi myoga in Japan. The wholesaler was excited about the potential of myoga and confirmed the views provided by Mr Dekura. However, the wholesaler cautioned about expectations of rapid growth as he has encountered hesitancy with some restauranteurs to unreservedly take up the use of myoga. He advised the use of a respected non Japanese chef to assit with promotion of myoga in Sydney in 2000.

Assess myoga price acceptance in the Sydney market

A viable commercial wholesale and retail price has been established in the Sydney market place. Uncertainty about the product and its uses rather than price is the barrier to growth of myoga sales in Sydney.

Extrapolation of potential market demand in Australia

Based on the information received from the product test marketed in Sydney in Februray/March 1998, the following quantities could reasonably be expected to be sold in the Australian market. Melbourne and Brisbane markets were supplied with limited quantities of myoga in March/April 2000 from the increased quantity that was harvested from the Albion Park site. Distributors in both cities have been appointed to distribute the crop.

Forecast Australian Myoga Market (kg) – *forecast by Agrilink Asia Pacific Pty.Ltd.*, September 1999

	Melbourne	Sydney	Brisbane	Total
2000	200	400	100	600
2001	300	500	200	1000
2002	500	800	400	1700

Packaging

The packaging, which is based on existing materials used in Japan, includes clipover clear plastic punnets, each containing 150g with 12 punnets per carton. Ten cartons were packed in an outer carton. Labelling included brightly coloured labels on each punnet which meet the Australian labelling requirements. The packaging allows the product to be transported without damage, easily cooled and is attractive when displayed. The punnets allow the user to reseal the package as individual myoga flower buds are consumed. A consumer guide has been developed in the form of a leaflet for use in the Australian market in 2000.

7.2 Japanese Marketing

As a result of the 'condition' affecting the original myoga plants and the decision to destroy these plants and replace them with superior plants from New Zealand, the second production and marketing visit to Japan was deferred until late 1999. This visit coincided with the first commercial shipments of Australian grown myoga to Japan.

Following the successful production of the small quantity of flower buds in March 1998, a sample consignment of two cartons, each containing 12 punnets of 150g each was sent to Japan. The purpose of sending this small shipment was not to test the likely level of Japanese interest in the product or the distribution or promotion elements of the marketing strategy, but to uncover any major issues (e.g. quarantine, cool chain handling, packaging, import procedures, etc), prior to larger volumes of product coming on stream. Also, this trial shipment allowed Australian quarantine officials and Agrilink Asia Pacific Pty Ltd the opportunity to become familiar with the product and to develop an export protocol for use in future years. Quarantine officials were invited to the site to inspect the growing plants in 1998/99, observe harvest activities being undertaken, inspect packing and storage facilities and to discuss product inspection procedures to ensure all Japanese import requirements were met.

The consignment was also used to familiarise the freight forwarding company with myoga and to provide product for assessment in Japan by Japanese Quarantine Authorities and to test import distribution.
The consignment was finally used for taste and visual assessment by Japanese food technologists who confirmed the product was suitable for the Japanese market. In particular, the Japanese assessors praised the shape and colour of the flower buds but indicated the flower bud size could be larger.

Prior to shipment, each individual flower bud of this consignment was recorded on photograph and linked with separate punnets to ensure any problems that arose could be tracked back to the source.

The Japanese Market Opportunity

Figure 1 Myoga Supply at the Tokyo Central Wholesale Market 1993 (tonnes).

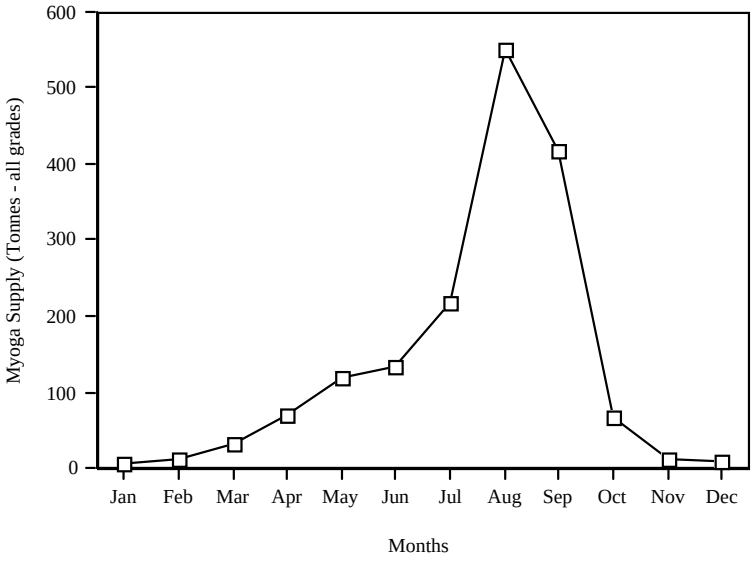
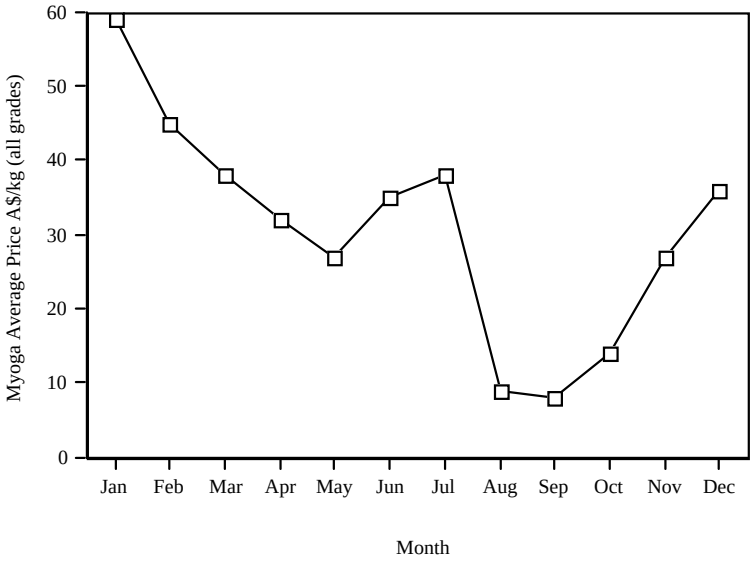


Figure 2 Myoga Average Price $A/kg (all grades) from the Tokyo Central Wholesale Market 1993 (exchange rate 70 Yen:$1A)



Forecast Production

Following the successful harvest of flower buds from the glasshouse trial production in Hobart, the shade house at New Norfolk in Tasmania and the Albion Park trial production site in New South Wales using superior myoga plants from New Zealand, the following production forecasts have been made;

Forecast Production and Growers – *forecast by Agrilink Asia Pacific Pty.Ltd., August 1999*

	1999/00	2000/01	2001/02	2002/03	2003/04
Number Growers	2	4	6	6	6
Capacity(ha)	0.5	4	12	12	12
Yield (t/ha)	0.5	2	5	10	10
Total Yield(t)	.25	8	60	120	120

The first commercial grower, in conjunction with Agrilink Asia Pacific Pty Ltd, has developing the first production unit, complete with shade house and packing facilities, at Albion Park in New South Wales.

8. Recommendations

Prior to the commencement of project, UT-9A (1994-97), it was not known whether or not myoga would flower in Australia. There was considerable speculation by the industry partners that either the environmental conditions were unsuitable or that particular aspects of the production protocol were deficient (eg excessive vegetative vigour arising from untimely and over abundant application of fertiliser nitrogen). During the course of this project, UT-17A (1997-99), it has been demonstrated conclusively that myoga will flower not only in Tasmania but in other regions of Australia and that the flower buds produced are capable of meeting the highest Japanese standards.

A most significant finding arising from this project has been the early identification of the defect "condition" associated with the inferior "type" of myoga. Failure to identify this "condition" in New Zealand has led to an exodus from the industry of all but one grower and has resulted in the loss of significant grower invested funds. The approach adopted during project UT-9A involved research visits by both researcher and industry partner, to both New Zealand and Japan. All visits yielded significant research and commercial outcomes that in turn have enabled the emerging industry in Australia to avoid almost certain disasters. The "condition" was identified and confirmed during consecutive visits to New Zealand in 1995 and 1996. The superior myoga type was also identified during these visits and a small quantity was imported to Australia in 1996.

This project allowed the multiplication of the superior myoga type, the successful production of flower buds from three trial production sites in Tasmania and New South Wales and the successful acceptance of Australian grown myoga in the Australian and Japanese markets.

It is planned to make further production and marketing visits to Japan, to finalise marketing arrangements for the marketing of Australian grown myoga.

Forced myoga production techniques will be investigated during these visits. The ability to alter and control production periods by manipulating cultural practices has profound implications for the Australian Industry in that the harvest date can be spread evenly over the months of highest demand in Japan. Finalising research and industry contacts in Japan to further the investigation of the "forced myoga" production has proven difficult, despite many attempts and varied approaches. However, arrangements are currently being confirmed with Japanese associates,Tassal Japan Ltd for potential visits to investigate "forced myoga" production.

A successful application has been made for an Australian Postgraduate Award (Industry) and this project commenced in December 1999. This APA (I) application focused on unresolved research issues, mainly relating to the flowering model, agronomic issues, "forced myoga production, extending harvest dates, post harvest storage and ongoing study of the differences between the "superior" and "inferior" types. Agrinlink Asia Pacific Pty Ltd has agreed to provide industry cash and in-kind funding for the duration of this award.

In addition, a voluntary research and development levy will be introduced by Agrilink Asia Pacific Pty Ltd on all product sold. The levy will be introduced in 2000/01 and will form an integral part of the industry structure.