RURAL INDUSTRIES RESEARCH
& DEVELOPMENT CORPORATION

Canaryseed

industry development for south-eastern Australia.

A report for the Rural Industries Research and Development Corporation

by R.M. Norton and J.F. Ford

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Researcher Contact Details
Dr Robert M. Norton
The University of Melbourrne
RMB 3000
Horsham VIC 3401
Phone: 03 5362 2207
Fax: 03 5362 2213
Email: rnorton@unimelb.edu.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: http://www.rirdc.gov.au

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Foreword

Farmers in the 400 to 500 mm rainfall zone are continually searching for profitable new crops to include in rotations. An example of their willingness to adopt new crops is the increase in lentil area sown, which is now almost 130,000 ha across the Victorian and South Australian cropping regions. The success of the adoption of new crops, with the development of new industries to process, market and export these crops, is contingent on grower confidence in the production and marketing systems that supports the crop. This research evaluates another crop option for farmers in the region. Most significantly, it links research, market development and information sharing using the model of industry development proven with the development of the lentil industry.

Canaryseed (*Phalaris canariensis*) is a minor crop in Australia, with production of around 10,000 t annually. The seed is sold into the international birdseed trade and prices tend to fluctuate in response to supply. Even though the market is highly discriminating, there are no quality criteria published, nor are guidelines available for growers to assist them meet market demands. While the crop is quite well adapted, there has been no systematic investigation into its management, integrating production protocols with market signals on product quality. More reliable production systems will provide growers with confidence in the crop, which inturn gives marketers security of supply of a quality product, enabling market development to occur with confidence.

This project was developed to thoroughly investigate the potential for establishing a canaryseed industry in southeastern Australia. It has adopted an integrated supply chain approach to the development of the industry with key partners providing input on variety development, crop agronomy, quality standards, marketing and grower liaison. The objective of the project is to provide farmers in southeastern Australia with a management and marketing package for canaryseed. This package includes aspects of sowing times, crop protection, variety performance, harvesting and marketing information on the crop.

This project was funded from RIRDC Core Funds, which are provided by the Federal Government. The industry partners in the project were The Lentil Company and The University of Melbourne.

This report, a new addition to RIRDC's diverse range of over 700 research publications, forms part of our New Plant Products R&D program, which aims to facilitate the development of new industries based on plants or plant products that have commercial potential for Australia.

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Peter Core
Managing Director
Rural Industries Research and Development Corporation

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This work would not have been possible without the support and interest of The Lentil Company, and in particular the directors and staff of that organisation. The foresight of Peter Blair and Wayne Beddison in taking up the marketing challenge of this crop is another example of how rural businesses can capitalise on local expertise and keep the benefits in local communities, which then flow through to that state and national economies. This report has also had significant contributions from Peter Semmler, Janine Carter and Rob Launder, all of The Lentil Company.

John Ford has used this research project as the basis of his Masters in Agricultural Science course, through The University of Melbourne, Department of Crop Production. The Department provided support and resources to John over the duration of his candidature. John has been supervised by Dr Rob Norton, and he has also drawn extensively on the expertise of Dr Ray Flood (Victorian Department of Natural Resources and Environment) and Dr Susan Knights (The University of Melbourne), both of whom acted as co-supervisors. The authors would also like to thank Dr Knights for her comments and expert opinion in chapter four of this publication.

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The Victorian Institute for Dryland Agriculture, through the Joint Centre for Crop Improvement, made available resources to support the phenology studies.

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Canaryseed opportunities:

Canaryseed is a crop suitable for production in the Wimmera, particularly the higher rainfall southern Wimmera regions. The market for canaryseed appears to be around 10,000 t domestic and 20,000 t for export. The current levels of production in southern Australia are low and this level is a reflection of the prices paid to growers for canaryseed compared to other grains.

Canaryseed quality

Quality criteria have now been developed for domestic and export markets, with two grades of canaryseed described for each market. These criteria have been tested by The Lentil Company and found to meet the needs of their export and domestic customers.

Agronomic issues

The future development of the industry in southeastern Australia is significantly constrained by lack of chemical options for annual ryegrass weed control in-crop, and through this research, management practices have been proposed to improve the crop competitiveness in this area. The agronomic issue is to produce a vigorous crop to compete against weeds, while balancing this early growth against water supply for grain filling later in the season and reducing height to minimise lodging.

Our research indicates that this balance can be somewhat met by sowing at rates of less than 30 kg/ha.

The crop has a low harvest index, typically in the order of 0.15 to 0.25 and management should aim to maximise HI by restricting vegetative growth.

Our limited data suggests that nutritional requirements are similar to wheat although growers would be discouraged from over application of nitrogenous fertilizers (> 30 kg/ha) as it can lead to crop lodging, which reduces seed quality and makes harvesting more difficult.

Growth regulators have some effect on stem height of canaryseed and their use warrants further investigation.

Development patterns and sowing times

Some genotypes exhibit a slight winterness (vernalization requirement) which means that canaryseed would not be suitable for late spring sowing.

Canaryseed has a similar temperature and photoperiod requirement to commonly grown wheat varieties, which suggests that it is suitably adapted for this region.

Later sowings (mid-June and later) have produced better seed yields than earlier sowings (May/June), although these sowing times can lead to low yields due to reduced moisture availability in dry springs. Early sowings tend to lodge, can become infected with powdery mildew and increase the exposure of the crop to frost damage at flowering and during early grain filling.

The selection of sowing times has implications for weed management, with later sowings providing growers with the opportunity to use pre-crop options such as cultivation, grazing or non-residual herbicides to control grass and broadleafed weeds.

Germplasm and cultivars

The commonly grown cultivar - Moroccan – yields around 1.5 t/ha under good conditions, while the glabrous line CDC Maria yields approximately 90% of Moroccan. An evaluation of several lines indicated that two lines, CA 984 and PI 175982, have a 20% yield advantage over Moroccan. Further work is proposed to develop these lines further.

High yielding lines for future development should involve the introgression of the "glabrous" trait, as this provides relief from the hazardous silicified trichomes that are present on the seed coats all lines tested except CDC Maria.

The future of the canaryseed industry is contingent on the continued development of markets, and there would appear to be solid long term markets in Asia, Europe and North America for small, high quality parcels of grain. The Australian product is recognised in these markets with acceptable quality, and holds a small freight premium compared to canaryseed from Canada.

With improved grower acceptance, due to more reliable production methods, the southern and central Wimmera has the production capability to meet this increased interest in the market.

Introduction

Farmers in the 400 to 500 mm rainfall zone are continually searching for profitable new crops to include in rotations. Farmers in these regions have shown willingness to adopt new crops, such as lentils, which have increased to almost 120,000 ha across southeastern Australia. The success of the adoption of new crops, with the development of new industries to process, market and export these crops, is contingent on grower confidence in the production and marketing systems that supports the crop. This research provides another crop option for farmers in southeastern Australia. Most significantly, it links research, market development and information sharing using the model of industry development proven with the development of the lentil industry.

Norton *et al.* (1998) provided an overview of the importance of developing new crops as farming systems altered in response to new husbandry systems, changing commodity prices or diseases in particular crops (e.g. *Ascochyta rabei* in chickpeas). They identified that the Wimmera was able to grow a wide range of cereals (wheat, durum wheat, triticale, oats, rye, barley, canaryseed), pulses (field peas, beans, chickpeas, lentils, fenugreek, vetch, lupins) and oilseeds (canola, mustard, safflower, linseed/linola) as well as annual and perennial pastures. In certain years sunflower and sorghum have also been successfully produced.

For a crop to fit into a farming system, Norton *et al.* (1998) proposed that the criteria that should be met. These are:

Machine planted and harvested, using existing equipment with only minor modifications.
Winter and spring crops, probably with a cold or long day length requirement.
Robust integrated weed, pest and disease management programs.
Low crop weed potential.
Produce a product or commodity that can be marketed successfully.

Of those criteria the marketing aspect is paramount. Without a potential market, the crop has no use. Alternatively, if there is no commodity available, a market cannot be developed. The market pull and the production push act in concert to develop new niches for commodities within existing or new markets, domestically and internationally. As a result, the approach when investigating new crops has been to seek partnerships with existing marketers who know what is demanded or have the capacity to develop new markets. The development of a stable industry will require that supply and demand be nurtured in tandem, and that marketing and agronomy are equally important in the development of new industries.

It is within this context that the research on canaryseed was conducted.

A small group of farmers in the Wimmera have been producing canaryseed over the past few years, with the current area estimated at 500 ha. Prices (approximately $500/t) and crop yields (1.5 t/ha) make the crop an attractive proposition in the wetter (>420mm) areas of the Wimmera, the Western District and lower south east of South Australia. The crop appears reasonably well adapted, although there has been no systematic investigation into the management of the crop. The crop is at the stage where it requires production and marketing support to develop into a significant crop option for growers. It is therefore at a similar stage to the lentil industry in the late 1980's, where there was uncertainty about continuity of supply due to untested production systems. This constrained investment in the development of markets for that crop. The Lentil Company (TLC) successfully established the lentil industry on a basis of integrating production, processing and marketing. This in turn has returned significant benefits to the rural and wider community. This research project has adopted a similar approach to the development of the canaryseed industry, by adopting a supply chain approach to the industry.

Canaryseed fits into current production systems, and can be sown and harvested with conventional equipment, producing yields between 1.4 and 2.0 t/ha. Canaryseed is reported to have good tolerance to soil salinity. Some current production problems (lodging, herbicides, nutrition, rotation) have been identified as constraining the expansion of the area sown, and this research aims to develop appropriate management practices to produce quality seed for export and domestic markets. The project establishes production protocols for this region. The fieldwork has attracted considerable grower interest and this has been complemented by TLC's grower support scheme.

Current production systems are untested, and the market for the product has been volatile, with prices ranging from $370/t to $750/t in the past few years. This is thought to be a consequence of variable production conditions in Queensland and northern New South Wales where the canaryseed is grown as an opportunity crop. Shifting the production base for this winter crop to a winter rainfall zone should provide better yield stability, ensuring product security for marketers and processors. Once the supply of product is secure, a viable industry can be developed to meet domestic markets initially and then flow on to new export markets.

The strategy to achieve the establishment of a value-adding industry based on canaryseed is to co-operatively develop the production protocols with existing grower networks, particularly through the existing client base of TLC. This company has approximately 250 grower clients in regions though suitable for the production of canaryseed. As well as using existing expertise, the field sites were used as focus for information sessions with growers.

Commercialisation of the canaryseed industry will be principally through TLC by active market development. The objective is to match the size and quality requirements of the market with the capacity of the production systems developed. It is proposed to develop strategic alliances with Canadian canaryseed exporters, and this will facilitate market penetration into existing markets. To develop such alliances, two trips were undertaken to discuss the Canadian industry as part of the market research. The commercialisation will also involve investigation of value adding opportunities such as seed cleaning and the use of glabrous types of canaryseed.

This report details the steps taken during the project, and discusses the key issues addressed. The first chapter gives some background on canaryseed, while the second chapter provides an analysis of the market potential for canaryseed, with the development of appropriate industry standards for quality. Through the project, we accessed and did some preliminary evaluations on a range of seedlines and this is discussed in chapter three. The fourth chapter reports on detailed phenology studies of canaryseed, compared to wheat, which will assist in the identification of appropriate sowing times and production districts.

From the market development research, it was identified that seed size is a key aspect of the quality and marketability of canaryseed, and chapter five reports on experiments aimed at agronomic packages to help maintain the seed size and colours demanded by the market. Chapter six provides a summary of some of the activities involved in market development and communication of the research to farmers and other stakeholders.

1. Canaryseed Background

Canaryseed (*Phalaris canariensis*), also known as canary grass, is a cool season annual crop, originating in the Mediterranean region. It has a growth cycle similar to wheat and oats, and has been grown over a limited area within southeastern Australia. At present, there are approximately 500 ha of canaryseed produced in southeastern Australia and virtually all of this is in the Wimmera region. Local yields have been in the range of 0.5 to 2.4 t/ha depending on season, and based on its current performance, it is thought the crop has potential in the winter rainfall areas with 400 to 500 mm annual rainfall.

Canaryseed is a member of the sub-tribe *Phalaridinae* within the tribe *Aveneae*, subfamily *Poaideae* family Poaceae. The genus *Phalaris* includes several species of significance to agriculture. The most important is the perennial pasture species *Phalaris aquatica*, which is one of the most widely grown grasses in southern Australia (Cade 1982). Reed canary grass (*P. arundinacea*) is occasionally grown as a pasture species in swampy areas. Lesser canary grass (*P. minor*) and bristle-spiked canary grass (*P. paradoxa*) are both weeds. Lesser canary grass is a significant weed in southern Australia, particularly on heavier soils in moderate to high rainfall regions such as the southern Wimmera. A comparison between the various species is given in table 1.1.

Table 1.1: Distinguishing features of phalaris species (from Cade 1982).

Species	**Rhizomes (underground runners)**	**Seed heads**	**Outer glume**	**Base of stem**
P. aquatica **Perennial**	Present	70-150 mm long	Wings about half as long as glume.	Swollen; exudes pink sap if cut.
P. arundinacae **Perennial**	Present	70-150 mm long, branching.	No wings.	Not swollen; exudes pink sap if cut.
P. minor **Annual**	Absent	30-60 mm long	Wings about half as long as glume.	Not swollen, no pink sap.
P. paradoxa **Annual**	Absent	50-10 mm long, bristly	Wings and glumes both pointed.	Not swollen, no pink sap.
P. canariensis **Annual**	Absent	15-40 mm long	Wings about two thirds as long as glume.	Not swollen, no pink sap.

Our approach to developing canaryseed as a crop has been to develop a model to address some agronomic and quality goals. Even though it is not within the scope of this project to set goals for the breeding of new canaryseed cultivars, we have used an approach of comparing current canaryseed cultivars to other cereals, particularly wheat, grown in southeastern Australia. This approach enables the challenges associated with the establishment of canaryseed within southern Victorian cropping rotations to be clearly stated so that management can address those issues.

Understanding the phenology

All commercial crop cultivars each have slightly different phenology that make them more or less suitable to any one sowing date. To maximise seed yield a crop must maximise dry matter production and mature prior to onset of high temperatures and summer drought, while flowering late enough to avoid spring frosts. To do this, any one cultivar has a unique set of responses to temperature, photoperiod and vernalisation. There has been little published on the phenology of canaryseed, and this report provides information about the response of canaryseed to the southern Australian environment.

A canaryseed variety that would be suitable for May-June sowing would be a variety with similar phenology to Rosella and Lawson, two commercial winter wheats that are commonly sown early in southern Victoria. Such a variety would have a slight vernalisation requirement and similar response to temperature and photoperiod to Lawson and Rosella. On the other hand, a variety suitable for sowing in June-July would have a similar phenology to that of Arapiles barley; showing a strong response to increasing temperatures and photoperiod length with little or no vernalisation requirement. A variety suitable for August-September sowing would have to be more sensitive to photoperiod and temperature than early and mid season canaryseed varieties to ensure that it matures prior to terminal summer drought. Schooner and Clipper barley are sown in late winter or early spring in southern Victoria to escape winter waterlogging. Both barley varieties show greater sensitivity to temperature than do mid or late season barley, suggesting that a canaryseed variety with a similar phenology would be suitable to be sown in late winter or early spring.

Strong early vigour

Early vigour in this publication is defined as the ability of a crop plant to achieve full ground cover early in development through rapid growth. Crop species with strong early vigour are more able to out compete other cohabiting species for light and available nutrients. Canaryseed appears to be a relatively poor competitor against grass weeds and this, combined with a lack of herbicides for in-crop weed control mean that good yields and quality in canaryseed will be assisted by increased vigour. An ideal canaryseed variety would have early vigour similar to that of barley. Unfortunately, probably because of small seed size, canaryseed early vigour up until the beginning of stem elongation is poor (Putnam 1996). Crop vigour can be improved in wheat by increasing plant density so that full canopy closure is achieved earlier (Carlson and Hill 1985). Increasing sowing rate may assist in alleviating poor early vigour in canaryseed crops in southern Victoria.

Increasing harvest index

Harvest index is a measure of how well a crop plant is able to convert dry matter into grain yield. Cereal breeders have increased harvest index by breeding plants with larger heads, larger grains, shorter and fewer culms and with better adaptation to local environments (Siddique *et al.* 1989). As a relatively new crop to the area, canaryseed has made only modest gains in efficiency of growth to yield compared to wheat. This highlights the need for change in canaryseed morphology and environmental adaptation. For the incorporation of desirable traits into canaryseed, the traits must first exist in collections of canaryseed accessions and related species throughout the world. Unfortunately for the future development of canaryseed, there has been very little genetic variability was found in the largest collection of canaryseed accessions and its closest relatives *P. brachystachis* and *P. truncata* (Matus 1999). Putnam (1996) suggests that hybridisation, mutagenesis and further plant collecting could provide sources of variation for breeding programs. However, to incorporate all desirable traits using these techniques would be very time consuming and require a substantial financial investment.

Crop management can alter harvest index, particularly practices such as sowing rates, time of sowing and crop nutrition. Some of the experiments described evaluate the impact of these practices on improving harvest index.

Resistance to lodging

Lodging reduces yield by limiting canopy light interception and increasing the rate of senescence within the canopy. Semi dwarf varieties of wheat, oats and winter barley can grow tall enough to lodge in southern Victoria because of the long growing season. A tall growing crop such as canaryseed with a slender weak stem is particularly susceptible to lodging in southern Victoria.

An ideal canaryseed plant would have a culm that is short and strong stemmed but current varieties are capable of growing to 1.9 metres in height and are weak stemmed (QDPI 1996). In the absence of a desirable variety it is possible to increase canaryseed plant density and reduce culm height (Holt 1989). Increasing plant density in canaryseed crops in southern Victoria may be a suitable management strategy to reduce lodging.

Large seededness

The visual appearance of canaryseed alone is of paramount importance to the successful marketing of canaryseed (see chapter 2). The birdseed trade requires seed with a golden brown colour, rounded and plump in shape. Maximising seed size will be a priority if southern Victorian canaryseed is to compete successfully against other sources of canaryseed. Our research has investigated the differences in quality within a range canaryseed cultivars. Furthermore, we have investigated the effects of high plant densities and late sowing on the seed size of canaryseed. Of particular interest here is an investigation of the effects of increasing crop vigour by raising seeding rates on seed size and product quality.

Absence of trichomes

The hull surrounding the canaryseed kernel is covered with silicified trichomes. These trichomes can become airborne and cause irritation of human skin and lungs. O'Neill *et. al*. (1980) found that canaryseed causes more than just skin irritation. Specifically, canaryseed trichomes were similar to, asbestos and glass fibre, known carcinogenic mineral fibres. Canaryseed trichomes were the likely cause of high rates of esophageal cancer in North-East Iran (O'Neil *et al.*, 1980).

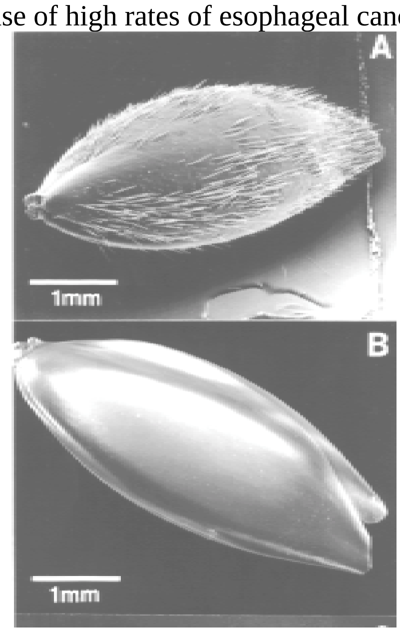


Figure 1.1: Seed characteristics of two canaryseed lines –Keet (A) which is a traditional line, and CDC Maria (B), which is a glabrous (or hairless) line. Both cultivars were developed in Canada by the University of Saskatchewan. Photomicrographs courtesy of Dr P. Hucl, University of Saskatchewan (http://www.usask.ca/agriculture/plantsci/hucl.html)

The evidence suggesting that canaryseed trichomes are carcinogenic agents is significant in the workplace, whether on-farm or in processing. It indicates the need for safety precautions when handling canaryseed. It emphasizes the need to obtain canaryseed cultivars that have a glabrous glumes. A Canadian cultivar called CDC – Maria, bred by Dr Pierre Hucl at the University of Saskatchewan, is currently the only commercial canaryseed cultivar without trichomes (figure 1.1). CDC Maria was by mutagenisis with sodium azide. It was registered in Canada in 1997 and described in 2001 (Hucl *et al.* 2001)

Figure 1.2: Canaryseed grown in experimental plots in 2000 at Horsham (Picture, J. Ford).

2. Markets and Potential Markets

The canaryseed industry in Australia is a relatively small industry, based in the summer cropping areas of Queensland and New South Wales, which produce about 7,500 t of seed (1993/4). Most of the seed is used as a component in feed for caged birds and the price shows large fluctuations in response to supply. Other crops also are produced as a component of caged birdseed, such as *Panicum miliaceum*, *Echinola crus-gallia*, *Seteria italica* and *Pennisetum typhoides*, but these are all warm season crops that would not be suited to the winter rainfall areas of southern Australia. There are also reports that canaryseed has potential as human food (Putnam, Muller and Hulc 1996) and several authors have proposed that future work be undertaken in this area (e.g. Robinson 1978).

The domestic and international markets for millets and canaryseed were analysed from an Australian perspective in 1996 (Twyford-Jones 1996, Twyford-Jones and Horsburg 1996).

Australian Production

Since 1993/4 production figures have been grouped with other crops, but up until then production has been up to 10,000 t (1990/91) and down to 1,800 t in 1991/92. Most of the seed is used as a component in feed for caged birds and the price shows large fluctuations in response to supply, which at retail level has a market value of around $60 million (Twyford-Jones and Horsburg 1996). Other crops also are produced as a component of caged bird seed, such as *Panicum miliaceum, Echinola crus-gallia*, *Seteria italica* and *Pennisetum typhoides,* but these are all warm season crops that would not be suited to the winter rainfall areas of southern Australia. Market research in Queensland (Twyford-Jones, 1996) has shown that traders buy birdseed on price rather than quality and that there is major competition from China. The Canadian's have a different view (Putnam *et al.* 1996) and suggest that world consumption is constant regardless of price, indicating little substitution between birdseed millets and canaryseed.

The selection of the particular seed to be used in the final birdseed mixture shows price sensitivity, with cheaper products substituting as prices fluctuate. Because of this substitution, the apparent consumption of canaryseed by the birdseed industry has varied between 9,000 t (1991/2) and 1,000 t (1992/3) (ABARE, 1996).

Australia has exported up to 1,700 t of canaryseed annually (1992/3), although the average for 1993-96 was about 640 t annually. The main market destinations were Japan, Italy, Taiwan and Indonesia. Exports are very variable and until supply is assured, it is felt that market development will be constrained. Australia was a net importer of canaryseed in 1994 and 1995, bringing in 2,218 t, mainly from New Zealand.

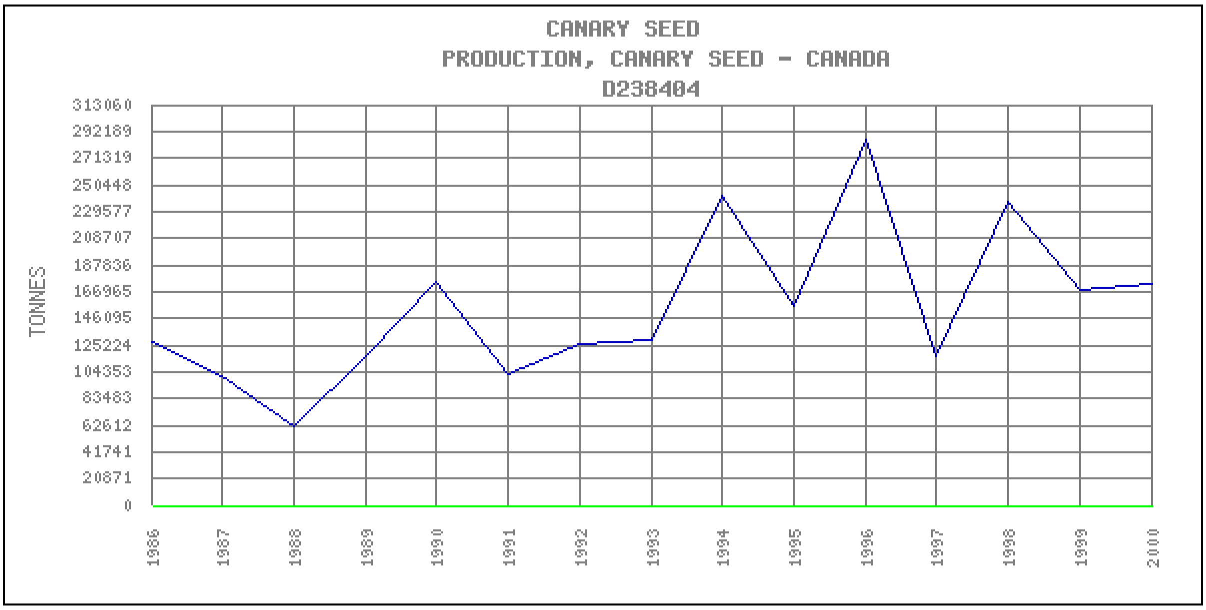
It is expected that the canaryseed industry could realistically produce 10,000 t for the domestic market and another 20,000 t for export. With an average price of $A430/t (which is the present Canadian price of 15 c/pound at an exchange rate of 0.78 AU$ in CA$, no freight advantage given), this would represent the development of an industry from a current farm gate value of $4M, to an estimated $13M. The key competitive elements for Australian canaryseed are through import replacement in the domestic market, and seasonal supply and freight advantages over Canadian product into Asian and Middle East export markets.

Canadian Production

Canada produces around 200,000 t of canaryseed annually, although production fluctuates significantly, in response to prices for all grains. In 2001, the area sown was under 75,000 ha, which is approximately one third of the area sown in 1998 (figure 2.1) and total production for 2000/2001 was estimated at 170,800 t (Stats Canada, 2001). Yields are usually a little over 1 t/ha and this account for about half the world production (table 2.2). Most production is in Saskatchewan (85%), with smaller areas in Alberta and Manitoba. The 6 year average export for Canadian canaryseed is about 115,000 t. which represent about two thirds of the world trade (Saskatchewan Agriculture and Food, 1996). These figures suggest that the world trade is about 180,000 t. The major export markets for Canadian canaryseed birdseed markets in Europe (46,000 t), Mexico (27,000 t) and Brazil (40,000 t). Significant markets exist in Germany, Venezuela, Japan, Taiwan, the United States of America and the Middle East.

Canadian production steadily increased until 1998 when 210,400 ha were sown, until the 2001 expectation is 74,900 ha (Statistics Canada, 2001).

Figure 2.1: Canaryseed production, Canada, 1985 to 2000. Source: Statistics Canada's Internet Site, *http://www.statcan.ca/english/Pgdb/Economy/Primary/prim11a.htm*, extracted June 25, 2001.



The present situation for canaryseed on the international market is quite buoyant with contracts available for canaryseed at around $500/t delivered to Dooen near Horsham. There is an international shortage of canaryseed as a consequence of low Canadian plantings, although as quickly as this short in the market developed, it can be addressed with new season plantings as growers respond to improved prices caused by lower availability.

Market Analysis for Australian canaryseed

The Lentil Company (TLC) has marketed Australian canaryseed into a range of domestic and international locations over the past five years. Since 1998 TLC has actively looked at market opportunities for this product. Results from TLC market research show that Australian canaryseed has two basic types of market, the niche market and the opportunistic market.

Niche market

Specific niche markets that TLC has identified are Western Australia, New Zealand and South Africa. Western Australia and New Zealand have strict weed seed restrictions for product going into their markets. Thus each seed lot must be sampled according to ISTA (International Seed Testing Association) guidelines and tested by an ISTA accredited laboratory. The statement of seed analysis that accompanies the consignment must be free of any specified weeds on their prohibited lists. These lists can change so the marketer has to keep up to date with any changes prior to making a sales contract.

For the New Zealand market, an import permit must be obtained from the Ministry of Agriculture and Forestry, New Zealand. As of February 2000 this contained 86 prohibited weed seeds. Western Australia also has a large prohibited weed seed list. Due to some weed seed problems in Queensland origin product WA had been sourcing Canadian product. TLC has successfully sold southeastern Australian canaryseed into this Western Australian market. However TLC has discovered some deliveries of canaryseed containing weed seeds prohibited for export to WA. These weeds were dock (*Rumex spp.*), tree hogweed (*Polygonum patulum*), and musk weed (*Myagrum perfoliatum*). Thus, paddock selection and agronomic management are vital to achieve sales into these markets. To achieve the right quality it is important that growers receive the advice and know how. It is considered important that the marketer has the ability to segregate and process the right quality grain for these markets compared to the less finicky markets.

Opportunistic market

Opportunity markets are essentially those where Canadian canaryseed is sold. Canada is the world's largest supplier of canaryseed by far. In 1999 their production was 166,000 t compared to 24,000 t from Argentina, the second largest producer (table 2.2). Thus sales to their markets depends a lot on Canadian production as this essential sets the world market price. Any prices to these markets will be more volatile.

The quality of Australian canaryseed is quite acceptable in the market place. Our market research indicates that buyers view Australian product as comparable to Canadian product in New Zealand, South Africa and Spain. However, for European buyers the shipping transit time of 30-35 days is detrimental to market acceptance. The exception is when canaryseed is in short supply and thus prices are high. In this situation European buyers will look for product of origins other than Canada at a reduced price. The European market is thus an opportunistic one.

Marketing Issues

Competitive advantages
Australia has a competitive advantage for delivery of canaryseed to some markets requiring "just in time" stocks. Our proximity to New Zealand (4 day shipping time port to port) and South Africa (14 day shipping time port to port) gives us an advantage over product from Canada to these markets, as buyers are able to minimise their inventory levels. For comparison the shipping time from Canada to New Zealand is approximately 25 days port to port.

Disadvantages
The canaryseed market is very conducive to product substitution when the price rises to high levels. Canaryseed is mostly used in bird food mixtures with other birdseed grains. The highest level it can be used in some bird mixtures is 70%. However birdseed producers tend to reduce the percentage usage of canaryseed in their blends depending on its input price. This is in order to keep the end product price stable to consumers. This means that canaryseed is fairly price elastic, *i.e.* demand tends to drop as price goes up.

Being the major supplier Canada tends to be the price maker. Thus Canadian yearly production, carry in and carry out stocks have an impact here. Also in Europe there is supply from the old Eastern bloc countries, which tends to get “dumped” onto the market at harvest and this can be destabilising. Also Canadian product is often sold FD (farmer dressed) in bulk shipments to European buyers who then clean and pack locally. This makes it difficult for Australian product shipped in containers to compete price wise.

Due to the much smaller size of the Australian crop it is difficult to give the market continuity of supply. Buyers often want a contract with shipments spread over time. This is difficult to do without a sure supply of product from canaryseed growers over the year. To help supply such a market, TLC has entered into a pooling price arrangement with some growers to nullify this problem to some extent.

Pricing

The prices received for Australian canaryseed will be linked to the prices paid for Canadian produce, plus any freight benefit accruing to the markets in which Australian canaryseed can be delivered. The price has fluctuated widely, which reflects the supply and demand pressures, as well as the effect of fluctuations in Canadian and Australian exchange rates. The exchange rate has been close to parity historically, but has firmed around 78 CAD to 100 AUD.

Table 2.1: Comparison of Canadian and Australian prices for canaryseed.

		Exchange Rate (CA$:AU$)				
c/lb	***CA$/t***	*0.75*	*0.78*	*0.81*	*0.84*	*0.87*
6	134	179	172	166	160	154
9	202	269	258	249	240	232
12	269	358	345	332	320	309
15	336	448	431	415	400	386
18	403	538	517	498	480	463

Our information collected in Canada indicates a firm to strong demand for canaryseed, with prices moving up around 15 Canadian cents per pound, after having been down around 9 cents per pound. Table 2.1 gives an indication of parity pricing for Australian canaryseed without any added freight benefit. During early June, 2001, the price was around AU$430 per tonne, but by November, the price was $900/t, due to the small size of the Canadian crop. It is unlikely that the price would remain at that level, as Canadian production will resume as growers respond to the market, and the world birdseed trade will substitute alternative into their mixes, such as millet and panics (Twyford-Jones, 1996).

Product quality

Use

Canaryseed is considered “the white bread” of the diet of canaries. After a month old it is suggested that canaryseed should make up 70% of the bird’s diet due to its ideal balance of basic nutrients. Canaryseed contains 14% protein, 5% fat, 21% fibre, 10% ash and 27% carbohydrate. Other grains are added to the canaryseed for a complete birdseed mix. Canaryseed is used in mixes for budgerigars, canaries, small parrots and finches but is not suitable for larger birds because of small seed size.

Buyer demands

Bird food buyers are particularly finicky about good visual appearance of the grain. Though the birds may eat a range of qualities it is humans buying the product and they will buy on appearance. Anything that detracts from the golden colour of the seed will downgrade its quality.

Seed suitable for the birdseed trade should be large and creamy white. Actual seed size is usually about 6 mm long by 1.5 mm wide, and the seed weights are in the range of 5 to 8 mg. No particular seed weight has been prescribed as yet, although larger seed appear more desirable. Based on these seed sizes, screen sizes can be proposed to meet those sizes and screening tolerance proposed as below.

While seed colour varies from creamy to brown, green seed is a major contaminant and care with the selection of correct harvest time is essential. Seed colour charts could be developed to provide standards. Seed heads should be completely changed colour, and the straw should also be completely golden. If immature, the heads are difficult to thresh and admixture increases, as well as increasing the proportion of green seeds.

A seed size and colour matrix may be appropriate for grading canaryseed into various classes to meet particular market requirements.

Delivery of consistent quality is thus vital to maintain market share. Buyers often want 1-2 containers per month of the same quality. Thus consistent production of consistent quality is important to keep an established market.

In Canada, canaryseed is usually cleaned to buyers' specifications, usually a minimum purity analysis of 99 per cent, with a maximum 4 per cent de-hulled seed. Seed quality criteria relevant to canaryseed are:

Physical Characteristics
Canadian data proposes a 50 lb. bushel weight, although it is acknowledged in the literature that the glabrous lines have a higher density than normal lines.

Physical damage
a) Dehulling (skinning) - Caution must be taken to keep dehulling to a minimum, since in Canada dehulled canaryseed is classed as dockage and must be cleaned out. Appropriate machine settings are available to assist with meeting this criterion at 4%.
b) Cracked grain can also be a problem, and appropriate drum speeds in harvesting equipment are important, as is careful handling with augers post-harvest.

For both these features, it is important to select an appropriate harvest time, when the crop is dry enough to thresh without green seed contamination and a minimum amount of cracked grain.

Moisture content
Canaryseed is considered dry at 13 per cent moisture and is readily threshable at this moisture content. Canadian experience is that it can be safely stored at this moisture content unless green seeds are present.

Ad-mixture, including foreign matter and weed seeds.
Particular weeds will create problems (e.g. OECD proclaimed weed seeds) and even within Australia, interstate trade could be restricted (e.g. Hogweed contamination into Western Australia). Screening tolerances will need to be developed.

Varietal purity
This will become important if the market demands the glabrous lines of canaryseed, which will need to be clearly identifiable, either through grower certification or testing. The seeds are different when viewed under a microscope (see figure 1.1) and this may need to be further assessed as a means of ensuring this line is the one delivered.

Improving quality

TLC has tested oiling canaryseed during the cleaning and packaging process, which gives the seed a glossier look. This has been quite well received by buyers. In addition this has reduced the level of itchy dust in the cleaning plant, of benefit to people working in this environment.

Export quality standards

The Lentil Company has developed export standards on which to use for its shipments (see Appendix 1). The Canadian Grain Commission has not developed grades for canaryseed as it does not fall under the authority of the Canada Grain Act. However canaryseed is sold on specific minimum purity and maximum hulled seed levels. TLC has based the standards on these and also according to other market factors.

Market growth

To service the markets identified, a more reliable supply of canaryseed is needed. This feature was also recognized in the Twyford-Jones (1996) report, which has an attachment concerning a market development tour reported by M. Briggs. It is clear that the needs to be a reliable set of crop management guidelines to keep the yield of the crop high enough to make it attractive to producers when considered in terms of gross margins. Better agronomic management techniques and higher yielding varieties would allow Australian producers to have more competitive product than the Canadians to market.

Based on these figures, it is thought that the canaryseed industry could realistically produce 10,000 t for the domestic market and another 20,000 t for export. TLC has already made experimental shipments of canaryseed for export, as well as into Western Australia.

Table 2.2. World Canaryseed Production (MT), 1990-1999.

	Spain	Turkey	Morocco	Mexico	Uruguay	Thailand	Australia	Bangladesh	Argentina	Canada	World
1990	594	169	3200	9499	1800	1800	8273	0	56900	172300	254535
1991	499	155	0	2648	1800	2000	9730	0	42200	100300	159332
1992	412	150	0	1132	1700	2000	1865	0	32120	124100	163479
1993	312	500	0	1064	1700	2000	9703	0	33242	127800	176321
1994	300	300	0	427	2000	2200	4000	0	23059	240400	272686
1995	68	560	0	1280	2000	2200	3000	0	23000	154600	186708
1996	103	350	0	1181	2500	2200	3000	0	17700	284600	311634
1997	70	350	0	628	2000	2200	3000	0	25000	115000	148248
1998	70	300	0	800	2000	2200	3000	162700	25000	235300	268670
1999	70	300	0	800	2200	2200	3000	0	24000	166000	198570
average	**250**	**313**	**320**	**1946**	**1970**	**2100**	**4857**	**16270**	**30222**	**172040**	**214018**
CV%	**123**	**240**	**-**	**140**	**12**	**7**	**65**	**-**	**39**	**47**	**27**

Source: FAO

3. Variety Evaluation

The current plantings of canaryseed in southeastern Australia are all based on the Queensland cultivar Moroccan. This cultivar lodges easily, particularly when sown at a normal cereal sowing time (May). The management of this crop, using altered sowing times, strategic nitrogen applications, grazing management and windrowing could reduce lodging and improve yields (Holt 1988). The crop is particularly susceptible to trifluralin and sulfonyl urea herbicides, while annual ryegrass (*Lolium rigidum*) and *Phalaris minor* can be a significant weed in the crop (Holt and Hunter 1987). Consequently, paddock selection is critical in the success of the crop, and it is thought that best yields could be following grass cleaned pastures or canola.

A significant problem in canaryseed is the presence of silica spicules on the lemma of canaryseed (Neuman and Mackay 1983), which result in severe skin and lung irritation. The Lentil Company has available a glabrous cultivar, on a testing agreement with the Canadian Special Crops Association (Hucl *et al.* 2001). In addition, a small collection of *P. canariensis* (six accessions) has been obtained from Dr Rex Oram (CSIRO). This includes diploid and tetraploid lines of canaryseed. This germplasm was evaluated as part of the project.

Even though canaryseed has been grown in the Victorian Wimmera for 10 to 15 years, there has been no evaluation to determine what canaryseed genotypes are best suited to the Wimmera environment. Consequently evaluation of genotypes for the Victorian Wimmera has been seen as an important priority in this project. Throughout the life of the project two commercial lines and 24 accessions have been screened for their adaptation to the Victorian Wimmera. The results from the evaluation of these genotypes are included in this chapter. Given the low intensity of testing, these results should only be interpreted as indicative of the adaptation of canaryseed lines to this region.

Materials and methods

Part I: Commercial Cultivar Evaluation

Six experiments conducted in 1998 and 2000 were used to evaluate CDC Maria and Moroccan for their adaptation to the Wimmera environment. The seed of both these varieties was obtained from The Lentil Company. Three of these experiments were sowing rate experiments and there were two nitrogen response experiments and a time of sowing experiment. Each of these experiments included control treatments of CDC Maria and Moroccan. Control treatments for each experiment received 120 kg/ha Pivot legume fertiliser and were sown at 15 kg/ha. Analysis and discussion includes only results from the control treatments of each experiment.

1998

In 1998, two experiments were conducted, one at Longerenong College and the other at Drung. These sites were approximately 25 km from each other. Each experiment was a randomised block design, with three times of sowing. Experiments were sown using a wintersteiger plotman and plots were 1.8 m wide and 10 m long. At Drung, time of sowing (TOS) 2 was abandoned because of severe ryegrass infestation. Table 3.1 shows actual sowing dates in 1998 experiments.

Table 3.1: List of TOS dates for 1998 Longerenong College and Drung experiments.

	TOS 1	TOS 2	TOS 3
Longerenong	29th May	23rd June	14th July
Drung	30th June	Not sown	19th August

Both of the 1998 experiments were severely affected by frost in October, resulting in low yields. Because of the confounding of yield due to frost yield has been estimated using DM yield at harvest and the average Harvest Index (HI) for each cultivar for 1999 and 2000.

1999
In 1999, there were three experiments conducted and they were located at Longerenong College, Toolondo and Dooen. Each experiment was a randomised block design. The Longerenong and Toolondo experiments were sown using a wintersteiger plotman plots were 1.8 m wide and 5 m long at Longerenong and 1.8 m by 10 m at Toolondo. The Dooen experiment was sown using a custom made trash handling cone seeder fitted with Ryan tynes and press wheels and plot dimensions were 1.8 m x 20m. Table 3.2 lists sowing dates for these experiments.

Table 3.2: List of TOS dates for 1999 Longerenong College and Drung experiments.

	TOS 1	TOS 2	TOS 3
Longerenong	7th June	27th July	
Toolondo	10th June	13th July	18th August
Dooen	22nd June	5th August	

2000
An experiment that included both Moroccan and CDC Maria was located at Longerenong College. The experiment was a randomised block design with two TOS and was sown using a wintersteiger plotman, plot dimensions were 1.8 m x 10 m.

Table 3.3: List of TOS dates for 2000 Longerenong College and Drung experiments.

	TOS 1	TOS 2
Longerenong	25th May	7th August

Part II: Accession Evaluation

1999 accession experiment
Twenty-five accessions were obtained from various sources with the objective of assessing their suitability to the Wimmera. Table 3.4 lists details the accessions selected, their origin and seed size. These accessions were selected from the larger collections on the basis of their larger seed size. All accessions were included in an experiment designed to bulk up seed for consequent evaluation. A nearest neighbor design was used because of the limited amount of seed available. Plot sizes were 2 m by 2 m. Data collected from this experiment was time to anthesis and 1000 grain weights.

2000 Accession Evaluation Experiment
On the basis of phenology and seed sizes in 1999, six accessions were selected for further examination in 2000. Table 3.5 describes the traits for each accession selected. The 2000 accession experiment was a completely randomised block design with eight treatments, six selected accessions and two commercial varieties, CDC Maria and Moroccan. From this experiment, dry matter production, seed yield, seed size and grain density were assessed, as well as the duration of the phenophase from sowing to anthesis and the duration of flowering (latter data not presented).

Table 3.4: Accessions, their reference numbers, origin, 1000 seed wt and source from which they were obtained.

Accession reference	origin	1000 seed wt	Source
PI 167 261	Turkey	7.30	Western Regional PI Station
PI170 622	Babaeski, Turkey	7.29	Western Regional PI Station
PI 170 627	Gelibolu, Turkey	7.00	Western Regional PI Station
PI 170 629	Ayvalik, Turkey	7.00	Western Regional PI Station
PI 170 633	Karacabey, Turkey	7.10	Western Regional PI Station
PI 174 299	Gaziantep, Turkey	7.00	Western Regional PI Station
PI 175 811	Orzulu, Turkey	7.00	Western Regional PI Station
PI 175 812	Kayseri, Turkey	7.50	Western Regional PI Station
PI 177 026	Turkey	7.20	Western Regional PI Station
PI 181780	Syria	7.00	Western Regional PI Station
PI 249 998	Iran	7.16	Western Regional PI Station
PI 249 999	Iran	7.21	Western Regional PI Station
PI 251 475	Turkey	7.00	Western Regional PI Station
PI 266186	Jordan	7.50	Western Regional PI Station
PI 284184	Morocco	8.50	Western Regional PI Station
PI 322 734	Turkey	7.90	Western Regional PI Station
PI 368 984	Portugal	7.00	Western Regional PI Station
CA1087			Margot Forde Institute
CA1089			Margot Forde Institute
CA377			Margot Forde Institute
CA402			Margot Forde Institute
CA984			Margot Forde Institute
CPI14690			Rex Oram, CSIRO

Table 3.5: Treatments included in 2000 accession evaluation experiment.

Accession	Origin	Trait
CDC - Maria	Canada	Control
Moroccan	Queensland	Control
PI 175812	Turkey	Early
PI 170633	Turkey	Late
CA 984	Unknown	Short
PI 266186	Jordan	Short
CPI 14690	Tetraploid - CSIRO	Large Seeded
PI 284184	Morocco	Large Seeded

Results and discussion

Part I: Commercial Variety Evaluation

Because it is a relatively new crop to this region, there have been no variety evaluation done to determine how well suited current commercial varieties are to the Wimmera environment. Over a period of three years and six separate experiments, the two commercially available varieties were evaluated to determine their overall adaptation to Wimmera environmental conditions. The two cultivars studied were Moroccan, a cultivar developed in Queensland in the early 1980’s and CDC Maria, a glabrous (lacks silicon hairs on the seed coat) variety recently developed in Canada. CDC Maria is of considerable commercial interest because of its glabrous nature. The silicon hairs on other canaryseed varieties are severe irritants which pose significant health and safety issues both on the farm and in processing plants handling canaryseed (Putnam *et al*. 1996).

Yield ultimately determines how adapted a cultivar is to a region because yield usually is the most important factor affecting crop profitability. In four of the six experiments between 1998 and 2000 there was no significant difference between the yield of Moroccan and CDC Maria, although Moroccan significantly out yielded CDC Maria by approximately ten percent in the Toolondo and Dooen experiments in 1999. This suggests that the yield penalty for growing CDC Maria is ten percent, a similar penalty was observed in Canada when CDC Maria was compared to the older non-glabrous standard cultivar Keet (Alberta Department of Agriculture 2000, Hucl *et al.* 2001). However, when averaged across all six experiments Moroccan out yielded CDC Maria by only 0.25%, suggesting a more extensive study maybe needed to determine the true yield difference between these two commercial lines, or to identify situations where one cultivar would out yield the other. A summary of this, and other features used to compare the lines, is given in table 3.6.

Table 3.6: Average seed yield, stem length, harvest index (HI), dry matter production at maturity (DM), 1000 seed weights and test weight (HW). Values are shown for Moroccan (M) and CDC Maria (C) and cells highlighted in bold are those in which there is a significant difference between CDC Maria and Moroccan, P = 0.05.

Site and year	Yield kg/ha)		Stem length (mm)		HI		DM (kg/ha)		1000 GW (g)		HW (kg/hl)	
	M	**C**	**M**	**C**	**M**	**C**	**M**	**C**	**M**	**C**	**M**	**C**
Drung 1998	570	565	*	*	*	*	3570	3540	*	*	*	*
Longerenong 1998	906	972	*	*	*	*	**6600**	**6075**	*	*	*	*
Dooen 1999	**476**	**523**	842	819	**26**	**21**	**3660**	**3840**	6.96	7.11	**7030**	**6180**
Toolondo 1999	**1357**	**1098**	471	448	26	21	9390	9490	6.45	6.36	*	*
Longerenong 1999	984	898	1134	1141	13	11.9	**7570**	**7600**	**5.62**	**5.90**	*	*
Longerenong 2000	408	442	**661**	**622**	9	8	**4470**	**4910**	5.05	4.67	**5500**	**5610**

Because canaryseed can grow up to 2 m high in good years, it is prone to lodging. Lodging affects yield by reducing light interception by the plant, and in canaryseed can lead to a prevalence of undesirable green seed in the final seed sample. In wheat and barley, reducing stem height by breeding and agronomy has reduced lodging, as well as improving crop yields. Therefore, a canaryseed cultivar with shorter stems is seen as advantageous. In the four experiments were stem height was measured, Moroccan was significantly taller than CDC Maria in only the Longerenong 2000 experiment.

Otherwise it was found that when averaged across four experiments CDC Maria was only 3.2% taller than Moroccan.

Dry matter production at maturity can be used as a measure of how well a cultivar responds to the growing season. Adequate growth provides the necessary resources for the plant to use to fill the developing seed from stem carbohydrate reserves and concurrent photosynthesis. On average, CDC Maria produced six percent more growth than Moroccan. CDC Maria produced significantly more growth than Moroccan in all experiments except the 1998 Drung and 1999 Dooen experiment. .

Too much growth during the season can reduce the proportion of water available from the soil to ensure photosynthesis occurs during grain growth. Harvest Index (HI) is the ratio of seed yield to total dry matter production, and is used to compare the efficiencies of different species and treatments on how a crop converts overall growth to yield. There were no significant differences in HI between Moroccan and CDC Maria between experiments. Data are not presented for the 1998 experiments because of sever frost damage. Moroccan had a HI 14% higher than CDC Maria when averaged across the 1999 and 2000 experiments (table 3.7), although when each experiment was analysed separately Moroccan was found to have a significantly higher HI than CDC Maria in only the 1999 Dooen experiment. The higher mean HI suggests that Moroccan is more efficient than CDC Maria at converting DM to yield, possibly explaining why Moroccan significantly out yielded CDC Maria in two experiments.

Table 3.7: Mean percentage by which Moroccan is greater than CDC Maria for all traits investigated. Negative values are those values in which the value for CDC Maria was greater than the value for Moroccan.

	Yield (%)	**Stem length (%)**	**HI**	**DM (%)**	**1000 GW (%)**	**HW (%)**
Avg Diff	0.25	-3.20	14	-6.00	0.12	-8.45

Based on these observations, the longer season CDC Maria seems less well adapted than Moroccan to the environments tested over these three years. Even though seed yield was similar, the longer growing season of CDC Maria was not exploited because of its lower harvest index.

Seed “plumpness” has been identified by markets as being an important criterion in successfully marketing canaryseed (TLC 2000). Plumpness was measured in this project by average seed weight, in this case 1000 seed weight. CDC Maria’s seed weight was found to be significantly higher than other commercial cultivars in studies completed in Canada (Alberta Department of Agriculture 2000). The seed sizes from the Longerenong 1999 experiment were consistent with the Canadian experience (table 3.6). However, when the percentage difference in grain weight between the two cultivars was analysed it was found that Moroccan was only 0.12 percent heavier than CDC Maria (table 3.7). This suggests that although CDC Maria can be “plumper” than Moroccan, there is no guarantee that the seed of CDC Maria will be larger than Moroccan in all seasons and situations.

Seed test weight (grain density) is a standard used to assess quality in many grain crops. No published standards exist for canaryseed although it is generally accepted that higher the seed density the higher the quality, and this mainly has implications for the transport and storage of the grain, because both are costed basically on volume. Test weights of both cultivars studied were analysed in the 1999 and 2000 density experiments at Dooen and Longerenong. CDC Maria was found to have a significantly higher test weight than Moroccan in both experiments. CDC Maria was still able to maintain its advantage over Moroccan even though the 2000 Longerenong site was severely affected by haying off in October.

Despite the yield penalty to CDC Maria, it has captured a significant proportion of the Canadian plantings, with growers recognizing the superior handling properties (R.Launder, *pers.comm.*).

Part II: Accession Evaluation

The accessions prefixed with CA were sourced from the Margot Forde Institute in New Zealand, and the seed from these lines was up to 30 years old. As a consequence, these accessions established poorly and little data other than 1000 seed weight and time to anthesis could be obtained. The accession PI 175 812 was the earliest accession, taking 84 days to reach anthesis. The tetraploid accession and PI 266 186 had the heaviest 1000 seed weights of the accessions studied in the 1999 experiment (table 3.8). Despite the poor conditions and small plot sizes, enough seed was bulked up for all accessions for subsequent experiments.

Table 3.8: Seed size (1000 GW) and time from sowing to anthesis (S-A) from the 1999 accession evaluation experiment at Longerenong.

Accession ref	1000 GW (g)	**S-A (d)**
PI 175 812	7.22	85.0
PI 167 261	7.20	89.0
PI170 622	6.90	89.0
PI 170 629	6.73	89.0
PI 174 299	6.82	89.0
PI 266186	7.43	89.0
PI 322 734	7.13	89.0
PI 368 984	6.73	89.0
CA1087	6.65	89.0
CA1089	7.06	89.0
CA402	6.09	89.0
CA984	6.98	89.0
PI 177 026	6.86	91.0
PI 181 780	6.67	91.0
PI 251 475	6.66	91.0
PI 284184	7.98	91.0
CA377	6.15	91.5
PI 170 627	6.89	93.0
PI 170 633	6.88	93.0
PI 175 811	6.89	93.0
CPI14690 tetraploid	8.01	93.0
PI 249 998	6.68	96.9
PI 249 999	6.87	96.9
LSD	0.12	**4.00**

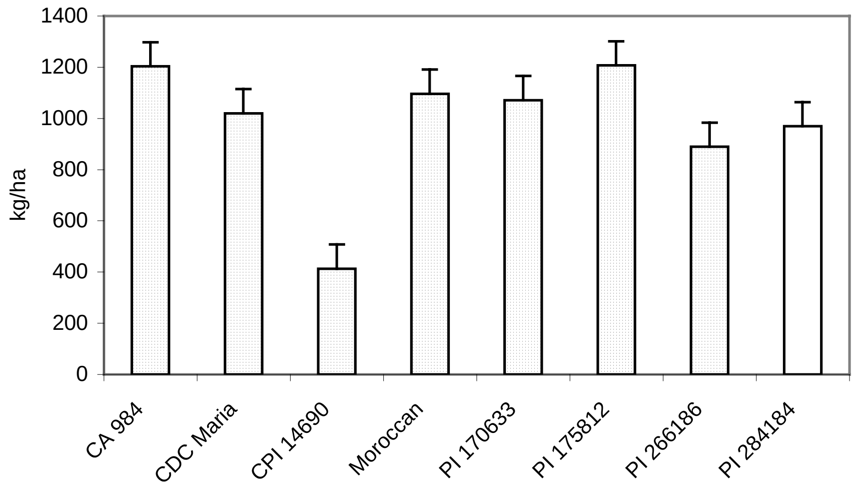


Figure 3.1: Yield (kg/ha) for eight canaryseed genotypes tested at Dooen Victoria in 2000, (LSD = 287, P = 0.05).

Despite the limited nature of the 1999 experiment, eight accessions were selected for further attention in 2000. An adequate amount of seed was bulked up in 1999 allowing for a fully replicated experiment to evaluate 1000 seed weight, time from sowing to anthesis (S-A), stem length (SL), test weight, Harvest Index (HI) and yield. Yield is perhaps the most important trait evaluated in selected accessions as it reflects how well the accession has coped with environmental conditions throughout the growing season. Yield was found to differ significantly between accessions, the poorest yield from the tetraploid line which yielded 413 kg/ha, significantly less than all other accessions evaluated in 2000 (figure 3.1). The line PI 266 186 was also a poor yielding accession, yielding significantly less than PI 175 812 and CA 984. Both PI 175 812 and CA 984 yielded approximately 1200 kg/ha, over 100 kg/ha more than the two commercial cultivars Moroccan and CDC Maria, suggesting that both accessions are worthy of more extensive evaluation in the Wimmera.

HI is a measure of how well an accession converts vegetable matter into yield. Of the accessions evaluated in 2000 PI 175 812 and PI 266 186 had the highest HI. The tetraploid accession was the poorest converter of vegetable matter to yield, converting only ten percent of growth to yield. The commercial cultivars CDC Maria and Moroccan were intermediate in their converting efficacy, with HI's of 14.3 and 16.0 percent respectively.

Less variation was found between the accessions selected for evaluation in 2000 than in 1999. There were only two days difference between the first and last accession reaching anthesis.. The difference in variation could have been due to changes in response to vernalisation (cold temperature) and photoperiod (day length) as the sowing date was delayed from June to August.

PI 175 812 was the earliest cultivar in both evaluation experiments, earlier than CDC Maria and Moroccan by 2.3 and 2.0 days respectively. Earliness is seen as an important trait for an adapted accession in the Wimmera as is it would enable the crop to be better able to escape terminal drought at grain filling. Further evaluation of PI 175 812 would establish the effect its earliness had on the accessions ability to adapt to the Wimmera environment.

Table 3.9: Results from evaluation experiment at Dooen, Victoria.

	CA 984	CDC Maria	Tetraploid CPI 14690	Moroccan	PI 170 633	PI 175 812	PI 266 186	PI 284 184	LSD
1000 GW (g)	6.71	6.88	7.06	6.29	6.31	6.54	7.62	7.20	NS
S-A (days)	111	112	112	111	112	110	111	111	1.3
Stem (mm)	833	793	673	834	844	865	757	725	Ns
Test weight (kg/hl)	66.8	74.6	61.4	66.5	68.5	67.8	69.6	64.0	3.4
Harvest index	14.4	14.3	10.0	16.0	17.7	19.2	18.9	16.6	4.6

No significant differences were found between the seed sizes of the accessions evaluated in 2000. Interestingly though, the accessions which yielded the least also had 1000 grain weight above 7.00 g. This suggests that there maybe compensation between grain yield and seed size with the available accessions, where lower yields lead to larger seed size.

No significant differences were found between the average stem heights of each accession. Stem heights in the 2000 experiment are similar to those reported in Canada (Alberta Department of Agriculture 2000).

In 2000, the test weights of the lines tested showed significant variation. The tetraploid accession had the lowest test weight (61.4 kg/hl), while the commercial variety CDC Maria had the highest test weight of the evaluated accessions, weighing 74.6 kg/hl. These values were similar for CDC Maria grown in Canada, where test weights were 70.5 kg/hl and 1000 seed weights 7.5 g.

Conclusions

The results from the commercial variety evaluation should not be considered as conclusive because even though it was found that Moroccan could significantly out yield CDC Maria, this did not always happen. Moroccan was considered better at converting DM into yield as it had a consistently higher HI than CDC Maria. CDC Maria appeared to have better grain quality than Moroccan, in particular the test weight of CDC Maria was significantly heavier than that of Moroccan in two consecutive years. Average seed weight and grain density of CDC Maria was about 10% heavier than Moroccan in a single experiment. However this was not always the case and the average seed sizes of both varieties were similar when averaged across all experiments. While earliness could be associated with higher harvest index and larger grain size, the difference in time from sowing to anthesis in these experiments was only a day.

The accessions CA984 and PI 175 812 yielded well in the 2000 evaluation and warrant further evaluation against the commercial lines CDC Maria and Moroccan. In particular PI 175 812 was a significantly better converter of growth to yield and took less time to reach anthesis in both 1999 and 2000 than other accessions. These data suggests that further evaluation is needed to recommend the best canaryseed genotypes for the Victorian Wimmera. We have sown one experiment in 2001 to provide additional information on the performance of Moroccan and CDC Maria, as well as CA 984 and PI 175 812. In 2002, we will have sufficient seed of all four lines to consider multi-site testing of these four lines.

4. Phenology

The key aspect to consider about the inclusion of a new crop such as canaryseed into farming systems is the factors that control its phenology. Phenology is the study of plant development through time. In cereals such as canaryseed phenology, is determined by three environmental factors, *viz:*

Photoperiod (day length), which lets the plant know whether it is the appropriate time of year to flower.

Vernalisation (cold requirement), which ensures that plants which are adapted to cold climates flower in spring after a period of growth in autumn and winter.

Temperature, which affects the rate of physiological processes in the plant.

In this part of the research project, we aimed to determine whether canaryseed responds significantly to changes in photoperiod, vernalisation and temperature. From this understanding, we can estimate appropriate sowing times for canaryseed throughout the year.

Materials and methods

Four canaryseed genotypes and three wheat controls were included in this experiment. Two of the canaryseed genotypes are commercial cultivars, one from Queensland and the other from the University of Saskatchewan Canada. The two remaining accessions (PI 170633 and PI 175812) have been sourced from the USDA germplasm collection. These two lines were selected because they were earlier and later than the other lines tested in the germplasm experiments described in chapter 3,

The three wheat controls used in this experiment were chosen because they show different responses to photoperiod, temperature and vernalisation. They represent the full range of responses to photoperiod, temperature and vernalisation exhibited by commercial wheat varieties grown in southern Victoria. The variety Rosella was included for its mild vernalisation requirement, Thatcher was included because of its sensitivity to photoperiod Sunset was included because of its insensitivity to photoperiod and vernalisation.

Environmental treatments included in the nested plot design were two lighting regimes (natural and 18 hour photoperiod) and four vernalisation treatments (0,2,4 and 6 weeks vernalisation treatment at 4°C). Each of the environmental treatments was repeated at sowing dates of 17th April (autumn), 17th July (winter) and 17th of October (spring). Sowing dates will be referred to as TOS throughout the rest of this chapter.

Fully emerged leaves were counted on the oldest culm of each plant in 10 to 14 day intervals from each time of sowing up until flag leaf emergence. A fully emerged leaf was deemed to be a leaf whose ligule had grown past the ligule of the subsequent leaf. Anthesis was noted as the date that the first anthers were observed extruding from the head on the oldest culm.

Results and discussion

Photoperiod response

Photoperiod response was measured as the difference between the time it took for the crop to reach anthesis under the natural photoperiod and the time it took when grown under an extended photoperiod. All treatments were fully vernalised. Photoperiod response was analysed using analysis of variance and figures 4.1 and 4.2 show the interaction between time of sowing and canaryseed genotype or wheat control. The four canaryseed accessions responded to saturated photoperiod by reducing time to anthesis by approximately 750, 320 and 170 °Cd when sown in autumn, winter and spring respectively. The spring responses of CDC Maria, PI 175 812 and Moroccan were not significantly different from zero, indicating that the time to anthesis for these accessions when grown under saturated photoperiod was similar to the time to anthesis under natural day length.

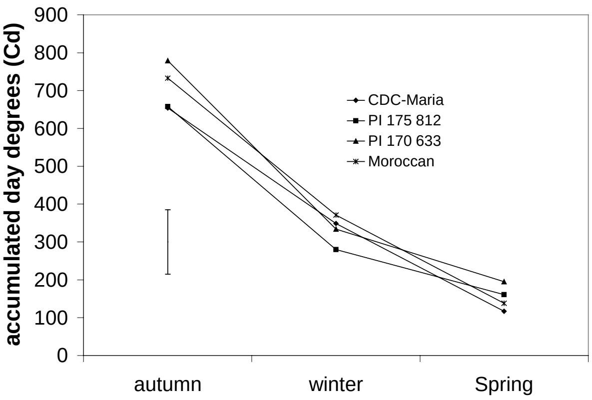


Figure 4.1: Response to extended photoperiod by canaryseed, measured as the difference in thermal time between the time to anthesis for natural day length treatments and extended day length treatments. Response is plotted for each time of sowing. LSD = 103.0, P = 0.05.

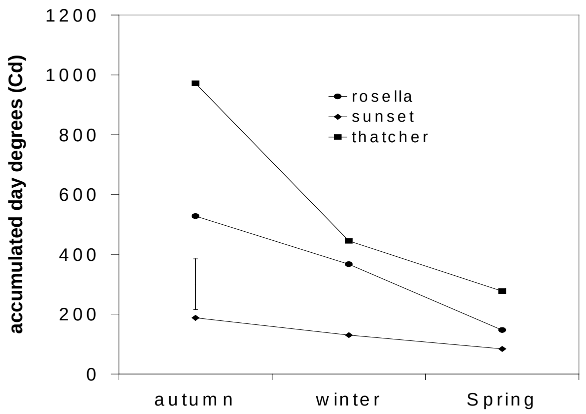


Figure 4.2: Response to extended photoperiod by wheat controls, measured as the difference in thermal time between the time to anthesis for natural day length treatments and extended day length treatments. Response is plotted for each TOS. LSD = 103.0, P = 0.05.

The wheat controls showed a greater range of responses to photoperiod than the canaryseed accessions studied (figure 4.2). Of the genotypes studied, Sunset responded the least to saturated photoperiod in all three sowing times, while Thatcher responded most significantly to all three sowings. Rosella was found to have an intermediate response between the unresponsive Sunset and responsive Thatcher. Of the wheat controls included in this study the response by Rosella to photoperiod was the most similar to that of canaryseed.

Vernalisation response

Vernalisation response is defined here as the difference in thermal time to anthesis between unvernalised treatment (control) and vernalised treatment (14, 28 and 42 days of vernalisation treatment at 4°C). Both treatments are under extended photoperiod conditions and share the same times of sowing.

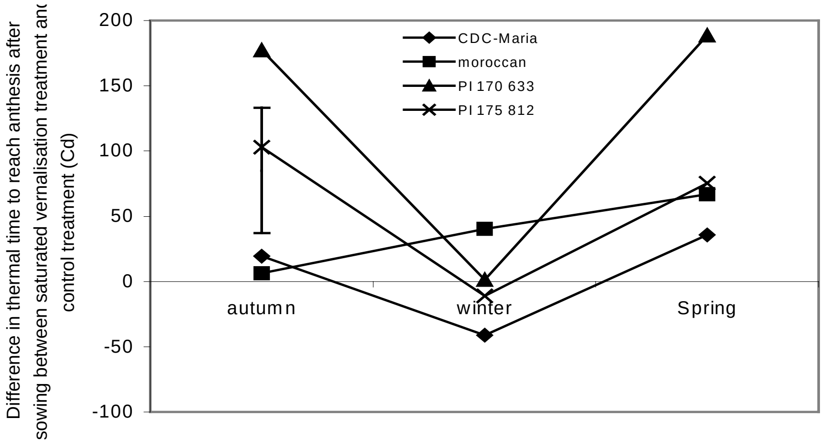


Figure 4.3: Average response to vernalisation for each canaryseed accession plotted against TOS. LSD = 89.0, P = 0.05.

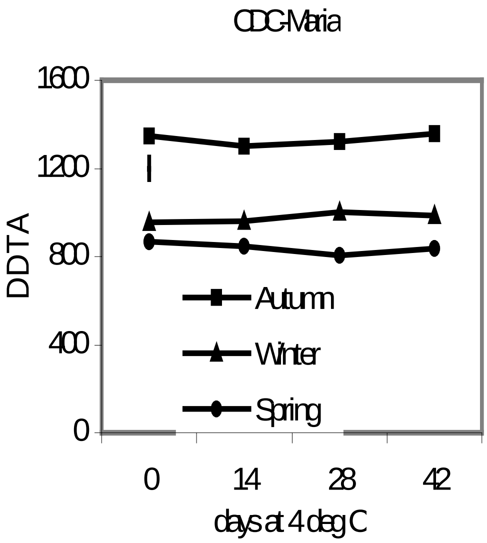


Figure 4.4: The effect of different vernalisation durations on the time to flower of CDC-Maria when grown under 18 hour photoperiod. DDTA -.degree days to anthesis

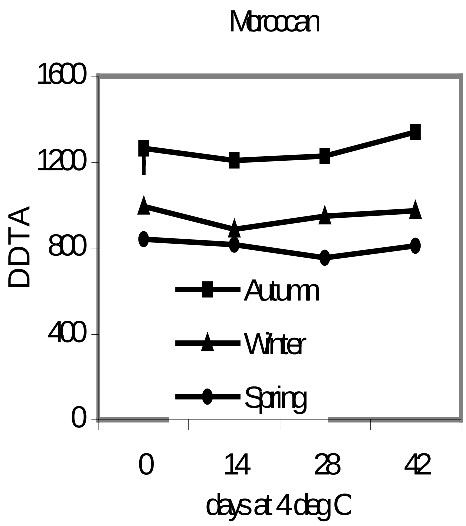


Figure 4.5: The effect of different vernalisation durations on the time to flower of Moroccan when grown under 18 hour photoperiod. DDTA -.degree days to anthesis.

The responses of canaryseed cultivars CDC Maria and Moroccan to different durations of vernalisation are shown in figures 4.4 and 4.5 respectively. Neither cultivar showed accelerated development when vernalised, indicating that they have no particular "winterness" or prechilling requirement. PI 170 633 was the only accession which responded significantly to vernalisation, responding to being vernalised for 14, 28 and 42 days by reducing time to anthesis by 141, 134 and 92 °Cd (LSD = 89.0 °Cd, P = 0.05) respectively (figure 4.6). The response of PI 170 633 was similar to, but not as marked as the vernalisation response of Rosella wheat (figure 4.7).

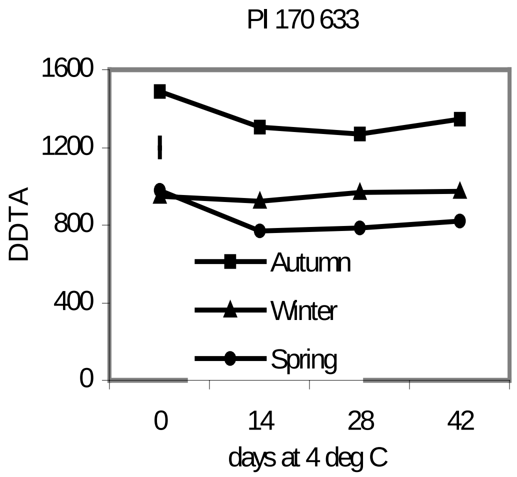


Figure 4.6: The effect of different vernalisation durations on the time to flower of canaryseed accession PI 170 633 when grown under 18 hour photoperiod.

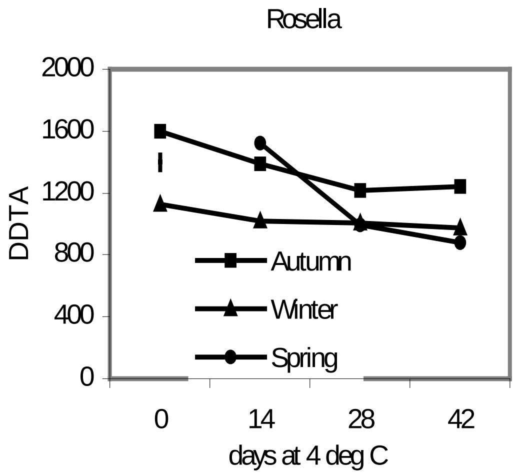


Figure 4.7: The effect of different vernalisation durations on the time to flower of the wheat variety Rosella when grown under 18 hour photoperiod.

When averaged across vernalisation treatments, PI 175 812 and PI 170 633 responded significantly to vernalisation in autumn by reducing time to anthesis by 178 and 103 °Cd respectively (figure 4.8). PI 170 633 was the only accession to show an average response to vernalisation in spring, reducing time to anthesis by 189 °Cd. Of the wheat tested, Rosella showed the expected response of an average response to vernalisation across each sowing time. Rosella responded significantly to each of the vernalisation treatments. The 42 day vernalisation treatment showed the largest effect, reducing the time to anthesis by an average of 200 °Cd. Averaged across each of the vernalisation treatments, Rosella was the only wheat control to show a significant response to the autumn and winter sowing times. The response of Rosella to the spring sowing could not be calculated because it did not reach anthesis.

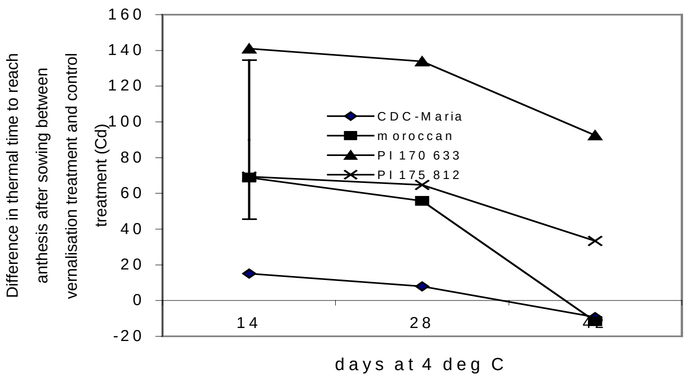


Figure 4.8: Average response to vernalisation for each canaryseed accession plotted against the duration of vernalisation. LSD = 96.3, P = 0.05.

Response to temperature

The response of cereal development to temperature can be measured using the response to thermal time when the plants have their vernalisation requirement satisfied and are grown under conditions of saturated photoperiod. Figure 4.9 compares the response of the canaryseed lines to various wheat types, and the graph shows that at a spring sowing, canaryseed reaches anthesis somewhat faster than Sunset or Thatcher wheats.

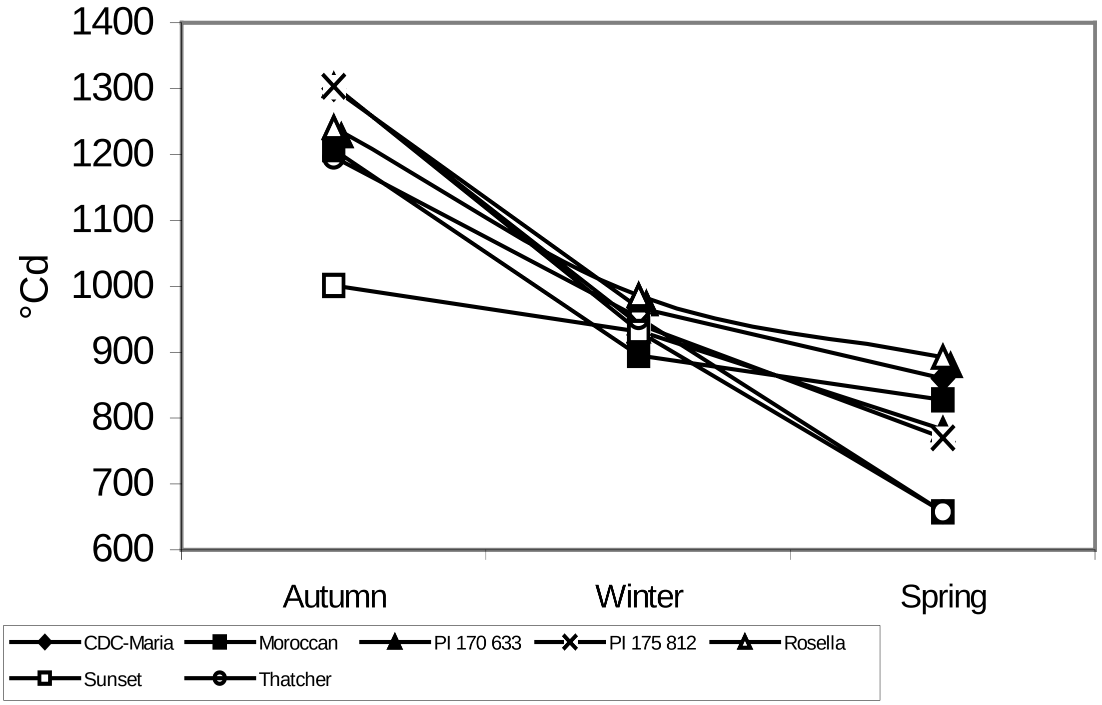


Figure 4.9: Response of four canaryseed lines and three wheat cultivars to seasonal sowing time in thermal time until anthesis, when photoperiod and vernalisation responses have been met.

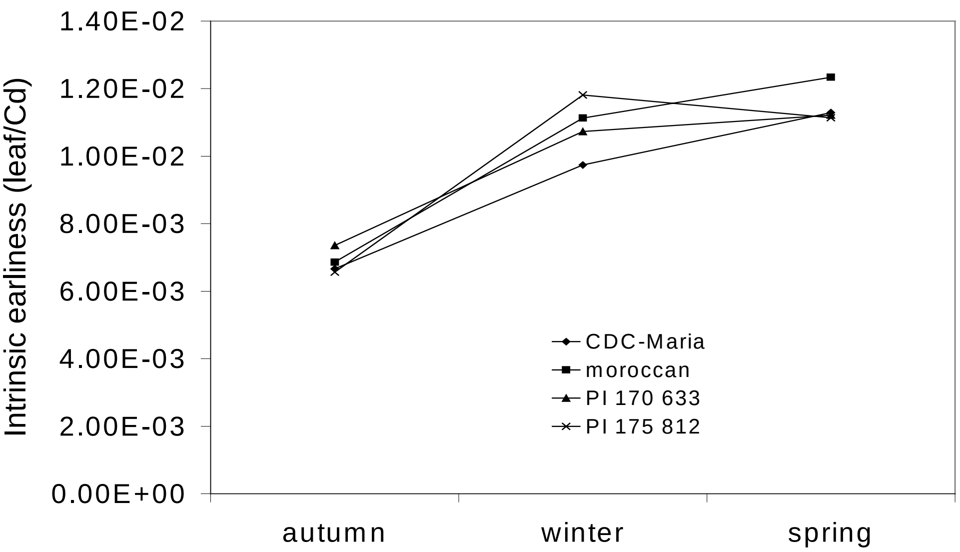


Figure 4.10: Intrinsic earliness for canaryseed over three times of sowing.

The response to thermal time to development is termed Intrinsic Earliness (IE) or basic development rate (Slafer and Rawson 1994) (figure 4.9), which is expressed as the thermal time required for the development of a leaf. When sown at the same time, each of the canaryseed genotypes studied had a similar response to temperature as measured by their IE, although as sowing was delayed from autumn to spring IE increased significantly (figure 4.10). IE for winter and spring sowings did not differ significantly. In contrast to the canaryseed accessions, IE for each of the three wheat controls was similar for each sowing time. The IE of the wheat controls for each time of sowing was significantly less than the IE for winter and spring sown canaryseed genotypes (figure 4.10). The canaryseed accessions responding similarly to the wheat controls only when sown in autumn (data not shown).

Based on these data, canaryseed responded to increasing temperature as sowing was delayed from April to October by increasing IE, in contrast to the wheat controls studied which retained a constant IE for each time of sowing. It is uncertain if this response is a true reflection of differences in true IE, or is a reflection of differing temperature sensitivities, maybe seen as different base temperatures in the derivation of thermal time.

Summary

In summary, little variation in photoperiod response was found between the canaryseed genotypes. All four canaryseed genotypes responded significantly to 18 hour photoperiod when sown in April and July indicating that canaryseed is a long day plant, which means that canaryseed prefers to flower when daylengths are increasing in the spring. This contrasts with the observations and conclusions of Calder (1965) who suggested that canaryseed was a day neutral plant.

In contrast to photoperiod response, there was significant variation in vernalisation response between the four canaryseed genotypes. Both PI 175 812 and PI 170 633 responded to vernalisation, although Moroccan and CDC Maria were not responsive. The minimum vernalisation requirement was two weeks for PI 170 633 in comparison to six weeks for Rosella. This supports the findings of Miller (1998), who suggested that the canaryseed genotypes he studied had a mild vernalisation requirement of two weeks.

The strong photoperiod and temperature response by canaryseed indicates that it would normally flower in spring. A consequence of this is that spring sowings are likely to lead the plant flowering before sufficient dry matter has accumulated to ensure that a economic seed yield can be harvested. It is proposed that autumn and winter sowing better suit the phenological controls that operate within canaryseed. With early sowings, flowering is likely to be delayed because of colder ambient temperatures and short daylengths. The existence of a slight vernalisation requirements in some canaryseed genotypes is interesting but probably has only minor implications for sowing times in southern Australia. At most sowing times, the vernalisation requirement would be met, so early sowings would not be necessary to meet this requirement.

Conclusion

The canaryseed genotypes studied in this experiment had photoperiod and vernalisation responses within the range of responses of several wheat controls adapted to the Victorian Wimmera (table 4.1). Canaryseed is suited to autumn and winter sowing because of its strong response to photoperiod and temperature. Some canaryseed genotypes had vernalisation responses, which suggests that they would be better suited to the colder regions of the Wimmera and early sowing times. However, this requirement was only small and is likely to be met in most situations. Canaryseed is not likely to be suited to spring sowings. The developmental patterns of CDC Maria and Moroccan are similar to a typical “spring” wheat.

Table 4.1: Magnitude and rating of response to temperature, photoperiod and vernalisation for the genotypes studied.

	Temperature		Photoperiod		Vernalisation	
	Response (ºCd)	Rating	Response (ºCd)	Rating	Response (ºCd)	Rating
CDC-Maria	108	**	373	***	13	*
PI 175 812	172	**	366	**	58.8	*
PI 170 633	150	**	436	***	107	**
Moroccan	68	*	414	***	74.5	*
Rosella	94	**	347	**	254	****
Sunset	274	****	134	*	-76.5	-
Thatcher	296	****	565	****	-46.6	-
LSD, $P<0.05$	112		100		88.0	

Figure 4.11: Canaryseed experimental plots at Longerenong, 1998 (photo, R. Norton).

5. Agronomic Studies on Canaryseed

Since 1998, we have conducted a series of field experiments to investigate various aspects of the management of canaryseed in the Wimmera. Over those three years, the results of these experiments, has to some extents, been compromised by a severe frost (1998) and two years of spring drought (1999 and 2000). Rainfall figures for these years are shown in figure 5.1.

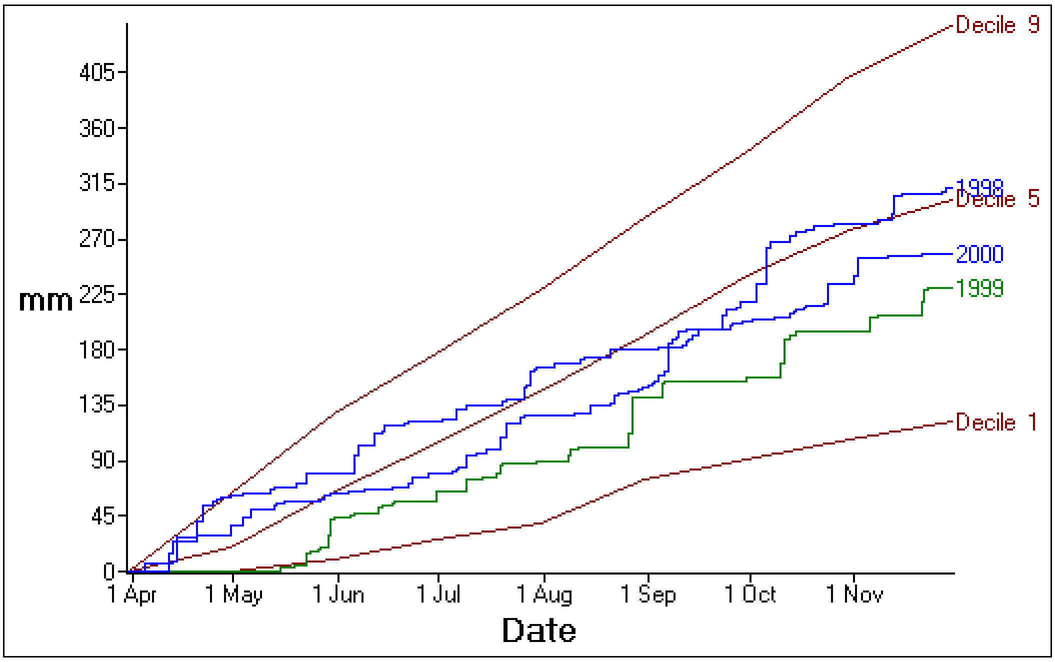


Figure 5.1: Seasonal rainfalls (April to November) at Longerenong (Dooen) for 1998, 1999 and 2000, against decile 1, 5 and 9.

The experiments have been designed to develop more reliable techniques to produce large seeded, weed free canaryseed suitable for the export trade.

1998 Field Experiments

The objective of these initial experiments was to provide preliminary information on the performance of two canaryseed lines, and the effects of time of sowing and applied nitrogen on yield and lodging. Two sites, approximately 40 km apart, were sown in the Wimmera. These sites differed in rainfall and temperatures, with the Drung South site being cooler and wetter than the Longerenong site. Both sites were sown at three different sowing times, commencing at mid May, with the latest sowing in August. Dry matter harvests were taken during the year, and growth and yield assessments made at harvest time.

Drung South 1998 experiment

An experiment with two cultivars (Moroccan and CDC Maria), three nitrogen rates (0, 25 and 50 kg N/ha) and three sowing times was established at Drung South, approximately 40 km south of the Longerenong campus. The site selected was prepared from a sub-clover and phalaris pasture. The earliest sowing time was unable to be sown due to wet conditions and the first sowing time became June 30. A second sowing time was August 19. Plots were 20 m long and 1.7 wide, sown with four replications in a randomised split plot design. Growth, yield and grain quality data were collected from the experiment.

Results

Yield of plots sown on the 19th of August (TOS 2) was significantly greater than those plots sown on the 30th of June (TOS 1). The cultivar Moroccan yielded significantly more per hectare than the Glabrous cultivar. Dry matter yield of plots sown on the 19th of August were significantly greater than those plots sown on the 30th of June. Cultivar did not have a significant effect on DM Yield in comparison to the effect cultivar had on grain yield.

No significant differences in harvest index were found between treatments.

There were no significant interactions between nitrogen application rate, sowing times or cultivars, and a summary of the results of the main treatments is shown in table 5.1.

Table 5.1: Results from Canaryseed experiments at Drung South. Asterisk indicates a significant difference between the means.

	Time of Sowing		**Nitrogen Application**			**Cultivar**	
	TOS1	TOS2	0kg/ha	25kg/ha	50kg/ha	Moroccan	CDC Maria
Yield (kg/ha)	71*	166*	113	125	118	132*	105*
DM Yield (kg/ha)	2069*	5261*	3584	3796	3614	3845	3485
Harvest Index							

	0.038
	0.030
	0.031
	0.034
	0.037
	0.033
	0.034
Plants/m sq	
	46.94*
	80.82*
	68.92
	59.64
	63.07
	71.14*
	56.64*
Hd/Plant	
	3.23*
	4.46*
	3.43
	4.07
	4.03
	3.65
	4.03
Heads/m sq	
	149*
	347*

	246
	247
	252
	256
	240
Grains / head	
	3.23*
	4.46*
	3.43
	4.07
	4.03
	3.65
	4.03

Sowing on the 19th of August had significantly more plants per square metre than plots sown on the 30th of June. The cultivar Moroccan had significantly more plants per metre squared than the glabrous cultivar. The later sowing also produced crops with significantly more heads per plant than plots sown on the 30th of June. Plots sown on the 19th of August had significantly more heads per plant than plots sown on the 30th of June.

Summary

Canaryseed sown at the later sowing time had higher grain and dry matter yields than plots sown on the 30th of June. Ryegrass competition was considerable in earlier sown plots while ryegrass competition in later sown plots was negligible due to cultivation prior to sowing. Indeed, the later time of sowing had to be abandoned due to heavy ryegrass infestation. This suggests that the difference in grain and dry matter yields might be in part explained by ryegrass competition.

The overall crop yields were very low, with low harvest indices and few grains per head. This was due to a severe frost during late October. The later sown experiments have more grains per head and a greater yield inferring that the earlier sown experiments were more affected by frost because they were at a developmental stage more susceptible to frost.

The cultivar Moroccan had greater grain and dry matter yields than the CDC Maria cultivar. The cultivar Moroccan also had a higher density, which suggests that difference in grain yield might partly be explained by better seedling vigour and survival.

Longerenong 1998 experiment

A second site, at Longerenong, was used for the sowing of an experiment of similar design to the Drung South experiment. In 1997, this site was fallowed. The same treatments were imposed, but an early sowing time – May 29 was included. Other details are as for the Drung South experiment.

Results
All treatments grew quite well during the season. The early sowing times were able to accumulate a around 6.5 t/ha of dry matter by maturity, despite the comparatively dry spring conditions. The application of 50 kg/ha of nitrogen caused lower seed yields than the lower or nil rate of application. The glabrous cultivar CDC Maria was significantly higher yielding than those sown with the cultivar Moroccan, although little value can be placed on these yields due to the effects of frost.

Canaryseed sown on the 23 rd June and 14th of July were had significantly greater HI than those plots sown on the 29th of May. Plots treated with 0 kg/ha or 25 kg/ha of nitrogen had significantly greater HI than plots sown with 50kg/ha of nitrogen. Again, frost had a significant effect on these data.

There were no significant differences in plant density or head numbers per plant. Plots sown with the CDC Maria cultivar had significantly more grains per head than those sown with the cultivar Moroccan.

Table 5.2: Results from canaryseed experiments at Longerenong in 1998. Superscript lower case characters indicate significant difference (P = 0.05).

	Time of Sowing			Nitrogen Application			Cultivar	
	TOS1	**TOS2**	**TOS3**	**0kg/ha**	**25kg/ha**	**50kg/ha**	**Moro-ccan**	**CDC Maria**
Yield (kg/ha)	23.2	26.4	25.4	27.3^{a}	26.2^{b}	21.5^{ab}	22*	37*
DM Yield (kg/ha)	6505	6110	6062	6393	6246	6037	6130	6321
Harvest Index (10^{-3})	3.49 ^{ab}	4.25 ^{a}	4.22 ^{b}	4.19 ^{c}	4.24 ^{d}	3.53 ^{cd}	3.69	4.29
Plants/m sq	102	185	105	104	187	100	125	136
Hd/Plant	3.66	3.30	4.77	3.55	4.55	3.63	4.45	3.37
Heads/m sq	370	374	505	366	524	358	474	358
Grains/head	1.64	1.74	1.66	1.75	1.82	1.48	1.49^{a}	1.87^{a}

Summary
Establishment in the Longerenong experiment was better than the establishment at the Drung site. This followed through to maturity, where the head density at Longerenong was more than the head density at Drung. This suggests that the yield potential of the Longerenong site was greater than the Drung site. The severe October frost however has appeared to affect the yields at Longerenong considerably; each treatment did not average more than two grains per head.

It is possible to consider the yield components of dry matter yield, plants per square metre, heads per plant and grains per head. However none of the treatments show any significant difference between yield components.

There is a significant difference in grain yield between the nitrogen application treatments. The 50 kg/ha of nitrogen treatment had a significantly lower yield than the two lesser treatments, suggesting a possible haying off effect.

Conclusions from 1998 Experiments

From these data, it is concluded that the Moroccan cultivar has slightly higher yields than CDC Maria, probably due to the earliness of Moroccan. Little can really be made of the agronomic adaptability of the crop due to the effects of frost. However, growth – in the absence of annual ryegrass – appears to be adequate, and with a harvest index of around 25%, seed yields of approximately 1.5 t/ha could be expected. An expected yield of this magnitude would indicate that the crop is well adapted to the environment of the Wimmera, particularly the southern Wimmera.

1999 field experiments

Following the 1998 experiments, three field experiments were designed to compare the effects of density and sowing time on canaryseed phenology, growth, yield and seed quality at three locations.

Longerenong 1999 experiment

The aim of this experiment was to contrast the phenology of two commercial canaryseed cultivars, one from Queensland and the other from Canada, with that of a mid season wheat and a long season wheat. Originally experiment was to contain four times of sowing however due to water restrictions, equipment failure and spray damage two of the four sowing times were abandoned. Two sowing times of two canaryseed lines and two check lines of wheat were used in 10 m by 1.7 m plots, grown in four replications. Plots were irrigated with 80 mm of water in September and October to escape drought. Data collected were phenology, growth, yield and seed quality. This site had fenugreek sown in 1998.

Results
Both Rosella and Goldmark wheat flowered significantly earlier than both canaryseed varieties when sown on the 7 June (table 5.3). The two canaryseed varieties flowered simultaneously when sown on the 7 June. In contrast Moroccan flowered significantly earlier than CDC Maria and Rosella. Rosella flowered at a similar time to CDC Maria; Rosella wheat has a mild vernalisation response suggesting that CDC Maria may also have a similar vernalisation response.

Table 5.3: Average calendar days from sowing to anthesis for two canaryseed varieties and two wheat varieties at Longerenong in 1999.

Treatment	**7 June time of sowing**	**22 July time of sowing**
CDC Maria (canaryseed)	132	99
Moroccan (canaryseed)	132	93
Goldmark (wheat)	121	92
Rosella (wheat)	123	100
LSD (within sowing time) (P = 0.05)	1.6	1.6

Table 5.4: Average yield (t/ha) for two canaryseed varieties and two wheat varieties at Longerenong in 1999.

Treatment	**7 June**	**22 July**
CDC Maria (canaryseed)	1.26	0.54
Moroccan (canaryseed)	0.93	1.04
Goldmark (wheat)	3.52	3.62
Rosella (wheat)	3.37	2.40
LSD (within sowing time) (P = 0.05)	0.6	0.6

There were no significant yield differences between the Canadian canaryseed variety CDC Maria and the Queensland variety Moroccan (table 5.4). Although the average yield of CDC Maria was greater than Moroccan when sown in June, while Moroccan on average out yielded CDC Maria when sown on the 22 July. Both canaryseed cultivars yielded significantly less than both Rosella and Goldmark wheat.

Toolondo 1999 Experiment

The aim of the Toolondo experiment was to investigate how canaryseed would perform under the cooler and higher rainfall conditions in the southern Wimmera. The treatments used here were two sowing times, three seeding rates and two canaryseed cultivars, compared to the wheat variety Goldmark. Phenological measurements were taken, along with growth, tiller counts, yields and seed size. The experiment at this site was on a triazine tolerant canola stubble.

Table 5.5: Average calendar days to anthesis for two canaryseed varieties and Goldmark wheat at Toolondo in 1999.

Treatment	13 July time of sowing	18 August time of sowing
CDC Maria (canaryseed)	108	87
Moroccan (canaryseed)	105	85
Goldmark (wheat)	103	87
LSD (within sowing times) (P = 0.05)	1.8	1.8

Both Moroccan and CDC Maria took significantly longer to reach anthesis than Goldmark when sown on the 13 July (table 5.5). However when sown on the 18 August Moroccan flowered significantly earlier than both CDC Maria and Goldmark. More detailed analyses of the thermal response of these varieties is presented in the previous chapter of this report, which covers the relative effects of daylength, vernalisation and temperature on the duration of phenophases in canaryseed.

Table 5.6: Average yield (t/ha) for two canaryseed varieties and Goldmark wheat at Toolondo when sown at different seeding rates in 1999.

Treatment	Sowing Rate (kg/ha)	13 July time of sowing	18 August time of sowing
CDC Maria	15	1.26	0.39
CDC Maria	30	1.20	0.50
CDC Maria	45	1.44	0.43
Moroccan	15	1.52	0.39
Moroccan	45	1.51	0.44
Goldmark	80	3.99	4.60
LSD (within sowing times) (P = 0.05)		0.27	0.27

The effect of varying canaryseed sowing rates on yield was not significant. Moroccan on average out yielded CDC Maria (table 5.6). While Goldmark significantly out yielded canaryseed at both times of sowing; there was considerable contrast between canaryseed yields at both sowing dates despite favourable spring rainfall. The large reduction in yield of canaryseed treatments sown on 18 August could be due to poor seed set because of high temperatures or inadequate fulfilment of a vernalisation requirement.

Dooen 1999 Experiment

The aims of the 1999 Dooen experiment were to investigate the effects that cultivar, sowing rate and time of sowing would have on yield, seed size and stem height. Two sowing times, three seeding rates and two varieties of canaryseed were compared against a check line of wheat, the cultivar Goldmark. The experiment design was similar to the experiment at Toolondo however the experiment received 114 mm less growing season rainfall. This area was sown to peas in 1998.

Table 5.7: Average yield (t/ha) for two canaryseed varieties and Goldmark wheat at Dooen when sown at different seeding rates in 1999.

Treatment	Sowing Rate (kg/ha)	22 June time of sowing	5 August time of sowing
CDC Maria	15	0.42	0.53
CDC Maria	30	0.46	0.55
CDC Maria	45	0.47	0.55
Moroccan	15	0.46	0.58
Moroccan	30	0.48	0.62
Moroccan	45	0.46	0.60
Goldmark	80	1.48	1.60
LSD (within sowing times) (P = 0.05)		0.07	0.07

Average yield of Moroccan was greater than CDC Maria for all treatments (table 5.7). In all treatments the 5 August time of sowing out yielded the 22 June time of sowing. Canaryseed yielded approximately a third of Goldmark wheat when sown at the same time.

CDC Maria had an average 1000 seed weight greater than Moroccan (table 5.8). As canaryseed sowing rate increased 1000 seed weight decreased with both canaryseed cultivars. One thousand seed weight for canaryseed appeared to be unaffected by sowing date. The grain density (kg/hl) followed a similar pattern to seed weights, with CDC Maria having a mean grain density of 70.7 kg/hl compared to the density of Moroccan of 62.0 kg/hl. Neither sowing time nor seeding rate significantly affected grain density in this experiment.

Table 5.8: Average 1000 seed weight (g) for two canaryseed varieties at Dooen when sown at different seeding rates in 1999.

Treatment	Sowing Rate (kg/ha)	22 June	5 August
CDC Maria	15	6.98	7.25
CDC Maria	30	6.88	7.09
CDC Maria	45	6.91	6.88
Moroccan	15	6.97	6.96
Moroccan	30	6.8	6.9
Moroccan	45	6.51	6.42
LSD (within sowing times) (P = 0.05)		0.24	0.24

The effect of increasing sowing rates was to decrease average stem length (table 5.9). Timely spring rainfall resulted in canaryseed treatments sown on the 5 August being taller than treatments sown on 22 June. In contrast the stem length of Goldmark reduced when sown on 5 August.

Table 5.9: Average stem length (mm) for two canaryseed varieties and Goldmark wheat at Dooen when sown at different seeding rates in 1999.

Treatment	Sowing Rate (kg/ha)	22 June	5 August
CDC – Maria	15	686	977
CDC – Maria	30	692	998
CDC – Maria	45	681	909
Moroccan	15	600	1082
Moroccan	30	739	860
Moroccan	45	690	768
Goldmark	80	936	684
LSD (P = 0.05)*		297	297

* for comparison between time of sowing, Goldmark and canaryseed treatments.

Table 5.10: Average calendar days from sowing to anthesis for two canaryseed varieties and Goldmark wheat at Dooen in 1999. Flowering times are the means of the sowing rates used.

Treatment	22 June time of sowing	5 August time of sowing
CDC – Maria	125	92
Moroccan	121	91
Goldmark	123	103
LSD (within sowing times) (P = 0.05)	1.8	1.8

Moroccan was earlier flowering when sown on the 22 June than Goldmark wheat and CDC Maria (table 5.10). Both CDC Maria and Moroccan reached anthesis significantly earlier than Goldmark when sown on the 5 August.

Conclusions from the 1999 experiments

The Moroccan cultivar was higher yielding than CDC Maria. As well as this, the following conclusions were drawn from the 1999 experiments:

- Increased sowing rates leads to increased plant density, which reduces the average seed weight of canaryseed.
- Higher sowing rates can give better yields than lower sowing rates, maybe because of better early crop vigour.
- A sowing rate of 30 kg/ha gave acceptable yields and did not reduce seed size.

Sowing time had little effect on the yield of canaryseed up until an early July sowing, after which yields decline significantly.
Canaryseed yields approximately one third of yield of wheat sown in the same environment.

2000 Field Experiments

In 2000 a further series of small experiments were designed to evaluate the effects of sowing times, cultivar and seeding rates on canaryseed. The experiments were sown at Longerenong and Dooen, along with two other sites at Penshurst and StArnaud, that were used mainly to give additional information on crop phenology. No results of those two sites are given, as only phenological data was collected.

Longerenong 2000 experiment

This experiment repeated the design used at Dooen and Toolondo in 1999, with two sowing times, three seeding rates and two canaryseed cultivars, compared to wheat. However, the difference in sowing times for this experiment was much larger that the differences in the 1999 experiments. This site was a triazine tolerant canola in 1999.

Table below summarises the effects of seeding rate, cultivar and sowing time on yield and seed size. The seeding rate of 15 kg/ha was produced the highest mean yields, but there was a significant interaction between seeding rate and time of sowing. At the earlier sowing time, the lowest sowing rate was the best, with the 30 and 45 kg/ha rate similar. When sown later, there was no significant difference between the three rates. In terms of seed size, the lowest rate produced the largest seed, with the higher rates similar. The later sowing time was significantly higher yielding than the earlier sowing, with higher harvest indices.

Table 5.11: Effect of seeding rate, sowing time and variety on the yield and 1000 seed weight of canaryseed at Longerenong in 2000. Means for variety and TOS with an asterisk are significantly different at P=0.05.

	Yield (t/ha)	Harvest Index (%)	1000 seedwt (g)
SeedRate (kg/ha)	Mean	Mean	Mean
15	0.42	8.0	4.86
30	0.36	6.4	4.36
45	0.36	6.1	4.21
LSD (P=0.05)	0.03	0.8	0.28
Variety			
Moroccan	0.37*	7.3*	4.64*
CDC Maria	0.39*	6.4*	4.32*
TOS			
May-25	0.18*	2.2*	3.85*
Aug-07	0.58*	11.5*	5.11*

There was a significant interaction between seeding rate and cultivars, and this showed that at the later sowing time, seeding rates did not affect the yield, while at the earlier sowing time, higher seeding rates significantly reduced yields (figure 5.2).

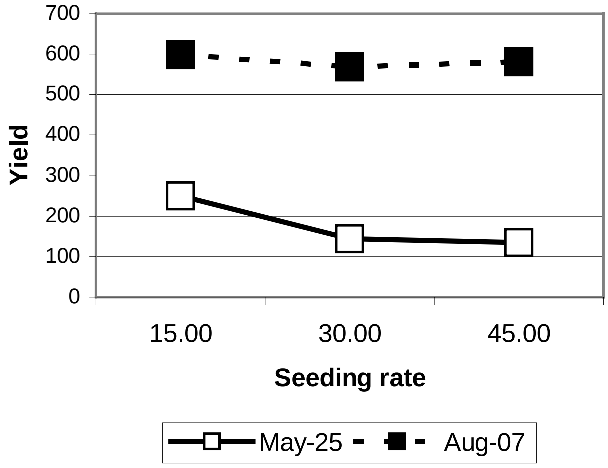


Figure 5.2: The effect of sowing rate and sowing time on the yield of canaryseed sown at Longerenong in 2000. Means are derived from two cultivars.

Dooen 2000 Fertilizer Experiment

A small fertilizer experiment was conducted at the Dooen (TLC) site. The experiment evaluated the effects of additional phosphorus and nitrogen fertilizers on growth, yield and seed quality of canaryseed. Fertilizer treatments used were basal dressings of Mono-Ammonium Phosphate (MAP, 12:22:0:2 N:P:K:S), Triple Superphosphate (TSP, 0:20:0:2) and Pivot 15 (15:13:0:11) applied to supply either 8 or 16 kg/ha of phosphorus, combined with 100 kg N deep banded at sowing as urea. These treatments were compared to an unfertilised control. The season had a poor finish and site mean yield was quite low (0.9 t/ha). The site was sown to field peas in 1999.

There were no significant differences between the base P fertilizer applications, but the application of additional N as deep-banded urea reduced yields from 900 kg/ha to 714 kg/ha. Harvest index declined from 10% to 8% with the additional N, indicating the additional nitrogen had induced extra water use and so this treatment became droughted earlier when compared to the treatments where no additional nitrogen was used. Seed size also declined from 5.62 g per 1000 seeds to 5.22 g per 1000 seeds with the use of deep-banded urea.

Dooen 2000 Herbicide Experiment

There are very few herbicides registered for broadleaf weed control in canaryseed. Canaryseed is recognised as being very susceptible to trifluralin pre-emergence, and this then limits the opportunity for weed control in crop. There is a range of post-emergence broadleafed herbicides that have been used and are registered in Canada, and this experiment aimed to provide preliminary information in Australian conditions. Due to poor seasonal conditions (site mean yield of 640 kg/ha), no useful information was gained from this experiment. Future work in this area should be conducted in close association with chemical companies to ensure that herbicide efficacy can be then be reflected on product labels. This site was also sown in field peas in 1999.

If growers are in doubt about any chemical, they should refer first to the product label to check that the product is registered for the intended use, and then review that decision with a competent agronomist who is familiar with the crop and its stage of growth.

Dooen 2000 Growth Regulator assessment

Plant growth regulators are a possible means of reducing plant height and therefore reducing lodging of the crop. Lodging causes uneven maturity and leads to undesirable levels of green seed in the final product. There would appear to be opportunities for using products such as chlormequat (Cycocel) and ethepon (Etheral) to reduce the height, and therefore improved the yield and seed quality of canaryseed.

Chlormequat is a bioregulator that improves resistance to lodging in wheat, rye and oats. In the UK it is recommended to be used before the second node stage on spring wheats. Chlormequat inhibits cell elongation which leads to shorter crops less prone to lodging. Ethepon is registered for use on barley in Victoria as an anti-lodging agent. It is recommended that ethepon be applied between early to late boot stage on barley, but before the awns or spikes emerge.

Our preliminary investigations indicated that timing of application is critical, as well as ensuring the crops are not drought stressed at application (Aventis 2000) as significant crop damage can occur where ethepon is used under those conditions.

Similar to the work on herbicides, there is scope for a rigorous investigation on the use of growth regulators on canaryseed, with particular emphasis placed on rates and timings to minimise lodging.

Conclusions from the 2000 experiments

In another year with a dry finish, canaryseed yields have not what we would generally consider to be their potential yield. Despite the poor finish, the later sowing was significantly higher yielding than the earlier sowing, and the higher seeding rates were again satisfactory in producing adequate seed sizes. This strengthens the evidence that canaryseed can be sown later, with moderate to high seeding rates and still produce good yields with suitable seed quality.

The fertilizer experiment conducted adds to the 1998 experiments on the use of nitrogen, and as a general practise, the use of supplementary nitrogen at seeding would be discouraged on moderate fertility sites such as those used here.

We would propose that further work be done concerning the application of herbicides and plant growth regulators on canaryseed.

Summary of agronomy experiments

The general conclusions from the work we have conducted since 1998 are that canaryseed appears suitably adapted to the climate and soils of the Wimmera and has a place as a minor crop in arable farming systems. It grows well, and produces dry matter production levels in the range of 4000 to 8000 kg/ha. Depending on how the season finishes, the crop is capable of producing grain yields in the range of 0.4 to 1.6 t/ha, although some growers have achieved yields over 2.5 t/ha in commercial crops. The best yields for canaryseed have been in the southern areas of the Wimmera, where there is slightly higher rainfall. Typically, the low yields are associated with poor harvest indices for the crop, and additional work is should be considered to review ways to improve HI for this crop. Options include careful attention to sowing time and the use of growth regulators.

Figure 5.3 presents a summary of the data collected in these experiments concerning the time of sowing and seed yield of canaryseed. These data show that early sowing has no particular yield advantage for canaryseed, as problems such as frost, disease and lodging all become significant when the crop is sown in May and early June. When sown later than approximately mid-July, the crop will flower and set seed during a time of high water demand, and this affects both yield and seed quality.

Figure 5.3: The relationship between time of sowing and seed yield. Values are means for the cultivars Moroccan and CDC Maria when grown in the Victorian Wimmera.

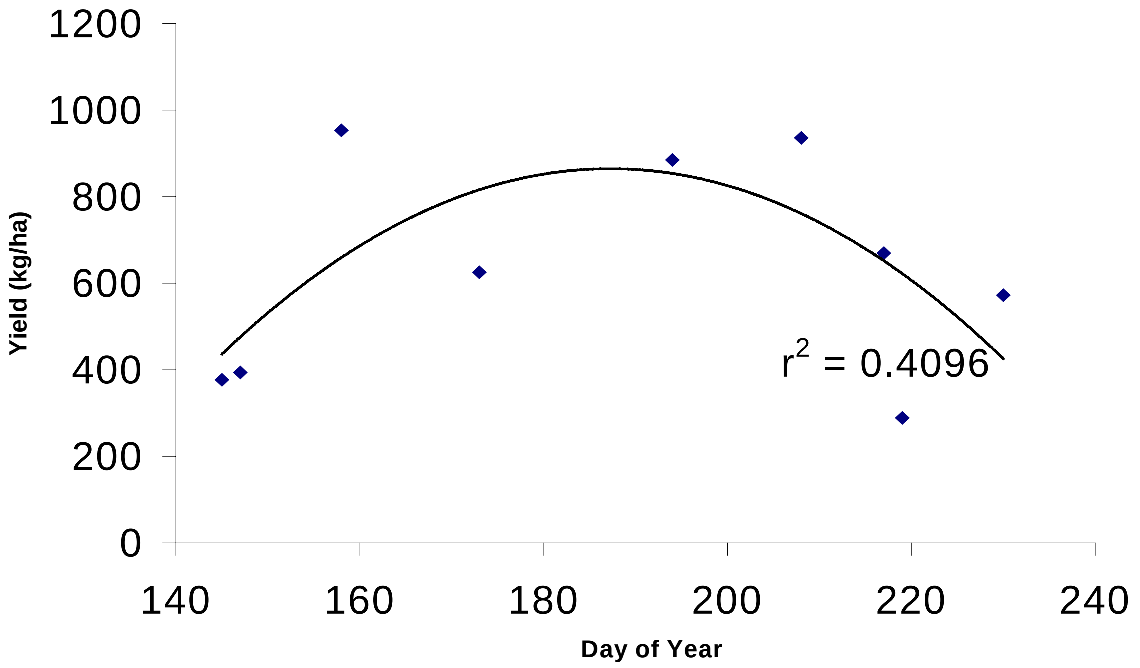


Figure 5.4: A summary of the effect of sowing time on the mean seed size of Moroccan canaryseed when grown in the Victorian Wimmera.

The relationship between seed size and sowing time (figure 5.4) shows that earlier sowings generally have larger seed sizes, and after mid-June, the seed size gradually declines, although there were some situations where seed size was not greatly reduced. If sown after mid-July, seed size could drop to below 6 g per 1000 seeds. Although no firm seed size criteria have been promoted, this value could be considered an agronomic benchmark below which the market acceptance of the seed could be questionable.

Based on these two data sets on yield and seed size, sowing later than day 180 (June 29) would produce the highest yields and the largest seed sizes.

It is difficult to make firm recommendations because of the dry seasons encountered over the experimental period, but it would appear that care should be taken with the use of supplementary nitrogen fertilizers, which can lead to poorer yields through lower harvest indices. We would also propose that higher seeding rates (30 kg/ha) are to be favoured as the way of improving crop vigour and reducing the impact of grass-weed competition. If higher rates are used, seed quality (size) can be reduced.

There are no crop protection chemicals registered for use on canaryseed, and additional testing would need to be considered to develop appropriate crop protection packages, particularly with respect to broad leaf weed control. There are unlikely to be useful grass weed herbicides developed, so the main tool for reducing the impact of annual ryegrass in particular, is to select paddocks that are relatively weed free. It is likely that the best canaryseed paddocks would be those following canola – either a conventional canola or a triazine-tolerant cultivar. Further work is required to determine the tolerance of canaryseed to soil residues of atrazine and simazine.

During the experiments we conducted, there were no insect pests observed, and the only disease identified was powdery mildew (*Erysiphe graminis*) which has also been noted in Queensland canaryseed crops (QDPI, 1999). The Lentil Company has noted problems in the past with RedlLegged Earthmite and Lucerne flea in canaryseed crops.

There is little information about the tolerance of canaryseed to various soil borne root diseases such as Take-All, Rhizoctonia and Cereal Cyst Nematode. As part of our research program flowing from these experiments, we intend to screen canaryseed lines for their susceptibility to these diseases. There is some information concerning the susceptibility of canaryseed to *Pratylenchus neglectus* and *P. thornei*. As a pre-crop, canaryseed left fewer nematodes in the soil than wheat (J. Thompson, *pers.comm.*). This also requires additional clarification in the southern wheat belt, as these tolerances and susceptibilities will largely determine the place that canaryseed can occupy in a crop rotation.

Figure 5.5: Canaryseed rows, Longerenong 1998 experiment, showing good even growth during July 1998. (Photo, R.Norton).

6. Industry Development

As part of this project, a focused series of industry development activities were undertaken. This included field days hosted by The Lentil Company, the presentation of research results at various meetings (scientific and grower), the publication of articles in various magazines (see appendix 3) and the writing of a growers guide to summarise the research findings and present the data to potential growers. Information about canaryseed has also been placed on the Longerenong web site.

Commercial Outcomes

The Lentil Company has also established a range of contacts in Canada, and has signed a testing agreement with the Canadian Special Crops Association concerning access to the glabrous line CDC Maria that has been evaluated in these experiments.

Arising from this research has been an increase in the area sown to canaryseed from around 500 ha in 1998, to around 1000 ha in 1999. Unfortunately, a run of dry seasons from 1998 until 2000 has resulted in canaryseed areas to remain low, as farmers look to more traditional crop options. Growers have viewed canaryseed as a high risk crop which has constrained the expansion in production. This season, indicative prices have been low, which has further deterred areas sown. Our estimate for the Wimmera for 2001 is around 500 ha, which is similar to the time when the project commenced. The buoyant price outlook for canaryseed is likely to make the crop more attractive, particularly now that an agronomic package is available to support the growers.

Depending on prices, now that a suitable agronomic package has been developed to improve grower confidence, the area sown could be expected to steadily increase towards 10,000 ha by 2006. Based on an expected average yield of 1.5 t/ha, this area would produce around 15,000 t of canaryseed for the local and export markets. Placement of this scale of produce into the market is not considered to place unreasonable pricing pressure, and should be a sustainable market scale in the short term. With expected grower returns of around $400 per t gross, this would then generate an industry of $6 million annual farm gate value.

Table 6.1: Wheat, Canola and Canaryseed comparative gross margins – Wimmera.

	Wheat			**Canaryseed**			**Canola**		
Crop Costs ($/ha)	150			120			200		
Typical Yield (t/ha)	3.0			1.5			2.0		
Typical Price ($/t)	160			400			350		
Price/Yield Matrix	**2.0 t/ha**	**3.0 t/ha**	**4.0 t/ha**	**1.0 t/ha**	**1.5 t/ha**	**2.0 t/ha**	**1.5 t/ha**	**2.0 t/ha**	**2.5 t/ha**
75% of Typical Price.	90	210	370	180	330	430	194	325	456
100% of Typical Price	170	**330**	490	280	**480**	680	325	**500**	675
125% of Typical Price.	250	450	650	380	580	880	456	675	893

The future of the industry is particularly price sensitive, as shown in table 6.1. This table shows the comparative estimated gross margins of wheat, canola and canaryseed. These crops were selected, as they are the ones most likely to compete for relatively weed free paddocks with good moisture and fertility levels. The lower cost of the canaryseed is attributed to using no nitrogenous fertilizers and no herbicides, and table 6.2 shows a typical cost structure for growing canaryseed in the Wimmera.

Canola is more expensive to grow than other crops because of the high demand for nutrients and the chemical weed and pest control programs needed.

The gross margins for canaryseed at typical yields and prices (table 6.1) compare favourably with canola and wheat. If prices drop below $300 /t for canaryseed, it will not be an attractive option compared to wheat or canola. This emphasises the need for forward selling or contracting of production for canaryseed, to lock into market and so reduce price risk to growers.

As a rotational crop, canaryseed will require a weed-free situation, and where trifluralin residues are not likely to be present. A suitable position could be following a triazine-tolerant canola crop, although we have – at present – no data on the tolerance of canaryseed to atrazine and simazine. It is as important to fit canaryseed into a rotational system as it is to ensure markets and production risks are minimised. There is only limited data on the susceptibility of canaryseed to common soil borne pathogens such as Take-All, Rhizoctonia, cereal cyst nematode and root lesion nematode. The susceptibility of the crop to these diseases may limit its use following other susceptible cereals, and a clearer definition of these tolerances is required. Further collaboration with growers will identify the best niche for canaryseed.

Table 6.2: Comparative costs for growing wheat, canaryseed and canola.

Crop	**Wheat – 3 t/ha**		**Canaryseed – 1.5 t/ha**		**Canola – 2 t/ha**	
Cost	Item number	Cost/ha	Number	Cost/ha	Number	Cost/ha
Seed bed preparation						
Chisel plough	2 times	$7	4 times	$28	2 times	$14
Presowing knockdown	1 l/ha	$8	1 l/ha	$8	1 l/ha	$8
Seed	75 kg/ha	$20	30 kg/ha	$15	5 kg/ha	$15
Fertilizers						
Double super + Zn	80 kg/ha	$27	80 kg/ha	$27	100 kg/ha	$33
Urea - predrilled	80 kg/ha	$30			100 kg/ha	$35
Pre-sowing herb.						
Trifluralin, plus application and incorporation	1 l/ha	$8	nil		1.5 l/ha	$10
Sowing						
Air seeder	$25/hr	$3	$25/hr	$3	$25/hr	$3
Post-sowing.						
Broadleaf Herb.	Estimate	$18	estimate	$18	Estimate	$30
Plus application		$3		$3		
Insecticides					RLEM	$5
Harvesting						
Windrowing					$25/ha	$25
SP header	$50/hr	$7	$50/hr	$4	$50/hr	$6
Insurance	1.1%	$5	1.1%	$7	1.1%	$10
Cartage	$2/t	$6	$4/t	$6	$3/t	$6
Total Variable Costs		**$147**		**$119**		**$200**

Communication

Meetings

A key aspect of the industry development has been the close liaison between growers and The Lentil Company in sharing information as it becomes available. The Lentil Company hosts an annual field day at its main research site, and each year, canaryseed has been a significant part of the presentations made and the discussion between growers and researchers (figure 6.1). As well as the main field days, other grower information exchange days are conducted with research staff from TLC, The University of Melbourne and growers. In 1998, we sowed demonstration plots of canaryseed at Birchip in association with the Birchip Cropping Group, and these were discussed at the annual field day attended by over 450 farmers. Another demonstration trial was sown at a south western Victorian site near Penshurst in 2000 in conjunction with Southern Farming Systems. The research sites at Longerenong have also hosted under-graduate student tours and discussion sessions, as well as farmer tours.

Another dimension to the industry development aspect of this project is the participation of the research team in a number of scientific meetings to discuss the outcomes of this research. Interest has been keen and there is now widespread awareness of the crop as an alternative cereal in the Wimmera and high rainfall regions of southern Australia.

A list of meetings and field days is given below:

The Lentil Company Field Days – October 1998, September and October 1999 and September and October, 2000.
Audience - growers.

Field Walk – Toolondo site, August 1999.
Audience - growers.

Birchip Cropping Group, Annual Field days, September 1999 and September 2000.
Audience – growers and agribusiness.

Grains Research and Development Corporation – High Rainfall Crop Updates – August, 2000.
Audience - growers.

Joint Centre for Crop Improvement – Annual Symposium – November 2000, October 2001.
Audience - academics, scientists, post-graduate students and industry people.

Australian Society of Agronomy – 10th Biennial Conference – January 2001.
Audience - scientists, industry people, post-graduate students.

Website development

This project has also been featured on the Longerenong College web site. The project brief has been made available, along with some updates of the work and presentations made to industry groups. The site can be accessed at **http://www.longerenong.com** .

Growers Guide

A summary of the research project and its application to growers has published as a “growers guide”. This small publication has been modelled on growers guides published by the Victorian Department of Natural Resources and Environment for fababeans, chickpeas, peas and lentils. This builds on an earlier information sheet produced by TLC, and is available at no charge to growers. Initial distribution of the growers guide will be through TLC's mailing list, while other copies will be made available through the Victorian Institute for Dryland Agriculture. A copy of the information enclosed in the growers guide is given in appendix 3 to this report.

Masters Degree

The final aspect of communication concerning this research was to collate and present the agronomic and phenological studies as a thesis for submission to the degree of Masters of Agricultural Science, at The University of Melbourne. From early on in the research, Mr John Ford was appointed to undertake the research and he is working towards submission of his thesis.

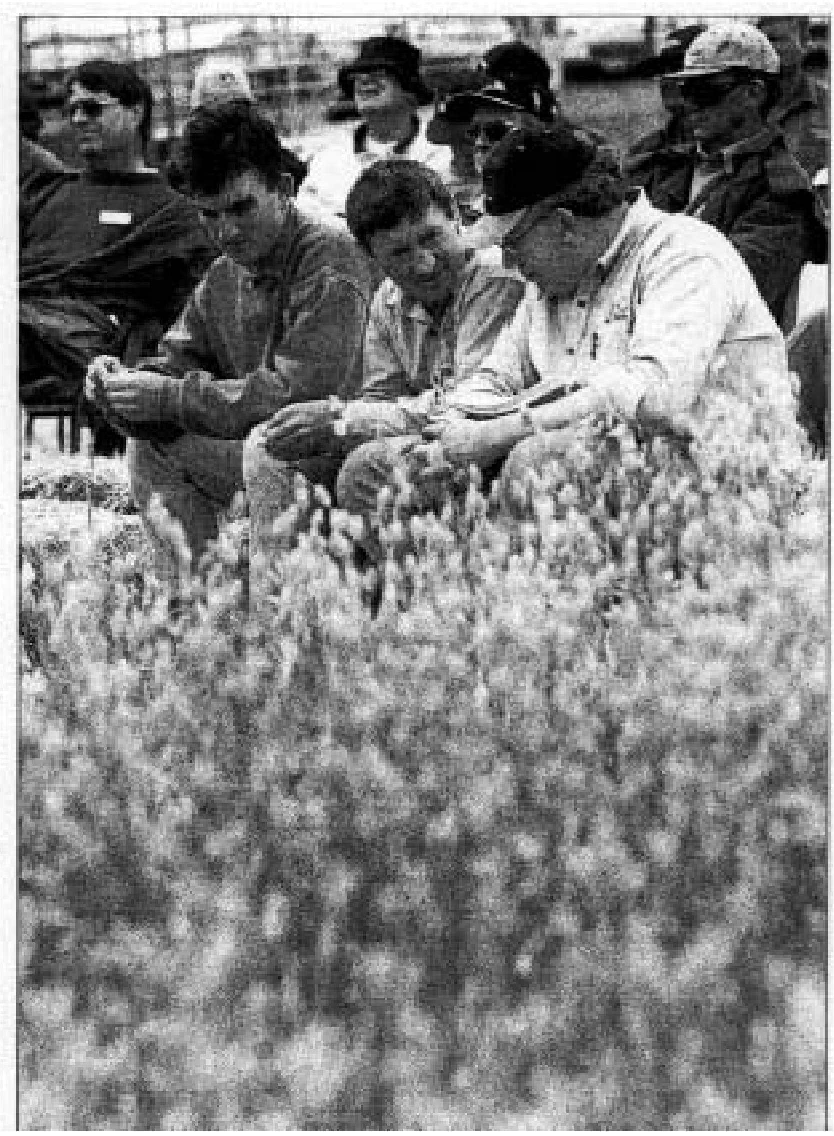


Figure 6.1: Wimmera Mail Times, "Wimmera Farmer Supplement", October 1998. Photo caption reads : "Green Lake farmer Brian Matuschka, IAMA Manager Darryl McCrae and The Lentil Company export consultant Peter Semmler listen to Longerenong College lecturer Rob Norton speaking about canary grass." *Photo courtesy of the Wimmera Mail Times, taken by David Fletcher.*

International Visits

This project provided partial support for two visits to Canada. The first was by Ms Janine Carter of The Lentil Company during the Canadian summer of 1998. The purpose of this visit was to discuss the access agreement that TLC had negotiated with the Canadian Special Crops Association and to inspect field crops of canaryseed in the prairie provinces of Alberta, Saskatchewan and Manitoba. It was from this initial visit that information about the general agronomic issues was collected. At that time, the Canadian industry was very buoyant with record plantings feeding interest in the crop.

In 2001, Mr Peter Semmler and Mr Rob Launder, both of The Lentil Company, attended an international pulse trading symposium in Vancouver, British Columbia. As part of that visit, they had discussions with various trading companies on the commercial opportunities for Australian canaryseed. It was largely based on those discussions that the information presented in chapter 2 of this report was compiled. The areas sown in Canada have declined significantly since the visit of Ms Carter in 1998 as a result of lower world prices, but this reduced production is now flowing through to a major shortage of grain in the world trade. Over the past three months, we have had discussions with companies from the United States of America, the United Kingdom and Canada concerning the opportunities for Australian canaryseed entering the world market. Unfortunately, due to seasonal conditions in this region, there is very little capacity to meet the demand for 2001, but it would appear that the world market is likely to have very low carryout stocks until production picks up in Canada.

Also, as part of the research project, the authors of this report have been in contact with research scientists in Canada and Europe concerning canaryseed.

Continuing work

Through its involvement with TLC and other industry groups, The University of Melbourne will continue with investigation into canaryseed. In 2001, we have planted a small experiment with four of the best accessions from the 2000 experiment and will use this to bulk up seed for more extensive testing in the next few years. In addition, through the Joint Centre for Crop Improvement, there is the opportunity for under-graduate honours projects on various aspects of canaryseed agronomy. We have proposed some screening of canaryseed against the diseases Take-All, Rhizoctonia and Cereal Cyst Nematode, all of which would make appropriate honours projects.

TLC will continue with its agronomic work on developing crop protection packages appropriate to the crop.

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8. Appendices

Appendix 1. Canaryseed quality standards

Part A: MINIMUM RECEIVAL STANDARDS FOR NO.1 CANARYSEED

Physical characteristics

The canaryseed shall be hard and well-filled and typical colour for the season.

The canaryseed shall be free from animal excreta, rodents, live insect pests and any chemical not registered for use on stored canaryseed or in excess of legal tolerances.

There shall be nil tolerances on pickling compounds/seed dressings or any fungicide added to the canaryseed as a seed dressing and any tainting agents and/or other contaminants imparting an odour not normally associated with canaryseed, including caked, bin burnt and/or mouldy canaryseed which are a result of product storage.

There shall be nil acceptance on Toxic and/or Noxious weed seeds which are prohibited by state laws against inclusion in stockfeeds.

Moisture content

The maximum moisture content allowable is 12%.

Purity

The minimum purity shall be 97% by weight.

Foreign matter

Foreign matter shall not exceed 3% by weight of which no more than 0.5% shall be unmillable material (soil, dirt, stones) and no more than 1% ryegrass retained over the 1.2mm slotted screen.

Screen sizes

For grading in the defective categories, samples will be drawn from grain that has passed through a 3.0mm round hole screen and retained over a 1.2mm slotted screen.

Defective grain

Poor colour (hulled seed) and cracked seed tolerance = 4% (max)

Weed seed exclusions and tolerances

There is a nil tolerance for tree hogweed, dock and muskweed unless otherwise specified. There shall be no more than 1% ryegrass retained over the 1.2mm slotted screen.

PART B: MINIMUM RECEIVAL STANDARDS FOR NO.2 CANARYSEED

Physical characteristics

The canaryseed shall be hard and well filled and typical colour for the season.

The canaryseed shall be free from animal excreta, rodents, live insect pests and any chemical not registered for use on stored canaryseed or in excess of legal tolerances.

There shall be nil tolerances on pickling compounds/seed dressings or any fungicide added to the canaryseed as a seed dressing and any tainting agents and/or other contaminants imparting an odour not normally associated with canaryseed, including caked, bin burnt and/or mouldy canaryseed which are a result of product storage.

There shall be nil acceptance on Toxic and/or Noxious weed seeds which are prohibited by state laws against inclusion in stockfeeds.

Moisture content

The maximum moisture content allowable is 12%.

Purity

The minimum purity shall be 98% by weight.

Foreign matter

Foreign matter shall not exceed 2% by weight of which no more than 0.5% shall be unmillable material (soil, dirt, stones).

Screen sizes

For grading in the defective categories, samples will be drawn from grain that has passed through a 3.0mm round hole screen and retained over a 1.2mm slotted screen.

Defective grain

Poor colour (hulled seed) and cracked seed tolerance = 5% (max)

Part C: MINIMUM EXPORT STANDARDS FOR NO. 1 CANARYSEED

Physical characteristics
The canaryseed shall be hard and well filled and typical colour for the season.

The canaryseed shall be free from animal excreta, rodents, live insect pests and any chemical not registered for use on stored canaryseed or in excess of legal tolerances.

There shall be nil tolerances on pickling compounds/seed dressings or any fungicide added to the canaryseed as a seed dressing and any tainting agents and/or other contaminants imparting an odour not normally associated with canaryseed, including caked, bin burnt and/or mouldy canaryseed which are a result of product storage.

There shall be nil acceptance on Toxic and/or Noxious weed seeds which are prohibited by state laws against inclusion in stockfeeds.

Moisture content
The maximum moisture content allowable is 12%.

Purity
The minimum purity shall be 99% by weight.

Foreign matter
Foreign matter shall not exceed 1% by weight of which no more than 0.5% shall be unmillable material (soil, dirt, stones).

Screen sizes
For grading in the defective categories, samples will be drawn from grain that has passed through a 3.0mm round hole and retained over a 1.2mm slotted screen.

Defective grain
Poor colour (hulled seed) and cracked seed tolerance = 4% (max)

Weed seed exclusions and tolerances
There is a nil tolerance for tree hogweed, dock and muskweed unless otherwise specified.

Part D: MINIMUM EXPORT STANDARDS FOR NO. 2 CANARYSEED

Physical characteristics

The canaryseed shall be hard and well filled and typical colour for the season.

The canaryseed shall be free from animal excreta, rodents, live insect pests and any chemical not registered for use on stored canaryseed or in excess of legal tolerances.

There shall be nil tolerances on pickling compounds/seed dressings or any fungicide added to the canaryseed as a seed dressing and any tainting agents and/or other contaminants imparting an odour not normally associated with canaryseed, including caked, bin burnt and/or mouldy canaryseed which are a result of product storage.

There shall be nil acceptance on Toxic and/or Noxious weed seeds which are prohibited by state laws against inclusion in stockfeeds.

Moisture content

The maximum moisture content allowable is 12%.

Purity

The minimum purity shall be 98% by weight.

Foreign matter

Foreign matter shall not exceed 2% by weight of which no more than 0.5% shall be unmillable material (soil, dirt, stones).

Screen sizes

For grading in the defective categories, samples will be drawn from grain that has passed through a 3.0mm round hole and retained over a 1.2mm slotted screen.

Defective grain

Poor colour (hulled seed) and cracked seed tolerance = 5% (max).

Appendix 2: Publications from the research.

Ford, J.F., R.M. Norton, S.E. Knights and R.G. Flood (2001). High Sowing Rates Reduce Seed Weight in Canaryseed (Phalaris canariensis L.). *Proceedings of the 10th Australian Agronomy Conference, Hobart, 2001* p 131. (full paper on CD ROM).

John Ford (2000). Canaryseed a new crop for southeastern Australia. Northern Irrigated Cropper.

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John Ford, Rob Norton, Sue Knights, Ray Flood (2000) Growing quality canaryseed (Phalaris canariensis L.), GRDC Grower Updates, August 2000. (http://www.grdc.com.au/)

Norton, R.M., Knights, S.E. and McCormick K.M. (1998). New grain crops for southeastern Australia. Proceedings of 4th Cropping Zone Conference (Ed R.M. Norton), Tatura October 29-30, 1998. p31-32.

Following submission of his Master's Thesis, John Ford intends to publish three papers from this work.

HIGH SOWING RATES REDUCE SEED WEIGHT in CANARYSEED (*Phalaris canariensis* L.)

J.F. Ford[1], R.M. Norton[1], S.E. Knights[1] and R.G. Flood[2]

[1]*Joint Centre for Crop Improvement, Longerenong College, The University of Melbourne. Horsham, Vic 3401*
[2]*Department of Natural Resources and Environment, VIDA, Horsham,*

ABSTRACT

Phalaris canariensis L. (canaryseed) is a potential winter crop for southern Victoria. Canaryseed is intolerant to current grass herbicides and has poor early vigour. Increasing plant density and delaying time of sowing are potential agronomic solutions to control annual grass weed such as annual ryegrass (*Lolium rgiidum*). This paper reports to results of experiments that investigate the effect of increasing plant density and delaying time of sowing on average seed weight.

Increasing plant density from 120 to 308 plants m^{-2} and delaying sowing did not significantly reduce average seed weight. However, increasing plant density from 120 to 308 plants m^{-2}, significantly reduced average seed weight ($P = 0.05$).

INTRODUCTION

Crop species diversity in cropping rotations is an important way to manage environmental and agronomic risks. Currently cropping rotations in southern Victoria include wheat, barley, peas, beans and canola. The addition of *Phalaris canariensis* L. (canaryseed) to southern cropping rotations will give farmers one more option to help widen crop rotations and reduce disease risks in particular.

Southern Victorian farmers use triazine tolerant (TT) canola varieties at the start of their cropping rotation to reduce large populations of *Vulpia bromoides* Gray, (silver grass), *Phalaris minor* Retz.,(annual phalaris), *Phalaris paradoxa* L.(annual phalaris), and *Lolium rigidum* Gaudich. (annual ryegrass) in subsequent crops. Because of this opportunity to reduce weed burdens, the area planted to TT canola has increased from an estimated 3050 ha in 1995/96 to an estimated 9130 ha in 1998/1999 (1, 2). Canaryseed is susceptible to available pre- and post-emergent grass herbicides (5), and the widespread use of TT canola provides a niche in rotations with low annual grass weed pressure that may suit canaryseed.

Increasing plant density to improve early vigour and delaying time of sowing to allow for non-selective weed control are agronomic methods being investigated for use in southern Victoria. However, both these practices may reduce seed size, which is an important quality criteria for the birdseed market (3). This experiment was established to assess the effect of these practices on average seed weight.

MATERIALS AND METHODS

The experiment was located at Dooen, Victoria (36º40’07 S, 142º18’05 E) in 1999 on a Wimmera grey clay soil (6). Prior to each time of sowing 675g ha^{-1} of glyphosate was applied to kill existing weeds. Plots were sown directly into standing wheat stubble using a cone-seeder fitted with Ryan press wheels.

The experiment was designed as a randomised complete block with four replications of three sowing rates (15, 30 and 45 kg ha^{-1}) with two sowing dates (June 22 and August 05) using two cultivars (CDC Maria and Moroccan). CDC Maria is a CDC Maria line imported from Canada while Morroccan was selected in Queensland for the northern grain belt and is widely grown commercially in Australia.

Broad leaf weeds were controlled at 4-leaf crop stage, using a mixture of 412.5 g ha^{-1} of bromoxynil and 300 g ha^{-1} of MCPA.

One metre of row was harvested at the four leaf stage to determine dry matter and plant density. A sub sample of 10 plants was randomly selected from through out the plot to determine leaf area. Leaf area was determined using Leica leaf area metre.

Plots were harvested once all heads had ripened (grain moisture content 12 %) to determine overall yield. A sub sample of 200 seeds was used to determine average seed weight.

Rainfall was recorded at Longerenong College, three kilometres south of experiment site. The May to October toal was 199 mm which is a decile 2 season in 110 years of rainfall data.

RESULTS

Figure 1 shows the average plant density from the 15 kg ha^{-1} treatment (120 plants m^{-2}). This was significantly less that the 30 kg ha^{-1} and 45 kg ha^{-1} sowing rate treatments (213 plant m^{-2} and 308 plants m^{-2} respectively).

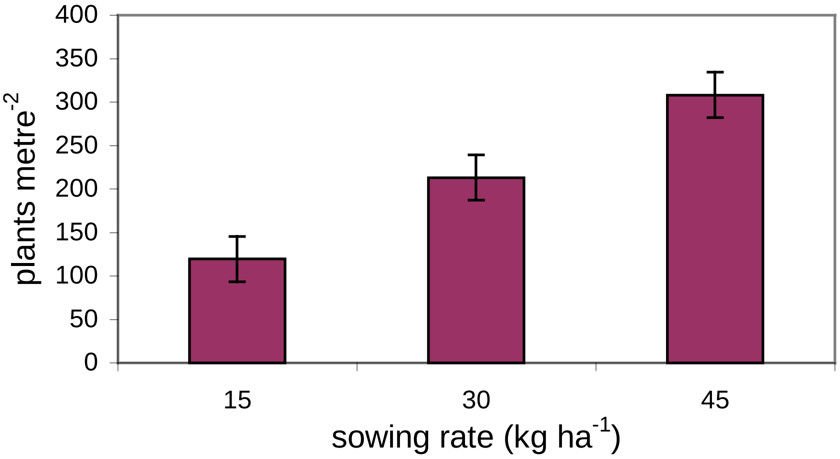

Figure 1. Plant density of Canaryseed at three sowing rates. LSD = 26.14, P = 0.05

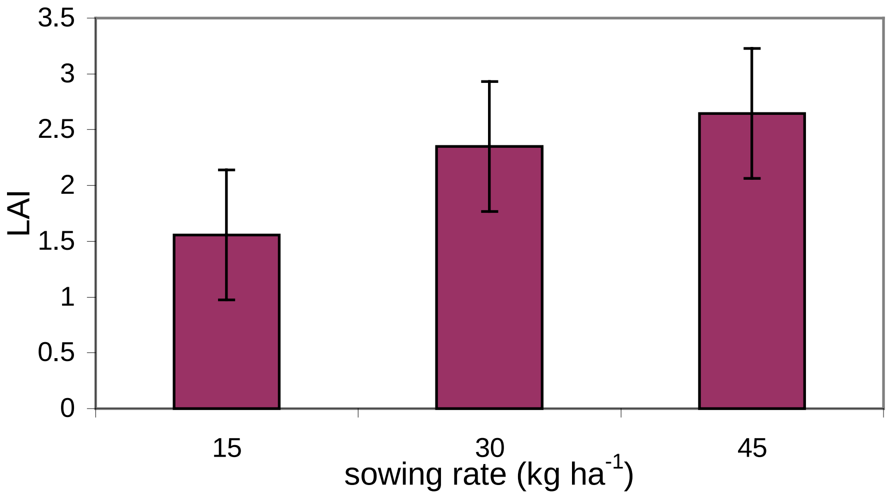

Figure 2. Leaf area index of Canaryseed at three sowing rates. LSD = 0.59, P = 0.05

The effect of increasing sowing rate from 15 kg ha^{-1} to 30 and 45 kg ha^{-1} was to increase average LAI from 1.6 to 2.4 and 2.7 respectively (P = 0.05). The higher sowing rates were not significantly different with respect to LAI (figure 2).

Increasing sowing rate from 15 kg ha^{-1} to 30 kg ha^{-1} did not affect seed weight, but the highest sowing rate caused a decline in seed weight from 7.04 to 6.68 µg (figure 3) When averaged across the two sowing dates, the mean seed weight of CDC–Maria was significantly higher than Moroccan (average seed weight 7.00 µg and 6.76 µg respectively).

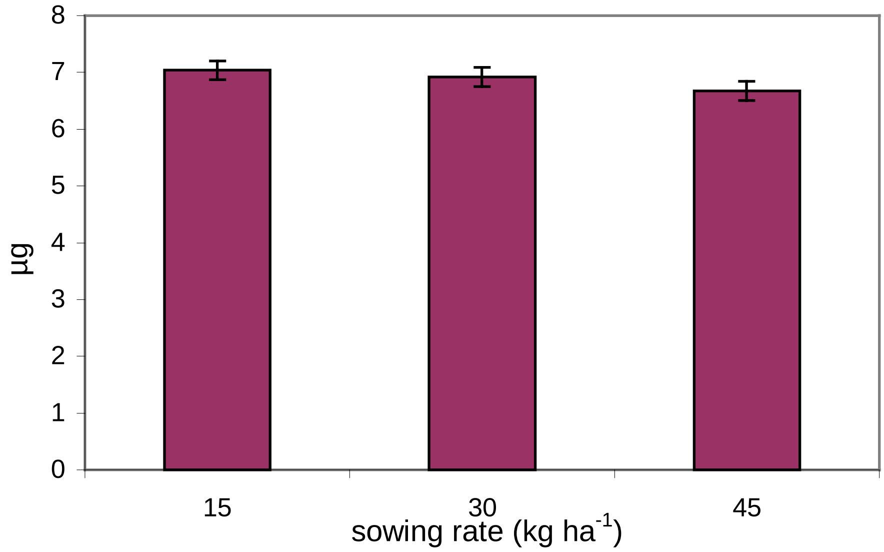

Figure 3. Single grain weight for Canaryseed at three sowing rates. LSD = 0.17, P = 0.05.

The average seed yield of plots sown on the 5 August were higher than the earlier sowing although there was no interaction. Between vareitey and seeding date.

out yielded plots sown on the 22 June by (average yield 571 kg ha $^{-1}$ and 460 kg ha^{-1}), P = 0.05.

Increasing sowing rate from 15 kg ha^{-1} to 30 and 45 kg ha^{-1} did not affect yield significantly (P = 0.05). Mean yield was 515 kg ha^{-1}.

DISCUSSION

Increasing plant density in barley (*Hordeum vulgare* L.) has been shown to suppress weedy species while maintaining economic yield (7, 9). To improve the poor early vigour of canaryseed (8), plant density was increased from 120 to 308 plants m^{-2}. Leaf Area Index (LAI) is an important measure of early vigor (10), increasing plant density from 120 to 308 plants m^{-2} increased LAI from 1.6 to 2.7. Increasing plant density from 120 to 230 plants m^{-2} increased LAI from 1.6 to 2.4, suggesting that early crop vigour was significantly improved by increasing plant density. However the difference in LAI between 230 and 308 plant m^{-2} was not significant suggesting that a plant density of 230 plant m^{-2} is the minimum required to optimise early vigour.

Yield was unaffected by plant density, suggesting that Canaryseed like other cereals is able to adjust yield components so that kernels m^{-2} remains unchanged (4).

Large plump seed is demanded by bird seed markets (3). In contrast to (4) increasing plant density from 120 to 308 plants m^{-2} significantly reduced average seed weight. While increasing plant density from 120 to 230 plants m^{-2} had no significant effect on average seed weight. These are preliminary results in a decile 2 year suggesting that competition for soil moisture reduced seed size at the highest plant density.

Summer drought during grain fill is a potential threat to seed quality as late sown crops may run out of soil moisture while finishing grain fill. No significant difference in seed size between the 5 August and 22 June sowing dates was measured despite a dry season. It is possible that the 5 August time of sowing was able to take better advantage of 38.6 mm of rain in October because it out yielded the 22 June sowing date by 111 kg ha^{-1}.

CONCLUSIONS

The preliminary results from this experiment suggest that, increasing plant density improved early vigour in canaryseed. Increasing plant density did not reduce yield, however at the highest plant density average grain weight was significantly reduced. Delaying sowing until 5

August did not negatively affect yield or average grain weight.

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Canaryseed a New Crop for South Eastern Australia

John Ford

A collaborative research project at Longerenong College is currently investigating agronomic issues relevant to developing a Canaryseed industry in South Western Victoria. This project is a partnership between the University of Melbourne, The Lentil Co and the Rural Industries and Development Corporation. The project is part of the New Grain Crops Research program being conducted under the supervision of Dr Sue Knights and Dr Rob Norton at Longerenong College. This program attempts to introduce new crops into the cropping regions of Victoria. Canaryseed at the moment is a “niche market” crop, subject to wild price fluctuations. Little is known about its agronomy and the full potential of the crop. When looking at this crop, farmers must remember the other “new crops” that have travelled the path of a new crop in Victoria began their journey as a unknown crop in a insecure niche market. Over time these crops found larger markets, better adapted varieties were bred and more suitable agronomic practices were established.

What is Canaryseed
Canaryseed is an annual crop plant, which is a member of the same genus that contains *Phalaris aquatica* a common pasture species and roadside weed here in Australia. Other weedy cousins of Canaryseed are the annual Canary Grasses; *Phalaris minor* and *Phalaris paradoxa,* both of which are common crop weeds.

What is Canaryseed used for?
Canaryseed is grown and marketed today solely as a component in bird seed mixes. The present world market for Canaryseed is approximately 300,000 tonnes. Canada is the major market supplier producing up to 250,000 tonnes per annum for export and domestic markets. It appears that the Canadians have the Canaryseed market sewn up, however opportunities do exist. The Canadian department of agriculture estimates the world wide bird seed market to be increasing at three percent per annum. Market demand is being driven by more and more people living in high density housing throughout the world. Pets, other than caged birds and fish, are not practical in such housing. Birds are the second most common pet after fish.

Marketing Opportunities for Canaryseed
Australia currently imports much of its birdseed from other sources, in particular China. An opportunity exists for import replacement. Due to Australia’s proximity to Asia we are well placed to provide seed to some of the world’s largest birdseed markets.

Commodity Prices and on Farm Marketing
The world Canaryseed market is a niche market, because of this it is prone to under and over supply. Consequently the price of Canaryseed varies greatly depending on the size of the North American crop, not unlike most other agricultural commodities produced in Australia. The price can vary from A $ 350.00 / ton to A $ 700.00 / ton depending on the Canadian cropping season. Fortunately Canaryseed can be stored easily, on farm storage is essential if good prices are to be received for the crop.

Quality of the seed at harvest is essential for successful marketing. Seed Merchants buy seed entirely on visual characteristics. Seed has to be uniform in size, shine and colour. Seed is easily dehulled and split if drum speeds at harvest are too fast. Green seeds find their way into the sample if the crop is harvested too soon. Timely and careful harvesting could make the difference between selling your crop at a market premium and having a silo full of almost worthless grain.

Production Considerations that are not yet proven about Canaryseed

Canaryseed is an under researched crop - little is known about what it can and cannot do. It is generally accepted that the crop is more tolerant of salinity, waterlogging and pratylenchus infestation than wheat. How tolerant the crop is of these things in comparison to crops other than wheat is not known for sure. However thinking a little about the plant and where the plant evolved may help predict some answers. The plant is shallow rooted, most shallow rooted species are adapted to waterlogging. Canaryseed evolved in the middle east an area of the world which like Australia is arid and has high levels of soil salinity. The crop would also have coevolved with wheat and chickpeas, suggesting that it would also have had to tolerate the same parasites which infected those crops. If anyone thinks they would like to grow Canaryseed in an environment which is challenged by salinity or waterlogging my suggestion would be to grow only a little at first too see what happens.

Canaryseed in Australia

Canaryseed was grown in South Australia in the 1840's as a forage crop for horses. Canaryseed has been grown as a winter crop in Southern Queensland and Northern NSW since the 1970's. Canaryseed is better adapted to the cooler climates of Victoria and Southern NSW, small acreages of Canaryseed have been grown in Victoria since the 1970's. Problems with ryegrass and annual phalaris have prevented the crop from becoming more popular in Victoria. At the moment there are no herbicides registered to control grass weeds in Canaryseed. However with the popularity of triazine tolerant Canola (TT Canola) in Victoria, an opportunity exists to incorporate Canaryseed into cropping rotations immediately after TT Canola. There is potential for versatility with Canaryseed, sowing in spring in irrigation or high rainfall areas to overcome severe waterlogging for example.

How to grow Canaryseed

The fertiliser requirements for Canaryseed are similar to those of wheat, though it would be wise not to apply too much nitrogen as the crop is prone to lodging. Canaryseed is generally sown as a winter crop and harvested in December. Canaryseed has a high moisture requirement and will probably need irrigating in the northern areas of Victoria. Canary is not very drought tolerant and is not well adapted to dry cropping areas, Canaryseed also suffers from powdery mildew in some years.

If the crop is sown in spring to be irrigated over summer seed will have to be chilled for two weeks to ensure early flowering. The crop can be grazed by stock up until stem elongation. Grazing could be useful in reducing the amount of lodging at harvest.

Table 1. Table of Canaryseed agronomic information based on Darling Downs Winter Crop Management Note Book 1999 – 2000 edition (Queensland Department of Primary Industries).

Sowing Time:	April – September, later sowings may require chilled seed
Seeding Rate:	9 – 15 kg / Ha
Sowing Equipment:	Standard combine or airseeder, crop maybe direct drilled or conventionally sown
Row Spacing:	18 cm
Fertiliser Requirements:	As for wheat
Sowing Depth:	50 – 75 mm
Disease:	Susceptible to Powdery Mildew, in severe cases consult agronomist
Harvest time:	December – January
Harvest Equipment:	Conventional combine harvester
Yield:	Dryland 1.0-1.5 t/ha Irrigated 2-3 t/ha
Moisture:	13 %
Grain weight:	70 kg/hl
Market:	Normal merchant channels

Strategies for Growing canaryseed (*Phalaris canariensis* L.) in Southern victoria

John Ford[1], Rob Norton[1], Sue Knights[1] and Ray Flood[2]
[1]JCCI, Department of Crop Production, University of Melbourne VIC 3401, Australia
[2]JCCI Fellow, VIDA, Horsham 3401, Australia

INTRODUCTION

Canaryseed (*Phalaris canariensis* L.) is a winter crop with the potential for inclusion in southern Victorian cropping rotations. Canaryseed is marketed entirely on visual appearance and plump golden seed is essential (1).

Canaryseed has poor early vigor (2) and is susceptible to all available grass herbicides (3). It is proposed that increasing plant density and delaying sowing to allow for non-selective weed control will reduce competition from grass weeds.

In 1999 a experiment was conducted to determine the effect of sowing date and plant density on average seed size and yield.

MATERIALS & METHODS

A experiment was located at Dooen, Victoria conducted in 1999 on Wimmera grey clay. The cultivars Moroccan and CDC Maria were sown on 22nd June and 5th August at sowing rates of 15, 30 and 45 kg/ha.

RESULTS & DISCUSSION

Density & Yield. No significant differences in yield were observed between 15, 30 and 45 kg/ha sowing rate treatments. Mean yield was 475 kg/ha.

Density & Seed Size. Increasing sowing rate from 15 kg/ha to 30 kg/ha did not significantly reduce seed size. Seed size declined as seeding rate went from 15 kg/ha to 45 kg/ha (figure 1).

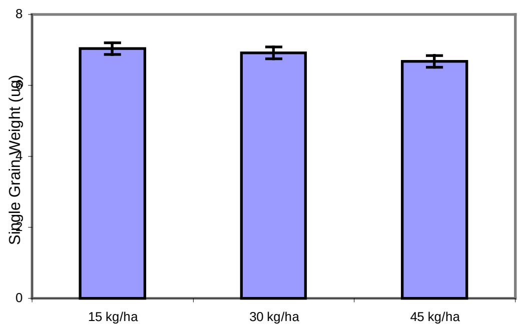

Figure 1: Canaryseed single grain weight of 15, 30 and 45 kg/ha sowing rates. Error bars indicate LSD, P = 0.05.

Time of Sowing. The 5th August sowing significantly out yielded the 22nd June sowing by 111 kg/ha. This suggests there is no significant yield penalty when time of sowing is delayed until late winter in the Victorian Wimmera.

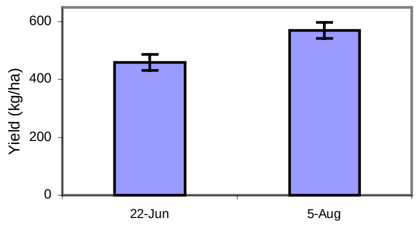

Figure 2: Average yield of Canaryseed sown on the 22nd of June and 5th of August 2000. Error bars indicate LSD, P = 0.05.

Summary of Preliminary Findings:

Sowing rates can be increased to 30 kg/ha without affecting yield.

Increasing sowing rate to 30 kg/ha will not significantly reduce seed size.

Sowing Canaryseed maybe delayed until late winter to enable grass weed control to be done.

ACKNOWLEDGMENTS

This project is funded by the Rural Industries Research and Development Corporation, and The Lentil Company. I would like to thank Longerenong College staff for their generous support.

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Title

Growing Quality Canaryseed (Phalaris canariensis L.)

Description

Research Update - Southern Region - 2000

Key Words

Canaryseed, Increase Plant Density, Delay Sowing

***GRDC Codes**

Program 2.3 Coarse Grains Productivity

Authors

John Ford, Rob Norton, Sue Knights, Ray Flood Joint Centre for Crop Improvement, The University of Melbourne.

Presented

Hamilton, VIC

*Note - this report may contain independently supported projects, which complement the work in this GRDC research program.

Take Home Message

Canaryseed is a niche market crop.

Canaryseed is a potential crop for moderate to high rainfall areas.

It is not possible to control annual grass weeds in Canaryseed using herbicides.

Non-selective methods of weed control must be used when preparing paddocks for Canaryseed.

Delaying sowing until a second germination of weeds after the winter break may assist in reducing weed competition and product contamination.

Increasing sowing rates to 30 kg/ha will increase yield and increase competitive ability of crop without significantly affecting seed size.

Another Option for Southern Victoria

At present there are only a few crops incorporated into rotations in southern Victoria. **Canaryseed** (*Phalaris canariensis* L.) is a cereal with the potential to increase diversity in southern Victorian cropping rotations because of its potential to withstand waterlogging. Canaryseed is the preferred ingredient in bird seed mixes for aviary birds because of its excellent nutrient profile. The birdseed market is a volatile niche market that places emphasis on product quality. Grain colour, size and uniformity are extremely important for successful marketing of Canaryseed.

The single most important agronomic problem concerning Canaryseed in Southern Victoria is its sensitivity to grass herbicides. Canaryseed is susceptible to group D pre emergent grass herbicides (trifluralin) and post-emergent group A and group B grass herbicides. Increasing the competitiveness of Canaryseed crops by increasing plant density is a possible way of coping with annual grasses in Canaryseed while delaying sowing to allow for non-selective weed control (mechanical or non-selective herbicide).

A experiment at Dooen found that increasing sowing rate could increase crop competitiveness, increase yield and improve quality. Delaying time of sowing for six weeks allowed for increased weed control prior to sowing while still providing an economic yield.

Dealing with Grasses: Increase Plant Density & Delay Sowing

Two potential ways to overcome the negative effect on yield and quality annual grass weeds have in Canaryseed is to increase plant density and to delay sowing.

Increase Plant Density

Increasing sowing rate increased yield. Increasing sowing rate from 15 kg/ha to) kg/ha and 45 kg/ha sowing rates increased yield from 499 kg/ha to 528 kg/ha ıd 520 kg/ha respectively. Canaryseed was more vigorous during establishment,) kg/ha and 45 kg/ha sowing rates had 50 % more leaf area than did the 15 kg/ha eatments. However better yield and vigour came at the cost of seed weight. anaryseed markets recognize small seed as inferior, a consideration that must be ken into account when sowing at high rates. To ensure that seeding rate affects ed size as little as possible sowing at 30 kg/ha is suggested. A 30 kg/ha sowing te ensures better vigour and yield.

Table 1. Results from 1999 Canaryseed sowing rate experiment at Dooen, Victoria.

Sowing Rate (kg/ha)	Plant Density (plants/square metre)	Leaf Area Index at Early Tillering	Yield (kg/ha)	Single Grain Weight (ug)
15	120	0.62	499	7.04
30	208			

0.94

528

6.92

45

308

1.06

520

6.68

LSD (p = 0.05)

26

0.24

34

0.17

Delay Sowing

Delaying sowing to allow for weeds to germinate after a light cultivation soon after the break maybe a useful way to ensure that Canaryseed faces as little competition from annual grasses as possible.

Table 2. 1999 Canaryseed yield from two sowing dates at Dooen, Victoria.

Date Sown	Yield (kg/ha)
22 - June	460
5 - August	571
LSD (p = 0.05)	28

Canaryseed was sown in June and six weeks later in August with a May - October rainfall of 199 mm at Dooen Victoria. August sowing treatment out yielded the June sowing by 25 %. The six-week delay in sowing allowed a second germination of weeds to be controlled by roundup application before sowing in August.

Delaying sowing does have associated risk because of the chance of low spring rainfall. Times of sowing experiments are currently being repeated to confirm 1999 results.

Further work on Canaryseed

Rural Industries Research Development Corporation (RIRDC) is funding further Canaryseed research on:

Growth regulators to reduce lodging of Canaryseed crops.

Characterising phenology of Canaryseed in Southern Victoria.

Screening overseas varieties for adaptation to southern Victorian conditions.

John Ford Ph: (03) 5322 2222

Email: j.ford2@pgrad.unimelb.edu.au

New Grain Crops for Southeastern Australia

Rob Norton, Sue Knights and Kate McCormick
Joint Centre for Crop Improvement, Longerenong College, The University of Melbourne.

In southeastern Australia, the whole farming system has been dramatically altered by the widespread adoption of new crops, the development of new husbandry sysstems (e.g minimum tillage and raised bed systems), fuelled by declining terms of trade for grazing industries. The are opportunities for new crops within existing cropping areas, as well as moving into high rainfall and low rainfall environments. The development of canola has changed rotations and provided farmers with a widely adapted and profitable crop. This achievement did not come about easily, and was the result of genetic improvements in oil fatty acid composition and the reduction in seed glucosinolates. The Australian success is also a consequence of the success of breeding for blackleg resistance. While it is doubtful that a new crop will come along with such a huge impact as canola, it does indicate that at one time canola was thought of as new and novel.

In the Wimmera, we are able to grow a wide range of cereals (wheat, durum wheat, triticale, oats, rye, barley, canaryseed), pulses (field peas, beans, c
hickpeas, lentils, fenugreek, vetch) and oilseeds (canola, mustard, safflower, linseed/linola) as well as annual and perennial pastures. In certain years sunflower and sorghum have also been successfully produced. Although the current range of crops is diverse, there are still some significant opportunities to develop new crops for as our farming system evolves.

Criteria for a successful new crop for southeastern Australia

For a crop to fit into our current farming system, there would appear to be several criteria that should be met. These are:

* Machine planted and harvested, using existing equipment with only minor modifications.
* Winter and spring crops, probably with a cold or long daylength requirement.
* Robust integrated weed, pest and disease management programs.
* Low crop weed potential.
* produce a product or commodity that can be marketed successfully, with a net value of around $5 million annual farmgate sales.

Of those criteria the marketing aspect is paramount. Without a potential market the crop has no use. Alternatively, if there is no commodity available, a market cannot be developed. The market pull and the production push both act to develop new niches for our commodities within existing or new markets, domestically and internationally. As a result, our approach has been to seek partnerships with existing marketers who know what is demanded or have the capacity to develop new markets. We feel it important that supply and demand be nurtured in tandem, and that marketing and agronomy are equally important in the development of new industries.

Old new crops

Canola is the most recent and also the most successful of the current new crops, along with chickpeas and lentils. These crops are all now firmly established within our farming system, although their place may be fragile due to disease susceptibility. Following this group, there are several new crops that are well on the way to becoming established within traditional agriculture. These are narbon bean (*Vicia narbonensis*) and mustard (*Brassica juncea*) Both crops are in focused plant breeding programs and we are assured that an edible oil mustard is getting closer.

Renewed old crops

There are new industries developing in a couple of areas, such as in new oilseed crops with modified oil properties (e.g. high oleic, high lauric and high erucic *Brassica napus* or high oleic safflower). Gene transfer technology will continue to develop new types of our current crops, but there is an agronomic and ecological imperative that insists that our rotations must be diverse. There is also likely to be consumer resistance to genetically modified food, and this may enable "naturally" produced food to maintain a place at the table.

Of the older crops, we believe that safflower has enormous potential. Agronomically it has features that fit it into environments where soils may need dewatering: as a different family (Asteraceae) to cereals and pulses it has useful disease resistances: and as it is late sown it could assist with weed management. With the development of high oleic acid lines of safflower, the crop can enter an edible oil market similar to canola oil. Alternatively, safflower could be developed as an identity preserved oil for specialist uses.

Our group has commenced a small project with The Lentil Company and the RIRDC on canaryseed (*Phalaris canariensis*), which is used in the birdseed trade domestically and overseas. Although not a new crop in Australia, there are only about 500 ha grown in the winter rainfall areas, despite the fact that it would appear best suited to these areas.

There are also possibilities of shifting traditional summer crops to southern Australia and cold tolerant maize is an interesting opportunity. Similarly, cold tolerant sorghum and sunflower could also be options for high rainfall cropping regions.

New New Crops

There may also be opportunities for crops with novel oil properties such as crambe (*Crambe abysinnica*), or meadowfoam (*Limnanthes alba)* which cotain high levels of erucic acid. We have initiated as project on crambe, to review some earlier work and to investigate the physiology of this interesting crop. Because of the biodegradability of erucic acid, this particular fatty acid is likely to be in demand as a lubricant as well as a replacement for mineral oils in a range of uses. Lesquerella (*Lessquerella fendleri*) produces hydroxy fatty acids similar to castor oil, as well as a gum with potential uses in the food industry.

Within the oilseed group there is also demand for particular fatty acids such as gamma linolenic acid for "nutraceutical" uses from crops such are borage (*Borago officinalis*) and evening primrose (*Oenethera biennis*). Although these oil types (gamma linolenic acid) have already been introgressed into *Brassica napus* there is still likely to be a market for non-transgenic crops.

Within the spice trade there are good, but small markets for coriander (*Coriandrum sativum*) and fenugreek (*Trigonella foenum-greacum*). Annual and biennial caraway (*Carum carvi*), anise (*Pimpinella anisum*), dill (*Anethum graveolens*) and cumin (*Cuminum cyminum*) are also crops that are grown for essential oils, and are grown in similar enviroments overseas. There are some growers locally producing coriander, dill and anise, but only on a small scale. There is also a developing market for medicinal herbs, including species from European, Chinese, North American and Australian herbalisms, but we consider these crops **-** unless annual seed crops to be outside our area of expertise. Also, because of the very small size of the market, the markets look susceptible to overproduction.

As a consequence of this market fragility, it could be considered that it is not the crop that is being developed, but the industry. As such, all the relevant infrastructure to support a new rural industry should be investigated

New Crop Resources

Internationally, there is a great deal of interest in new crops, and to find out more probably the best web site it at Purdue University in Indiana, and it is available at <**http://www.hort.purdue.edu/newcrop**>. Other good web sites are at the Crop Development Centre, University of Saskatchewan, The Centre for Economic Botany - Royal Botanic Gardens Kew and the Altenative Crops Technology Interaction Network based in Surrey in the UK. There is also an Australian New Crops Newsletter produced in Queensland and can also be sourced on the web. Recently, the RIRDC and Western Australian Department of Agriculture sponsored the first New Rural Industries Development conference in Perth. The Victorian Department of Natural Resources and Environment have also just developed a policy on developing new industries (including new crops).

In developing new crops, access to useful genetic variation is critical, and the international germplasm collections are a resource which is available to all. Through the Australian Temperate Field Crops Collection, researchers such as our group, have access to the huge germplasm collections in the USDA and throughout Europe, as well as Australia. This is, at present, accessible to all, although many countries are becoming very protective of their genetic resources. The newest term to arise is "biopiracy", where lines collected and bulked up are then granted plant breeders rights. Australia has been accused of this with some recent crop releases, and this is probably the largest threat to new crop development. Another issue that should be carefully thought through - irrespective of plant breeders rights - is the Intellectual Property agreement concerning those sponsoring the development on a new crop.

Model for New Crop Development:

At Longerenong through the Joint Centre for Crop Improvement, there are active research projects on fenugreek, crambe, canaryseed and safflower. The model for development is to approach funding agencies on an *ad hoc* basis, with various industry partners. There is no dedicated infrastructure to support these projects and this approach is likely to work only slowly.

A model for a more concerted and focused effort on developing new grain crops could be by forming a consortium of interested partners, both commercial seed companies, farmers, RDC's, state government and university. The consortium could be core funded to work on new crops development, and the outcomes of the research put up for commercialization through the partners. Issue of Intellectual property rights will be handled within the consortium and if none of the partners are interested in the crop under development, then expressions of interest could be called from parties outside the consortium.

We have no preconceived ideas about the structures, but appreciate that the development of new crops must be a co-operative effort involving marketing, germplasm development, agronomy, pathology and farming systems.

Appendix 3: Draft Only

Canaryseed Growers Guide

A guide to the production of canaryseed.

Rob Norton and John Ford
The University of Melbourne

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RURAL INDUSTRIES RESEARCH
& DEVELOPMENT CORPORATION

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Contact Details
Dr Robert M. Norton
The University of Melbourrne
RMB 3000
Horsham, 3401
Victoria
Phone: 0353 622207
Fax: 0353 622213
Email: rnorton@unimelb.edu.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:	http://www.rirdc.gov.au

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Acknowledgements

Introduction

Canaryseed (*Phalaris canariensis*) is a minor crop in Australia, with production of about 10,000 t annually. The seed is sold into the international birdseed trade and prices tend to fluctuate in response to supply. Even though the market is highly discriminating, there are no quality criteria published, nor are guidelines available for growers to assist them meet market demands. While the crop is quite well adapted, there has been no systematic investigation into its management, integrating production protocols with market signals on product quality. More reliable production systems will provide growers with confidence in the crop, which inturn gives marketers security of supply of a quality product, enabling market development to occur with confidence.

This growers guide is an outcome from a project that was developed to thoroughly investigate the potential for establishing a canaryseed industry in southeastern Australia. The objective of the project is to provide farmers in southeastern Australia with a management and marketing package for canaryseed. This package includes aspects of sowing times, crop protection, variety performance, harvesting and marketing information on the crop. The project covered variety development, crop agronomy, quality standards, marketing and grower liaison.

The funding to prepare and print this report was derived from RIRDC Core Funds, which are provided by the Federal Government. The industry partners in the project were The Lentil Company and The University of Melbourne.

Suitability of Canaryseed for your farm

Soils

Canaryseed will grow well on most soils types. It has some tolerance to water logging, but will basically be suited to any situation where wheat can be grown. There is some evidence that it has moderate salinity tolerance, similar to barley.

Climate

Canaryseed is a cool season crop, best sown in the winter, and harvested in summer. It has a development pattern that suits it to relatively late sowing. It is susceptible to frosts and high temperatures and/or water stress during grain fill can severely affect grain yields.

Rotations

The key issue for successful and profitable canaryseed crops is to avoid paddocks that have a high level of grass weed pressure, especially annual ryegrass (*Lolium rigidum*). There are no herbicides available to control annual ryegrass in canaryseed and so selecting paddocks with low weed seed burdens is important.

Checklist for Canaryseed

Which Paddock:

Best suited in regions with more than 420 mm average annual rainfall. Select a paddock with low grass weed pressure, such as one following canola. Avoid paddocks that might contain high trifluralin residues.

Risks and benefits of growing canaryseed

Canaryseed is a moderately risky crop to grow, and the selection of an appropriate paddock is the factor most critical in achieving good yields. Price risk can be minimised by contracting the production.

The major production risk is with grass weed pressure, and this can be minimised by paddock selection, late sowing and a moderately high seeding rate. In the rotation, canaryseed has the capacity to reduce *Pratylenchus neglectus* levels and provides an alternative cereal option to growers.

Agronomy summary

Sowing Time:	June until September, or about one month after wheat.
Seeding Rate:	25-35 kg / ha
Sowing Equipment:	Standard combine or airseeder, crop maybe direct drilled or conventionally sown
Row Spacing:	As for wheat – although narrow rows may assist with weed competitiveness.
Fertiliser Requirements:	As for wheat – prefer lower fertility paddock.
Sowing Depth:	50 – 75 mm, rolling may be useful.
Diseases:	➢ Susceptible to Powdery Mildew, in severe cases consult agronomist. ➢ There are no data on the susceptibility of canaryseed to cereal cyst nematode, rhizoctonia or take-all. ➢ Has some tolerance/resistance to *Pratylenchus neglectus*.
Weed control	Very limited chemical options, requires a low grass weed pressure paddock.
Insect pests	Redlegged earth mites, lucerne flea and aphids have all been seen on canaryseed crops.
Harvest time:	December – January, timed when first florets start to dry and burst. May benefit from windrowing.
Harvest Equipment:	Conventional combine harvester
Yield:	Dryland 0.8 - 2.5 t/ha
Moisture:	12 %
Grain weight:	70 kg/hl
Market:	Normal merchant channels or preferably by forward contract.

Canaryseed, its uses and its markets

Canaryseed (*Phalaris canariensis* L.) is a cereal grain crop with the potential to be grown in southern Victoria. It is also known as canary grass or just “canary”. It is relatively easy to grow, and the inclusion of canaryseed into rotations should provide growers with an alternative crop that has good waterlogging tolerance and is reasonably profitable.

Canaryseed is an annual crop plant, which is a member of the same genus that contains common phalaris (*Phalaris aquatica*), a common pasture species and roadside weed here in Australia. Other weedy cousins of canaryseed are the annual canary grasses; *Phalaris minor* and *Phalaris paradoxa*, both of which are common crop weeds.

Canaryseed at the moment is a “niche market” crop, subject to large fluctuations in price. Little is known about its agronomy and the full potential of the crop. When looking at this crop, farmers must remember the other “new crops” that have traveled the path of a new crop in Victoria began their journey as an unknown crop in a insecure niche market. Canola, lentils and chickpeas have all been new crops and over time as these crops found larger markets, better adapted varieties were bred and more suitable agronomic practices were established. A reliable supply of good quality grain then gives marketers the confidence to secure long-term markets for the produce and so an industry can be established.

Canaryseed in Australia

Canaryseed was grown in South Australia in the 1840’s as a forage crop for horses and since then has been grown as a winter crop in Southern Queensland and Northern New South Wales. Since the early 1970’s, it has become a crop of minor significance in the Wimmera, as well as being grown in southern Queensland as a winter crop, although agroecologically it is better adapted to the cooler southern climates.

Fluctuating prices and problems with ryegrass and annual phalaris have prevented the crop from becoming more popular in Victoria. There are no herbicides registered to control grass weeds in canaryseed and none are likely to become available. However with the popularity of triazine tolerant Canola (TT Canola) in Victoria, an opportunity exists to incorporate canaryseed into cropping rotations immediately after TT canola. On paddocks prone to waterlogging, canaryseed presents a viable late sowing option on irrigation or in high rainfall areas.

The uses of canaryseed

Canaryseed is the preferred ingredient in birdseed mixes for aviary birds because of its excellent nutrient profile. The birdseed market is a volatile niche market that places emphasis on product quality. Canaryseed is grown and marketed now solely as a component in birdseed mixes. The present world market for canaryseed is approximately 300,000 tonnes. Canada is the major market supplier producing up to 250,000 tonnes per annum for export and domestic markets. Despite their dominant position in the market, there are opportunities for Australian growers and traders to develop markets. With more people living in high density housing throughout the world, the Canadian agricultural agencies estimate that the worldwide birdseed market to be increasing at three percent per annum. Large pets such as dogs and cats are not practical in such housing with the result that birds are the second most common pets after fish.

Canaryseed has also been investigated as a potential human food, because of its good protein quality. At this stage, there is no human consumption market, nor is one likely to develop in the near future.

In the birdseed trade, canaryseed competes with a range of summer grains that can also be blended into the final product. Depending on price, commercial birdseed mixtures can contain a range of millets and panicums, as well as canaryseed. Because of this substitution, the market is quite complex and prices move quickly in response to production levels of all these species.

The market for canaryseed

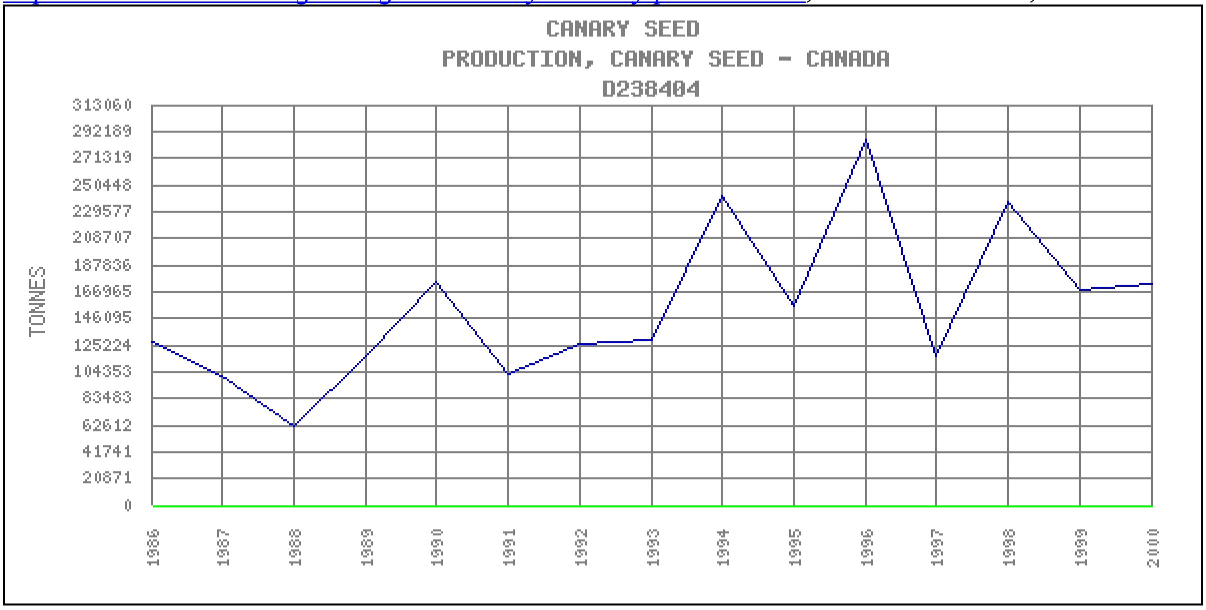
The present world market for canaryseed is approximately 300,000 tonnes. As mentioned above, Canada is the major market supplier producing up to 250,000 tonnes per annum for export and domestic markets. While the Canadians do control the major proportion of the world market, but significant opportunities exist for Australian canaryseed, either as import replacement in Australia, or to enter new or existing export markets. Australia currently imports much of its birdseed from other sources, in particular China and an opportunity exists for import replacement in the domestic market.

The amount of Canadian canaryseed entering the world market is a major factor in pricing of the crop for export, and from time to time, significant market shortages develop. Due to Australia's proximity to Asia we are well placed to provide seed to some of the world's largest birdseed markets. Because of freight advantages for Australian canaryseed over produce from North America, our exporter can enter the market with confidence.

Commodity prices and on-farm marketing

The canaryseed market is a relatively small and specific market, and because of this, it is prone to periods of under and over supply. Consequently, the price of canaryseed varies greatly depending on the size of the North American crop, not unlike most other agricultural commodities produced in Australia. The Australian price can vary from $350/t to $700/t, depending on the Canadian cropping season which is very variable (figure 1). Fortunately canaryseed can be stored easily, and on-farm storage is essential if good prices are to be received for the crop.

Figure 1: Canaryseed production, Canada, 1985 to 2000. *Source: Statistics Canada's Internet Site, http://www.statcan.ca/english/Pgdb/Economy/Primary/prim11a.htm, extracted June 25, 2001.*



Quality of the seed at harvest is essential for successful marketing. Seed merchants buy seed entirely on visual characteristics. Seed has to be uniform in size, shine and colour. Seed is easily dehulled and split if drum speeds at harvest are too fast. Green seeds can find their way into the sample if the crop is harvested too soon. Timely and careful harvesting could make the difference between selling your crop at a market premium and having a silo full of almost worthless grain.

Due to the highly volatile price for canaryseed, it is recommended that the crop be grown on contract with reputable seed traders, who have access to domestic or international markets. Most of these traders offer area-based contracts for canaryseed. While spot prices may appear attractive from time to time, contracts will provide growers with security and an assured price.

Returns from Canaryseed

The comparative costs for producing a canaryseed crop are shown in table 1, compared to wheat and canola. These figures are indicative only and based on the production systems of the mid to southern Wimmera of Victoria.

Table 1: Comparative costs for growing wheat, canaryseed and canola.

Crop	**Wheat – 3 t/ha**		**Canaryseed – 1.5 t/ha**		**Canola – 2 t/ha**	
Cost	Item number	Cost/ha	Number	Cost/ha	Number	Cost/ha
Seed bed preparation						
Chisel plough	2 times	$7	4 times	$28	2 times	$14
Presowing knockdown	1 l/ha	$8	1 l/ha	$8	1 l/ha	$8
Seed	75 kg/ha	$20	30 kg/ha	$15	5 kg/ha	$15
Fertilizers						
Double super + Zn	80 kg/ha	$27	80 kg/ha	$27	100 kg/ha	$33
Urea - predrilled	80 kg/ha	$30			100 kg/ha	$35
Pre-sowing herb.						
Trifluralin, plus application and incorporation	1 l/ha	$8	nil		1.5 l/ha	$10
Sowing						
Air seeder	$25/hr	$3	$25/hr	$3	$25/hr	$3
Post-sowing.						
Broadleaf Herb.	Estimate	$18	estimate	$18	Estimate	$30
Plus application		$3		$3		
Insecticides					RLEM	$5
Harvesting						
Windrowing					$25/ha	$25
SP header	$50/hr	$7	$50/hr	$4	$50/hr	$6
Insurance	1.1%	$5	1.1%	$7	1.1%	$10
Cartage	$2/t	$6	$4/t	$6	$3/t	$6
Total Variable Costs		**$147**		**$119**		**$200**

The gross margins for canaryseed at typical yields and prices are shown in table 2. At these prices and yields, canaryseed compares favourably with canola and wheat. If prices drop below $300 /t for canaryseed, it would not be an attractive option compared to wheat or canola. This emphasises the need for forward selling or contracting of production for canaryseed, to lock into market and so reduce price risk to growers.

Table 2: Wheat, Canola and Canaryseed comparative gross margins – Wimmera.

	Wheat			**Canaryseed**			**Canola**		
Crop Costs ($/ha)	150			120			200		
Typical Yield (t/ha)	3.0			1.5			2.0		
Typical Price ($/t)	160			400			350		
Price/Yield Matrix	**2.0 t/ha**	**3.0 t/ha**	**4.0 t/ha**	**1.0 t/ha**	**1.5 t/ha**	**2.0 t/ha**	**1.5 t/ha**	**2.0 t/ha**	**2.5 t/ha**
75% of Typical Price.	90	210	370	180	330	430	194	325	456
100% of Typical Price	170	**330**	490	280	**480**	680	325	**500**	675
125% of Typical Price.	250	450	650	380	580	880	456	675	893

Crop Management

Variety selection

There are only limited options when selecting canaryseed cultivars. In southern Australia, the most common cultivar is ***Moroccan***, which was introduced by the Queensland Department of Primary Industries and subsequently adopted by southern growers. It has a plump cream seed, demanded by the market. In our experiments it yielded well, however, like all cultivars except CDC Maria, Moroccan has silica hairs on the seed coats, which are intensely itchy when the seed is harvested.

The Lentil Company has arranged access for Australian growers to the cultivar ***CDC Maria***, which was developed in Canada. CDC Maria has similar yields to Moroccan but was specifically bred with no hairs on the seed coat. As a result, it is now becoming the industry standard in Canada because it reduces the irritation of the other lines. Relative to Moroccan, CDC Maria is a little later in its maturity, but both cultivars grow to a similar height. Despite its later maturity, CDC Maria seems to yield slightly better than Moroccan under drier conditions. CDC Maria grew a little taller and produced slightly more growth than Moroccan in these experiments in the southern and central Wimmera.

The seed from both varieties is acceptable to the market, and the CDC Maria seed is slightly larger than seed from the Moroccan variety. CDC Maria seed can only be obtained from The Lentil Company.

Our experiments have also compared some other canaryseed lines, which we selected from international germplasm collections on the basis of their relative large seed size. At present, these lines are only recognised by numbers, and they will be further evaluated in the future as additional seed is bulked up. Table 3 is a summary of these experiments with the lines tested at Dooen.

Table 3: Summary of the features of various canaryseed genotypes tested 1998 to 2000.

	Moroccan	**CDC Maria**	**CA 984**	**Tetraploid CPI 14690**	**PI 170 633**	**PI 175 812**	**PI 266 186**	**PI 284 184**
Seed Yield (Relative to Moroccan)	100%	102%	110%	38%	98%	94%	81%	88%
Maturity (days relative to Moroccan)	=	+2	=	+3	+2	-2	=	=
Height	Tall	Tall	Tall	Short	Tall	Tall	Mid	Mid
1000 GW (g)	6.29	6.88	6.71	7.06	6.31	6.54	7.62	7.20
Test weight (kg/hl)	67	75	67	61	69	68	70	64

There is insufficient data on the newly introduced lines to recommend them for sowing in southern Australia, although further testing is proceeding.

Seed Quality

Seed selected for sowing should be cleaned and free of weed seeds. If possible, seed should be germination tested and seeding rates adjusted to account for germination percentage. Avoid seed that has green, cracked or skun seeds, as these samples will be of reduced germination percentages.

There are no data on appropriate seed dressings for canaryseed.

Paddock preparation

The seedbed should be firm and weed free. Because the seed is small relative to other cereals, canaryseed seedlings are relatively weak and cannot force their way up through compacted and/or cloddy seedbeds. Provided grass weed burdens are low, the crop can be direct drilled and in these situations, we would recommend the use of press wheels or rollers, particularly where soil moisture is limiting. Moderate compaction around the seed will enhance the rate of emergence providing the soil surface is not compacted.

In our experiments, we have used both direct drilling and cultivation to develop seedbed. If cultivating, then do not work the paddock too deeply as this will bring up clods and leave an uneven surface. Make the earlier workings deeper and then progressively raise the cultivation base until it is around 5-7 cm deep. This will allow the seed to be placed at around 5 cm.

A knockdown herbicide or a presowing cultivation will assist with any weed control as sowing approaches.

Time of sowing

The experiments we conducted showed that if sown too early, the crop was exposed to frosts, had a tendency to lodge and was open to weed infestation. For these reasons, later sowing is preferred, even as late as mid July. Indeed, the experiments we did around the Wimmera had an optimum sowing time of July 09. See figure 2 for more information.

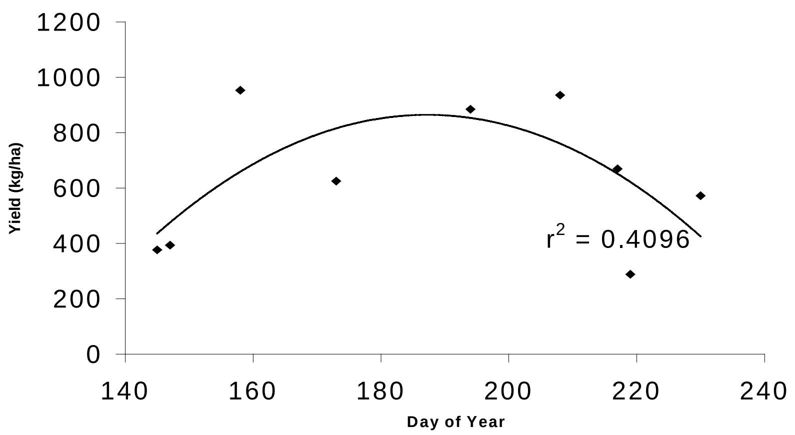


Figure 2: The effect of time of sowing on the yield of canaryseed.

The main benefit of this later sowing is that vegetative growth is restricted and the crop does not grow quite so tall. This later sowing will decrease the risk of the crop lodging, which gives lower yields and makes harvesting difficult. An additional problem with lodged canaryseed crops is that they mature very unevenly and so green seed can end up in the final grain sample, which could lead to it being downgraded when received by the marketers.

An additional benefit of later sowing is that it enables successive control over germinating weeds, particularly annual ryegrass. Because herbicides are not available, getting the seedbed as clean as possible at sowing is an important management goal. This could be done either with additional workings or by using knock-down herbicides.

Sowing earlier also produces smaller seed, as does sowing very late. An early July sowing results in good seed size and will assist market acceptance of your produce.

Establishment

Canaryseed can be sown with conventional seeding equipment, either air seeders or normal combines. Although we did no experiments with different row spacing, because the crop needs to compete well against weeds, narrow rows (around 150-175 mm) would be preferred. If weed pressure is thought to be low, then wide rows could be used.

Sowing rates should be relatively high, around 30 kg/ha, which would give an expected plant population density of around 400 plants per square meter. This is quite a high density for a cereal, and this density has proved successful because it provided vigorous crop competition against weeds, while not reducing seed size too much. The main benefit of the high seeding rate is that it restricts tiller production, which in turn makes the crop maturity more even. An even maturity reduces green seed contamination in the final sample. A higher seeding rate will reduce seed size.

Another feature contributing to the success of the higher seeding rate is due to the relatively late sowing of the crop. Late sown crops tend to produce less tillers per plant, and so to achieve a higher head population – which is achieved by a high seeding rate.

Nutrition

Our limited experience with canaryseed nutrition suggests that the phosphorus requirements are similar to other cereals, while trace elements would be expected to also be the same. Until further investigations are completed, canaryseed fertilizer programs should follow a similar pattern to other cereals.

The exception to this nutrition program is the use of nitrogen. Our experiments have shown that canaryseed yield and quality can be reduced if too much nitrogen is applied. Although we have not confirmed the base requirement, where we added 50 kg N or more, crop lodging became a problem, which led to yield loss and poor harvest sample quality. Accordingly, on moderate to high fertility paddocks, we would recommend no additional fertilizer nitrogen be added. On moderate to low fertility paddocks, additional N, maybe in the form of diammonium phosphate (DAP) or monoammonium phosphate (MAP) could be used, which where used to supply 20 kg of P, would also supply 18 or 9 kg of N respectively. Information from Canada indicates that only small amounts of fertilizer should be placed with the seed.

We have no data on the trace element requirements of canaryseed, but again, would expect that application rates for zinc and copper would be similar to milling wheats.

Weed control

There are no selective grass weed herbicides available for use on canaryseed. Control measures against annual ryegrass should be based on selecting a paddock with low weed pressure and making the crop as competitive as possible to smother out the ryegrass. Out of crop weed control measures such as spraytopping prior to the crop year, effective pre-crop control and cultivation should all be used to reduce grass weed burden.

There are some control options available to manage broadleafed weeds, and we recommend that growers discuss their problems with experienced agronomists. Again, paddock selection and pre-crop weed control may be the best options for control.

Pests and diseases

Very little is known about the response of canaryseed to common soil borne pathogens such as cereal cyst nematode (*Heterodera avenae*) or Take-All (*Guanmanomyces graminis*). Without confirmation, it would be assumed that canaryseed is susceptible to these pathogens. There is some information concerning the susceptibility of canaryseed to *Pratylenchus neglectus* and *P. thornei.* As a pre-crop, canaryseed left fewer nematodes in the soil than wheat (J. Thompson, *pers.comm.*). This also requires additional clarification in the southern wheat belt, as these tolerances and susceptibilities will largely determine the place that canaryseed can occupy in a crop rotation.

During the experiments we conducted, there were no insect pests observed, and the only disease identified was powdery mildew (*Erysiphe graminis*), a disease that has also been noted in Queensland canaryseed crops. The Lentil Company has noted problems in the past with RedlLegged Earthmite and Lucerne flea in canaryseed crops. No thresholds are available to indicate when spraying should be done, and there are only a very limited number of crop protection chemicals registered for use on canaryseed.

Harvest Storage and Handling

Harvest timing

The timing of harvest is critical for the production of good quality canaryseed. If harvested too early, the crop will be very difficult to thresh and so produce a poor sample. Early harvest will leave unacceptable green seed in the sample. If harvested too late, the sample will be easier to thresh and contain less contaminants, but the seed may be liable to cracking and some seed may be lost from the main stem as the head matures – termed floret blasting. Floret blasting occurs as the crop reaches maturity and the terminal flowers (florets) are shed from the top of the head. Uneven maturity is a particular problem with crops sown at low seeding rates, as the later tillers take much longer to mature, to the extent that the main stem can shed much of its seed before those tillers are ripe and free of green seed.

Some growers have tried to windrow (or swathe) the crop prior to harvest, but the earlier timing often leads to green seed contamination. Until further work has been done, it is recommended that the crop be direct headed.

A reasonable guide to crop maturity is to look for the first sign of floret blasting, and then to take a harvest sample, test it for moisture content and the presence of green seed. If moisture content is at 12% and there are no green seeds, then the crop is ready to harvest.

Machine settings

Canaryseed is difficult to thresh if it is slightly immature. Lodged and tangled crops can also make harvesting difficult. Dehulling the seed is undesirable, and may result in dockage, and so a drum speed of 500 to 750 rpm is recommended. The drum and concave clearance recommendations from north American experience suggest a clearance of 5 to 9mm (front) and 3 to 5mm (rear) and a low wind speed (similar to linseed or linola) should be used.

Handling and storage

Canaryseed is a relatively small seed and will easily flow out through gaps in storage bins or silos, similar to canola. Sealing of joints with a silicone based compound is recommended. It is easy to auger, although speeds should be slow and augers fully loaded to minimize damage to the grain.

The major hazard with harvest and storage, particularly with varieties other than CDC Maria, is the irritating hairs that become dislodged during handling. The seedcoat contains hairs made of silica that break off and cause intense itching in skin folds, and are also significant lung irritants. Research has linked these hairs to respiratory diseases and so minimum protection during handling should be properly fitted dust masks or a similar particulate matter filter.

The seed is not difficult to store, provided it is placed in storage at 12% moisture content or lower. Ideally aerated storage would be useful to cool grain and reduce the potential impact of grain storage insects. The selection of grain protection chemicals needs to be carefully discussed to ensure that any treatments are acceptable to the buyer.

Quality Standards

Quality of the seed at harvest is essential for successful marketing. Seed merchants buy seed entirely on visual characteristics. Seed has to be uniform in size, shine and colour. Seed is easily dehulled and split if drum speeds at harvest are too fast. Green seeds find their way into the sample if the crop is harvested too soon. Timely and careful harvesting could make the difference between selling your crop at a market premium and having a silo full of almost worthless grain.

To assist growers manage their crop to meet the market specifications, The Lentil Company have developed export and domestic standards for two grades of canaryseed, and those criteria are given below.

Minumum receival standards for Number 1 Canaryseed

Physical characteristics

- The canaryseed shall be hard and well-filled and typical colour for the season.
- The canaryseed shall be free from animal excreta, rodents, live insect pests and any chemical not registered for use on stored canaryseed or in excess of legal tolerances.
- There shall be nil tolerances on pickling compounds/seed dressings or any fungicide added to the canaryseed as a seed dressing and any tainting agents and/or other contaminants imparting an odour not normally associated with canaryseed, including caked, bin burnt and/or mouldy canaryseed which are a result of product storage.
- There shall be nil acceptance on Toxic and/or Noxious weed seeds which are prohibited by state laws against inclusion in stockfeeds.

Moisture content

- The maximum moisture content allowable is 12%.

Purity

- The minimum purity shall be 97% by weight.

Foreign matter

- Foreign matter shall not exceed 3% by weight of which no more than 0.5% shall be unmillable material (soil, dirt, stones) and no more than 1% ryegrass retained over the 1.2mm slotted screen.

Screen sizes

- For grading in the defective categories, samples will be drawn from grain that has passed through a 3.0mm round hole screen and retained over a 1.2mm slotted screen.

Defective grain

- Poor colour (hulled seed) and cracked seed tolerance = 4% (max)

Weed seed exclusions and tolerances

- There is a nil tolerance for tree hogweed, dock and muskweed unless otherwise specified.
- There shall be no more than 1% ryegrass retained over the 1.2mm slotted screen.

Minimum receival standards for Number 2 Canaryseed

Physical characteristics

- The canaryseed shall be hard and well filled and typical colour for the season.
- The canaryseed shall be free from animal excreta, rodents, live insect pests and any chemical not registered for use on stored canaryseed or in excess of legal tolerances.
- There shall be nil tolerances on pickling compounds/seed dressings or any fungicide added to the canaryseed as a seed dressing and any tainting agents and/or other contaminants imparting an odour not normally associated with canaryseed, including caked, bin burnt and/or mouldy canaryseed which are a result of product storage.
- There shall be nil acceptance on Toxic and/or Noxious weed seeds which are prohibited by state laws against inclusion in stockfeeds.

Moisture content

- The maximum moisture content allowable is 12%.

Purity

- The minimum purity shall be 98% by weight.

Foreign matter

- Foreign matter shall not exceed 2% by weight of which no more than 0.5% shall be unmillable material (soil, dirt, stones).

Screen sizes

- For grading in the defective categories, samples will be drawn from grain that has passed through a 3.0mm round hole screen and retained over a 1.2mm slotted screen.

Defective grain

- Poor colour (hulled seed) and cracked seed tolerance = 5% (max)

Minimum EXPORT Standards for Number 1 Canaryseed

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Acknowledgements

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