

# Chinese chard

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## Introduction

Chinese chard (*Brassica rapa* L. var. *chinensis*) is a biennial or annual plant available in many parts of the world. Chinese chard is native to eastern Asia and has been cultivated for thousands of years. Many names are used for Chinese chard, such as Chinese white cabbage, Chinese mustard, bok choy and pak choi. Chinese chard is unlike other cabbages because it does not form a true head.

Chinese chard has been grown successfully and is available in all Australian States. It has characteristic two-toned leaves with bright and/or ivory white leaf stalks topped with dark green leaves. The only exception is Shanghai Chinese chard, which has light green leaves and leaf stalks. The flowers of Chinese chard are bright or pale yellow about 1 cm long. The seeds are round, dark brown and weigh approximately 3 g/1000 seeds.

In Australia, Chinese chard is a very important leafy vegetable making up about 10% of the total Asian vegetables used by

volume, second only to Chinese cabbage. Chinese chard is easy to grow, produces relatively high yields and is very nutritious.

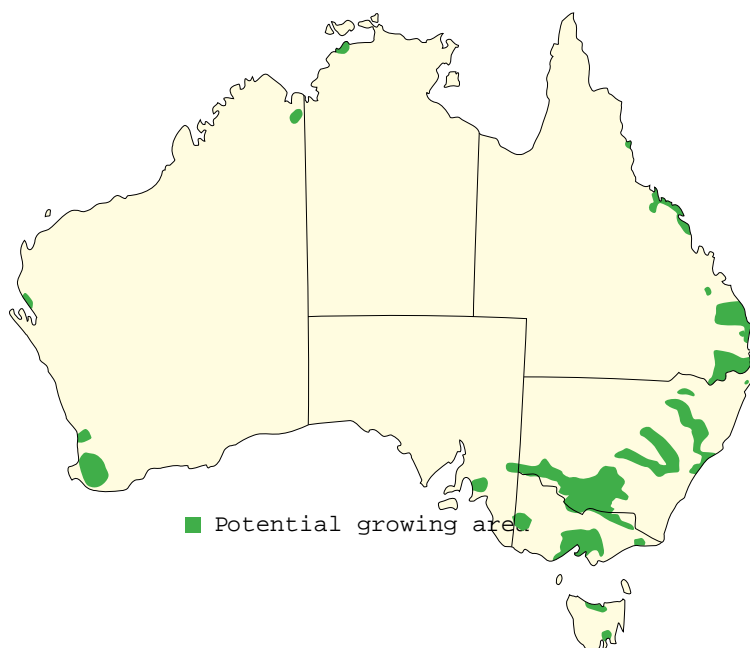
## Markets and marketing issues

Chinese chard is available in markets all over world and is found predominantly in Asian markets. Markets for it are large because it is used in most Asian meals. The average annual wholesale price for Chinese chard in Japan is \$4.50/kg (based on Yen 75= \$Aus1.00). The domestic market had a higher priority than the international market.

Chinese chard is available at most major wholesale markets

and Asian grocery stores throughout the year in Australia. In Sydney, the average wholesale price range is between \$0.50 and \$1.00/bunch. Similarly, the Melbourne Market average wholesale price was between \$0.50 and \$1.00/bunch. The average retail price in and around Melbourne was between \$1.50 and \$3.00/bunch.

Chinese chard has been given a high industry priority for expansion for the Australian fresh market on the basis of existing market and production information. It was also listed as one of the top five Asian vegetables for the three major trading channels: Asian restaurants, Asian grocery stores and Australian supermarkets.



## Production requirements

Most Chinese chards are essentially cool-season crops, preferring uniform conditions that are moist and in full sunlight for optimum plant growth. The ideal temperature for growth is between 15 and 20°C, but there are varieties available for warmer weather. Diurnal variations of 5 to 6°C appear to improve plant vigour. High temperatures and long days tend to induce bolting, which is also known as premature flower stalk formation. Most

varieties tolerate light frosts and the Shanghai Chinese chard is able to tolerate more severe frosts for short periods.

Chinese chard can be grown in a wide range of soils, but prefers fertile, high organic matter and moisture-retentive soils (e.g. rich loamy soil). The ideal soil pH is around 6.5–7.0 and lime should be added if it falls below a pH of 6. Adding lime to the soil profile is also thought to help reduce the incidence and severity of clubroot if present. Soft rots can also be prevented by preparing raised beds with improved

drainage and improved air circulation.

Chinese chard is shallow-rooted like most other brassica crops and requires frequent watering for optimum growth. Lack of moisture at any stage can promote bolting and poor quality plants. The water should be applied lightly and frequently, to reduce the chance of leaching soil nutrients and encourage healthy plant growth. Young plants should be protected from the wind as even the leaves of mature plants can be damaged by strong winds.

## About the authors



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See Key contacts for authors' addresses.

## Key statistics

Statistics are not available on Australian/principal State production, imports, exports for Chinese chard, mainly because of commercial sensitivities.

## Varieties

There is much confusion over the different types of Chinese chard. To simplify the problem they have been divided into four major groups, based on appearance.

- 1) The 'Chinese White Bok Choy' is a sturdy-looking variety with thick green leaves curling outwards. The leaf stalks are bright white, curved slightly and thin. The plants tend to reach a height of about 30 cm at maturity. Although they vary in their cold tolerance and have a tendency to bolt, they are vigorous. An example of a highly productive hybrid is 'Joi Choy'.
- 2) The green leaf stalk type, 'Shanghai Bok Choy', has leaf stalks which are light green in colour, broad, flat and widen at the base like the other bok choys. They are harvested at a height of around 15 cm. They are very hardy and able to grow all year round at temperatures between 18 and 21°C. A popular variety is 'Mei Qing'.
- 3) The 'soup spoon' type has thinner leaves and leaf stalks. The leaves are lightly cupped

and ladle-like while the leaf stalks are white and semi-circular. They grow to a height of 45 cm and there are shorter forms available. They are vigorous and versatile with good tolerance to cold and heat. Varieties include 'Japanese White Celery Mustard', 'Nikanme', 'Seppaku' and 'Tai Sai'.

- 4) The 'squat' or 'Canton' variety is the most compact. It is short with convoluted dark green leaves. The leaf stalks are white, short and thick. They can be harvested as baby bok choy or left to reach maturity. They are best adapted to warm weather and very apt to bolt in the cold weather.

## Agronomy

Most Asian vegetable producers grow their crops intensively on relatively small farms of only 1–5 ha. Some southern Australian Asian vegetable growers have intensified their production of Asian vegetables by growing in polyhouses. Polyhouses stop winds, increase light intensity within the structure and increase air temperature by several degrees, depending on the climate outside the polyhouse. Protected cropping assists growers to increase yields, improve quality and extend the time crops can be grown successfully. In addition, such vegetables are said to be more tender and less fibrous than when compared grown outdoors.

Chinese chard can be sown directly or transplanted into a well-prepared, raised bed. Spacing varies according to the type, variety used and size of

plant required. The large types like 'Chinese White' require 45 cm between each plant. The average within-row spacing for medium-sized varieties would be 18 to 23 cm and the small varieties, 2.5 to 10 cm apart. Rows should be 18 to 30 cm apart.

Seedlings can be raised in a heated environment at a minimum temperature of 18°C, and hardened off before transplanting. Transplants reduce the time plants are grown under adverse conditions, reducing the chance of bolting and the time to harvest. Commercial production of Chinese chard in greenhouse and polyhouse structures has been successful all year round. The seed is usually germinated in seedling trays at about 20°C and after emergence the temperature is reduced to about 10°C or less. The seedlings are generally transplanted in the greenhouse structure after 25 to 30 days of growth and if possible the temperature is raised to about 20°C a week after planting.

During late autumn to early spring when the weather is cool, only cold-tolerant types and cultivars should be grown, such as the Chinese White Bok Choy and soup-spoon types. Heat-tolerant varieties such as the Shanghai Bok Choy and Canton types, can be grown during summer conditions or in heated polyhouses.

On sandy or light soils, the highest yield of Chinese chard has been achieved with 200 kg/ha nitrogen and at the closest plant spacing of 0.1 m × 0.3 m. The plant spacings used were 0.1 m, 0.2 m, 0.3 m and 0.4 m with 0.3 m between rows. At 400 kg/ha of nitrogen yields actually decrease

and the incidence of soft rot damage increases. The fertiliser and spacing does not significantly affect the time Chinese chard takes to reach maturity.

## Pest and disease control

There are many weeds, insects and diseases that can reduce the yield of any vegetable crop. There are very few chemicals registered for use on Asian vegetables in Australia. Best practice management systems (e.g. IPM – Integrated Pest Management) should be adopted when controlling weeds, pests and diseases. Weeds compete for water, nutrients and space and must be controlled in the early stages of growth, because Asian vegetables are relatively slow-growing, especially when direct seeded. Hand weeding and dutch hoeing are commonly used for weed control. A pre- or post-transplant herbicide may be beneficial in reducing the competition from weeds.

The major diseases of concern when growing Chinese chard, are as follows:

Clubroot (*Plasmodiophora brassicae*) is distributed worldwide and is a major disease of all brassica crops. The soil-borne fungus develops slowly, entering the root hairs and forming club-like malformations on the roots. The plants become stunted and wilt during warm weather. Good management practices can help control clubroot. Common practice is to use a combination of long plant rotations with non-hosts,

maintenance of a soil pH at 7.3 or above, fumigation, sanitation and maintenance of a high soil organic matter. Farm hygiene is very important because it helps prevent the movement of clubroot from infected soil into clubroot-free areas. Future control measures may use combinations of chemicals, nutritional programs, rotation and clubroot resistant varieties.

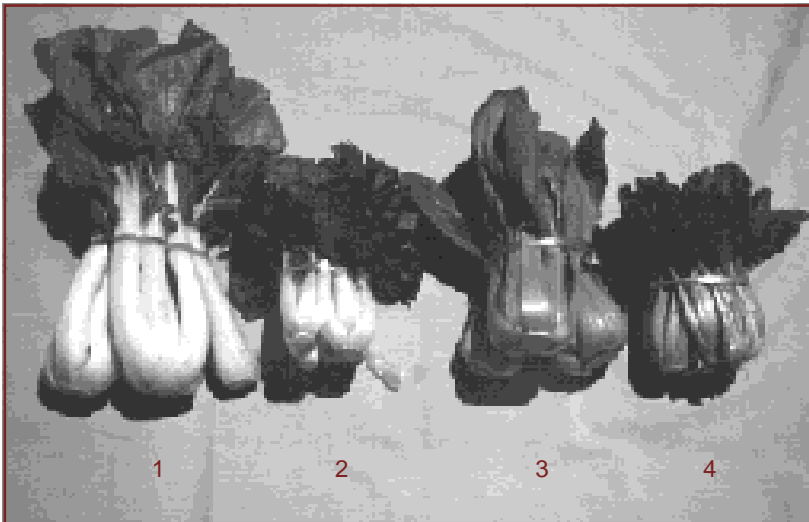
Downy mildew (*Peronospora parasitica*) is also a worldwide major disease of brassica crops. Infected leaves develop purple, yellow or brown patches on the upper surfaces and white to grey downy fungal growth underneath. Older leaves show signs of small necrotic areas that look like small black specks. During moist conditions the specks may enlarge to form large black patches. Plants should be

kept well ventilated to reduce the humidity and the risk of downy mildew. Overhead irrigation should be avoided where possible. Cruciferous weeds should be controlled.

White rust or white blister (*Albugo candida*) is distributed worldwide and is a less common disease of brassica crops, radish and other mustards. Symptoms include small circular spots raised on both sides of the leaves. On the underside of leaves, a mass of white powdery spores develops. Yellowish to green spots also develop on the top surface of leaves. White rust can be controlled by removing any cruciferous weeds, long plant rotations with non-hosts and by ensuring that all plant residues are completely decomposed before transplanting new crops.



Chinese chard



1. Chinese chard, 2. Baby Chinese chard, 3. Shanghai Chinese chard, 4. Chinese flat cabbage (tatsoi).

Edema (oedema) is a physiological disorder with symptoms that resemble small warts; these can join together to form a ridge. Usually they are found on the underside of leaves. The disease can occur when soil is warm and wet, but the air temperature is cool. The disease is favoured by prolonged periods of high humidity, which can occur in poorly ventilated polyhouses or glasshouses. Control of the disorder can be achieved by not allowing the soil to become too wet and in polyhouses by having good ventilation.

The major pests of concern when growing Chinese chard, are as follows:

Aphids (*Brevicoryne brassicae*) can feed on a large number of plant hosts. They have piercing and sucking mouth parts which they use to get sap from plants. Aphids can be found underneath leaves, and where they like to feed on new shoots and buds. Parts of the plant may wilt, look distorted and curled. The aphids can also act as vectors for a

number of viruses (e.g. turnip mosaic), causing even greater damage. Cruciferous weeds should be controlled as they host aphids.

Caterpillars (the larvae of moths and butterflies) will attack and severely damage brassica crops. Examples include the large and small cabbage white butterflies (*Pieris rapae*), the diamond back moth (*Plutella xylostella*) and the green looper (*Chrysodeixis eriosoma*). Many chemicals have been used to control caterpillars and resistance to some chemicals has developed, particularly for diamondback moth. Appropriate strategies such as IPM should be used for controlling caterpillars and in particular diamondback moth.

Snails and slugs (Class Gastropoda) are attracted to the succulent leaves of all brassica crops. They are of major concern to growers, because they eat whole young plants and can severely damage older plants. The greatest damage occurs during mild and damp weather,

when snails and slugs are most active. Snail and slug pellets are the most commonly used form of control.

## Harvest, handling and packaging, storage, postharvest treatments and processing

Preservation of food has been essential in Asia, to ensure that food was available during shortages such as those associated with a lack of production during winter. Vegetables are preserved by fermentation, pickling, drying, salting and adding sugar.

Chinese chard is usually hand-harvested at the base with a knife. Any old or damaged outer leaves are trimmed off and the butt trimmed flush at the base. There should be no blemishes or defects of any kind. Chinese chard can be ready to harvest 35–55 days after sowing. Yields average about 15 t/ha. Chinese chard should be harvested well before the outermost leaves turn slightly yellow, which is before the plant fully matures and becomes fibrous. The plants can bolt before maturity and should be harvested when there is any evidence of a flower stalk.

Chinese chard should be harvested in the cool part of the day and handled carefully as they are prone to physical injuries, such as bruising of the leaf stalk. As it is susceptible to wilting, Chinese chard should be used fresh as possible. In Australia, Chinese chard are bunched in groups of 2–3 plants. Bunching is not a good practice as the string/band used to tie

the bunch together causes damage. The white-stemmed varieties can be stored at 0–1°C with 85–100% humidity for a week while the green-stemmed variety can be stored for a little longer. Chinese chard can last up to 30 days in modified atmosphere packaging (MAP). Little is known about the effects of type and cultivar on storage life.

## Economics of production

Chinese chard has mainly been produced in Australia by Asian (Chinese and Vietnamese) vegetable growers and some traditional brassica growers, who have diversified into new crops. Equipment used for the production of other more traditional brassica crops such as cabbage, cauliflower and broccoli, can be used to grow Chinese chard. However, potential growers should be aware that Chinese chard is fast growing and may require more labour at harvesting than the

more traditional crops. Accurate costs of production analysis for Chinese chard, like most other Asian vegetables, are not available.

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