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Growing Asian vegetables

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The term 'Asian vegetables' describes a wide range of vegetables that are traditionally grown and used by Asian people. The diversity of Asian vegetables is very large and many of them are unfamiliar to most Australian growers and consumers.

In New South Wales, commercial Asian vegetable production is mainly confined to the outer Sydney and the Central Coast areas. Asian vegetables are sold fresh at either central wholesale markets or delivered directly to the Asian restaurants and vegetable shops.

Asian vegetables divide into three groups—leafy vegetables (including herbs), fruiting vegetables, and root vegetables (see Table 1).



Chrysanthemum

Choko



Taro root



Snowpeas



Chinese parsley



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GROWING REQUIREMENTS

Climate and soil

Most Asian leafy and root vegetables are essentially cool season crops, particularly the Brassica species—Chinese cabbage, bok choy, choi sum, gai lum, mustards, radish and turnip. In New South Wales, they grow best in the spring and autumn.

Producing high quality Asian vegetables during mid-summer and winter is difficult: the high temperatures and strong sunlight of summer prompts leafy vegetables to develop tough foliage, and with root vegetables the root rapidly becomes pithy soon after maturity. Low winter temperatures slow vegetative growth and stimulate the forming of flower-buds, and bolting in spring.

Asian vegetables can grow on a large range of soil types, but rich organic soils are the most suitable. For root vegetables, a light, sandy, well-drained soil allows straight and even root development and easy picking and washing after harvest.

Land preparation

A fine, well-prepared raised bed is important for growing Asian vegetables. Apply animal manure or compost about six weeks before planting to help build up the waterholding capacity of the soil and to balance the nutrient supply. Chemical fertiliser can be used as a side dressing when necessary.

Nutrition

Asian vegetables tolerate slightly acid soil, but the pH should not be below 5.0 (in calcium chloride solution). The best pH is within 6.0–7.0.

Animal manure is normally applied in rows, or broadcast; apply good quality fowl manure six weeks before planting, at the rate of 15 tonnes/ha (1.5 kg/m^2). Before planting, broadcast 1.5 tonnes/ha of a N:P:K (5:5:5) fertiliser to ensure that the young seedlings have a ready supply of major elements immediately after germination or transplanting. When the seedlings are established, side-dress them with potassium nitrate.

Sowing, plant spacing and harvesting

Most leafy and root vegetables are best sown directly into well-prepared raised beds, by hand or seeder. Sow the seed in rows, at a 5–10 mm depth. Dense sowing (and early thinning) will ensure correct plant populations. Seedlings germinate five to ten days after sowing. Thin the seedlings during early growth, preferably at the 'first true leaf' stage.

Fruiting vegetables and some leafy vegetables such as Chinese cabbage and bok choy can be sown in a seedbed or seedling trays, then transplanted when the seedlings have grown two or three leaves. Seedling trays with individual cells are ideal; Jiffy© peat pots are also suitable for gourd, bitter gourd, Chinese zucchini and luffa.

Table 1. The three groups of Asian vegetables. Leafy vegetables include a number of herbs that are extensively used in Asian cooking.

1. Leafy vegetables	
Chinese cabbage	(*Brassica pekinensis* RUPR.)
bok choy	(*B. chinensis* L.)
choi sum	(*B. parachinensis* Bailey)
gai lum	(*B. oleraceae var. alboglabra* (Bailey) Musil.)
mustard	(*B. juncea* COSS)
Japanese mustard e.g. mibuna, mizuna	(*B. rapa* L.)
water spinach	(*Ipomea aquatica* FORSK.)
Chinese/ Japanese spinach	(*Spinacia oleracea* L.)
chrysanthemum garland	(*Chrysanthemum coronarium* L.)
watercress	(*Roripa nasturtium-aquaticum*)
Chinese chive	(*Allium tuberosum* ROTTL.)
shallot, bunching onion	(*Allium fistulosum* L.)
Herbs	
mints	(*Mentha* species)
basil	(*Ocimum basilicum* L.)
perilla	(*Perilla frutescens* BRITTON *var. crispa* DECNA)
coriander	(*Coriandrum sativum* L.)
2. Fruiting vegetables	
bitter gourd (bitter melon)	(*Momordica charantia* L.)
Chinese zucchini	(*Benincasa hispida* COGN.)
gourds	(*Lagenaria siceraria* STANDLEY *var. hispida* HARA)
luffa	(*Luffa acutangula* ROXB)
okra	(*Abelmoschus esculentus* MOENCH)
eggplant	(*Solanum melongena* L)
hot chilli	(*Capsicum annuum* L.)
green soybean	(*Glycine max* (L.) MERR)
3. Root vegetables	
radish	(*Raphanus sativus* L.)
turnip	(*Brassica rapa* L.)
taro	(*Colocasia antiquorum* SCHOTT)
yam bean	(*Pachyrrhizus erosus* URBAN)
lotus root	(*Nelumbo nucifera* GAERTN)
water chestnut	(*Eleocharis dulcis* TRIN.)
burdock[a]	(*Arctium lappa* L.)
wasabi[a]	(*Wasabia japonica* MATSUM.)

[a] Burdock and wasabi are only used in Japanese cooking.

Table 2. Plant spacing, growing time and suitable growing season (Somersby, NSW Central Coast).

	Plant spacing (cm)	Growing time (days)	Growing season	Marketing form
Leafy vegetables				
Chinese cabbage	40	80	Feb-Dec	per head
bok choy	20-30	45	Feb-Dec	2-3 plants/bunch
choi sum	broadcast	50	Feb-Dec	10-12 plants/bunch
gai lum	broadcast	50	Feb-Dec	5-7 plants/bunch
mustard	broadcast	from 30	Feb-Dec	300 g/bunch
Japanese mustard	broadcast/40	from 40	Feb-Dec	300 g/bunch
water spinach	50	from 60	Nov-April	500 g/bunch
Chinese spinach	30	55	Mar-Nov	300 g/bunch
chrysanthemum	30	55	Feb-Nov	300 g/bunch
Chinese chive	broadcast/20	from second year	Oct-Apr	200 g/bunch
shallot	broadcast	from 60	year round	200 g/bunch
bunching onion	3-6	from 240	year round	2-3 plants/bunch
Fruiting vegetables				
bitter gourd	50-100	90	Oct-Apr	per kg
Chinese zucchini	100	90	Oct-Apr	per kg
gourd	100	90	Sep-May	per kg
luffa	100	90	Sep-May	per fruit
eggplant	50	90	Oct-Apr	per kg
hot chilli	25-50	90	Sep-May	50 g/bunch
green soybean	15	70	Oct-Apr	2-3 plants/bunch
Root vegetables				
radish	20	60	year round	2-3 roots/bunch
turnip (small)	10	45	year round	3-5 roots/bunch
turnip (large)	20	55	year round	per root
yam bean	10-20	180	Oct-May	per kg
burdock	5-10	from 120	year round	2-3 roots/bunch

Plant spacing (see Table 2) can be adjusted, depending on the vegetable variety and market demand, since there are several different plant sizes among species. Excessive plant densities produce small, irregular-sized and misshapen crops.

Growing times differ between varieties and with season, being normally shorter in summer and longer in winter. Table 2 shows the growing times of Asian vegetables planted in early spring (September) on the NSW Central Coast.

Irrigation

To produce high quality Asian vegetables, plants must have adequate soil moisture throughout their development.

Root vegetables are particularly sensitive to water stress, which causes pithiness in the root.

For leafy vegetables, overhead sprinklers provide the moist environment needed for tender foliage but also encourages fungal diseases, particularly in summer (not a favoured growing season).

Most fruiting vegetables respond best to trickle irrigation systems combined with black polythene mulch, to conserve moisture and control weeds.

Weed control

Weeds are a problem for Asian vegetables. Slow growth of the vegetables in the early stages makes them poor competitors with weeds. Weed control is essential from sowing time onwards, otherwise yield and quality are affected.

Pre-germinate weeds before planting the crop and control them with either knockdown herbicides or by cultivation. It is usually sufficient to hand-weed fast-maturing vegetables once during their growth. This group includes bok choy, mustards, Chinese spinach, and turnip.

Slow-maturing vegetables such as burdock only need weed control in the early stages because the vegetable foliage soon grows sufficiently to cover the ground.

After harvest

The crop is hand-harvested, then either tied in bunches (most of the leafy and root vegetables) or sold in bulk in cartons of five, ten or fifteen kilograms (see Table 2). Some vegetables can be harvested several times—for example, water spinach, chrysanthemum, Chinese chive, and the fruiting vegetables (except green soybean).

Like other vegetables, Asian varieties are susceptible to wilting. If possible, harvest them when it is cool, preferably in the early morning, and keep the produce cool and moist until it is put in cool storage.

In hot weather, pre-cool the crop to its optimum storage temperature as soon as possible after harvest. This is best done with forced-draught air cooling. Vacuum cooling benefits produce with a high surface-area-to-volume ratio, where rapid cooling is important, such as leafy vegetables.

The ideal storage conditions for many vegetables is a temperature of 0°C and a relative humidity of 90–95 per cent. But you must not freeze the produce: it can suffer extensive damage when thawing.

All these precautions maintain the quality of the vegetables and increase their storage life.

Pesticide use

Most Asian vegetables are eaten raw or cooked without peeling the skin, so you must be extremely careful if using pesticides; they must be registered and approved for use, and applied according to the directions on the product label. Postharvest chemical treatments are generally unnecessary.

Bok choy (*Brassica chinensis* L.)



Local and export markets

The Australian market for Asian vegetables is worth annually A$25–30 million to the growers; demand continues to grow. The export market, too, shows considerable potential. Asian countries annually import A$2 billion worth of oriental vegetables.

Seven varieties are considered to have particularly good export potential. Four are leafy varieties (bok choy, gai lum, choi sum, bunching onion); the other three (long white radish, Japanese turnip and burdock) are root vegetables.

BOK CHOY
(PAK CHOY, CHINESE CHARD)

Bok choy (*Brassica chinensis* L.) belongs to the mustard family, *Brassicaceae*, which is one of the most important and diverse groups of vegetables cultivated in Asia. It includes cabbages, Chinese cabbage, cauliflower, broccoli, Brussels sprouts, kale, radishes and turnips.

Bok choy, native to Asia, is a 'non-heading' type of Chinese cabbage. It is distinguishable by its leaves and petioles. The leaves are non-serrated, smooth and green; the petioles and mid-veins are usually white, thick and crispy. Another type, Shanghai bok choy, has light green petioles and mid-veins.

Bok choy is a good source of vitamin C, supplies valuable quantities of dietary fibre, and some potassium.

Pests and disease

Bok choy is attacked by the same pests that attack other Brassica crops, but aphids and green looper caterpillars are the most serious pests on the NSW Central Coast.

The most serious diseases of bok choy are bacterial soft rot and white rust.

Bacterial soft rot, caused by the bacterium *Erwinia carotovora*, is commonly found in decaying vegetable matter in the soil; the bacteria thrive in hot weather, invading tissue damaged either by fertiliser burn from side-dressing or cultivation (or both). The result is mushy decay of leaf petioles nearest the ground.

White rust (or white blister), caused by the fungus *Albugo candida*, is also a common disease found in bok choy and other mustard crops. Its symptoms are a mass of white small, circular, raised spots on both sides of the leaves. Spores are spread by wind and rain. Cool, wet weather favours infection and spread of the disease.

Control both diseases by destroying diseased crop residues, and by rotating crops for three or four years.

Harvesting and marketing

Harvest bok choy in spring or autumn, about six to seven weeks after sowing. Bok choy is hand-harvested, by cutting at the base of the plant, then tied in bunches of two or three. As bok choy is susceptible to wilting, harvest it in the early morning and keep it cool and moist until it is put in cool storage.

Varieties

There are few cultivars available in New South Wales. They are briefly described here.

Pak choy white. This Japanese cultivar stands erect; it has green leaf blades, and white petioles and mid-veins. The variety is susceptible to bolting (it occurred in all trials on the NSW Central Coast), so it should be harvested when young and small—with about nine to ten leaves and weighing 100–120 g (fresh).

Hypro F_1 This cultivar, introduced from Holland, resembles *pak choy white* but may be grown to a larger size (greater than 500 g fresh weight) and is less susceptible to bolting; in fact, it can be grown safely year round without risk of bolting.

Pak-choy green. This is a cultivar of Shanghai bok choy. The plant stands erect, its leaves curling outwards; the petioles and mid-veins are light green. The petioles are flat, broad and enlarged at the bottom.

Pak-choy green is a slow-bolting cultivar. It is harvested from 45 days after sowing in spring—when the plant has fifteen or sixteen leaves and weighs 180–200 g (fresh).

Shanghai bok choy



CHOI SUM (TSOI SIM, CHINESE FLOWERING CABBAGE)

GAI LUM (KAI LAN, CHINESE BROCCOLI)



Choi sum (*Brassica parachinensis* Bailey)

Gai lum (*Brassica oleracea* var. *alboglabra* [Bailey] Musil.)

Choi sum is fast growing and erect, with one main fleshy stem. The leaves, petioles and mid-veins are light green. The leaves are elliptic-shaped and non-serrated; the petioles are narrow and round. Choi sum flowers when it has seven or eight leaves. It is harvested as the first flower buds begin to open. All the plant is edible, including the yellow flowers.

It can be boiled, steamed or fried. It is rich in carotene (pro-vitamin A), calcium and dietary fibre. It also supplies some potassium.

The choi sum varieties tested on the Central Coast were similar in appearance and maturity.

Gai lum looks more like broccoli than a mustard. It is an upright plant with one thick and fleshy stem. The leaves, petioles and mid-veins are a darker green than choi sum. The leaves are also rounder than choi sum's, but the petioles are similarly narrow and round. Gai lum flowers when it has nine or ten leaves. The flowers are white. Like choi sum, gai lum is harvested as the first flower buds begin to open.

The flowers, the young stem and the two or three youngest leaves are all edible. Gai lum is an excellent source of vitamin C, and a good source of folic acid, dietary fibre and potassium.

There are not many varieties grown in New South Wales, and only one Japanese cultivar (Kailaan) is available.

Choi sum and gai lum belong to the mustard family, *Brassicaceae*. They are used extensively in Chinese cuisine, and both must reach flowering stage for harvesting. Both are cool season crops.

Sow them directly and densely in the row. Thin the seedlings to encourage quick growth, but keep the plants close together so they do not grow large and tough-stemmed.

Pests and disease

The most important pests found on choi sum and gai lum are aphids, green looper caterpillar and white butterfly caterpillar. The most important disease to affect both is white rust (see *bok choy*).

Harvesting and marketing

Choi sum and gai lum are harvested in spring and autumn, about seven or eight weeks after sowing. The plant is cut at the base, then tied in bunches of ten to twelve (choi sum) or five to seven (gai lum).

Postharvest treatment is similar to bok choy.

JAPANESE BUNCHING ONION (NEGI [Japanese], WELSH ONION)

Japanese bunching onion belongs to the onion family, *Amaryllidaceae*. The Asian communities use two main groups of bunching onion: the Japanese bunching onion (*A. fistulosum* L.) and the shallot (*A. fistulosum* L. var. *caespitesum* MAKINO).

In 1988, Japan produced 390,000 tonnes of bunching onion, worth about A$992 million, and imported nearly 6,000 tonnes, worth about A$12 million.

Japanese bunching onion has no bulb; it is grown for its blanched, thickened 'stem', which is actually an elongated leaf base (same as the leek). The single 'stem' grows to a 40-50 cm length, and is the main edible part. (Sometimes the leaves are also eaten.)

The 'stem' supplies some vitamin C and a small amount of carotene (pro Vitamin A), potassium and dietary fibre.

Shallot has multiple clovelets 20–30 cm high with a 0.5 cm stem diameter. The whole plant is edible. Shallots are grown worldwide, but predominantly in China and Southeast Asia.

Climate and soil

Bunching onions grow in a large range of temperatures but the best range is 15–20°C. They tolerate cold but once they reach a certain size, low temperatures induce bolting.

The crop is best sown in deep, fertile and well-drained soils as the 'stems' must be covered by soil throughout their growth to produce long white sheaths.

Bunching onions do not like acid soils; a soil pH of 6.0–7.4 is best. Avoid high soil moisture, which leads to oxygen deficiency.

Varieties

Japan uses two main groups of bunching onion: the short (or 'leafy') bunching onion and the long bunching onion.

Short bunching onion. This has short 'stems', and the leaves are soft and tender. The mature plant has four or five 'stems'.

Most types of leafy bunching onion are summer varieties; the plants stop growing in winter and their leaves turn yellow.

The cultivars available in Australia are Kyoto Market and Asagi Bunching; these may be used as spring onions.

Long bunching onion. Has a single, long 'stem', and the leaves are tough. The stem is white if covered by soil during growth, and grows up to 50 cm in length.

Most types of long bunching onion are winter varieties; they are not dormant during winter so they grow over a longer period. The result is the longer 'stem'.

Cultivars such as Ishikura, Feast, Tsukuba and Kiyotaki are available in Australia. These, too, may be used as spring onions.

Japanese bunching onion (*Allium fistulosum* L.) cultivars. The first two are short bunching onion.



Land preparation

It is important to kill weeds and produce a suitable tilth for planting. The first working should be deep, with subsequent cultivations aimed at producing a moist, friable tilth. If the soil is infertile and too acid, apply a generous dressing of well-rotted animal manure and agricultural lime (or dolomite) six weeks before planting.

Three or four side dressings are necessary during the growth period.

Sowing and plant spacing

The short (leafy) bunching onion is best thickly sown, by hand or seeder, into well-prepared raised beds. Thinning is sometimes required. Leafy bunching onions need at least four months' growth to reach a marketable size—a stem diameter of 1.5–2 cm and 10–15 cm of white 'stem'. For spring onions, harvest the plants earlier—two months after sowing.

Long bunching onion is best started in a seedbed, grown to a height of 12 cm and a stem diameter of 5 mm, then transplanted into a 15 cm deep furrow with 3–6 cm between plants (see Figure 1). This approach results in a uniform, high quality crop.

Figure 1. Transplanting long bunching onion.

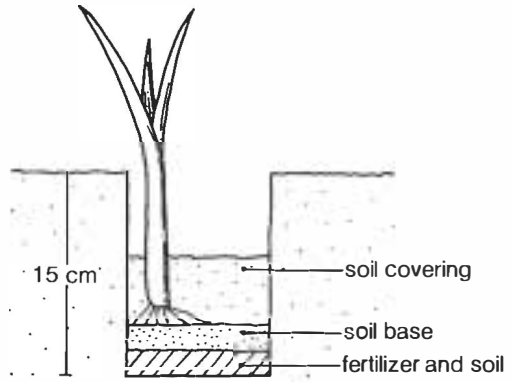
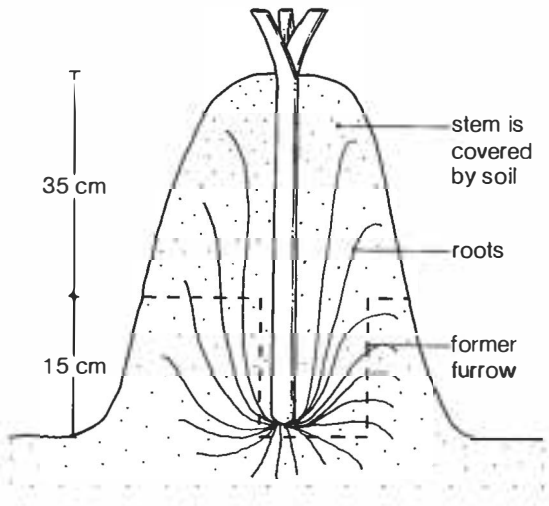


Figure 2. Keep the 'stem' covered so it grows long, white and slender.





Spring onion (early harvested bunching onion).

As the 'stem' grows, keep it covered with soil up to the growing point (see Figure 2). The soil covering results in a long, white, tender stem. The long bunching onion also takes a 'long' time to mature; a marketable size needs eight to twelve months' growth.

Weed control

You must control weeds from the start.

Before transplanting, pre-germinate weeds. During crop growth, control weeds by cultivation along the row or by using knockdown herbicides that are registered for use in onion crops. Hand-weeding along the row and cultivation between the rows may also be necessary.

Pests and disease

Only a few insect pests attack bunching onions; the significant ones are onion thrips and onion maggot. Cutworms and vegetable weevils cause some occasional harm.

The most important diseases found in bunching onion are downy mildew (*Peronospora destructor*) and Alternaria leaf spot (*Alternaria porri*). Downy mildew is common in moist weather, during spring and autumn. Its symptoms are pale oval spots on the leaves, which then turn yellow; a black secondary fungus may grow on the dead leaves. Downy mildew develops from previously infected crop residues. Cool, wet weather favours the disease.

Alternaria leaf spot occurs in summer. The symptoms are dark brown or black spots on the leaves, about 3 mm in diameter, with yellow edges up to 1–3 cm wide. The disease is spread by the spores on the leaves; the spores are carried from plant to plant by wind, rain and irrigation. Warm weather favours the disease.

Control both diseases by destroying crops immediately after harvest, spraying crops with the recommended fungicides and using resistant cultivars.



Oyster mushrooms



Chinese cabbage



Chillies

Chinese zucchini



Yam bean



Bean sprouts



Watercress





Bitter melon

Taro



Root ginger



Japanese bunching onion–continued

Harvesting and marketing

Short (leafy) bunching onion grown on the NSW Central Coast is harvested after four or five months' growth. In this time, the plant grows a 15 cm length of white 'stem' with a 1.5–2 cm diameter.

Long bunching onion is harvested after more than eight months' growth, to produce white stems over 35 cm in length with a 2–2.5 mm diameter.

Take care when harvesting long bunching onions, as the stems are deep in the ground. Cut the roots and leaves, leaving just 10 cm of green top. Remove the old yellow leaves and their blanched leaf sheaths.

Bunching onion is marketed either in bulk (5 or 10 kg cartons) without washing, or tied in washed bunches of two or three stems, with all but the top three or four leaves trimmed off.

Bunching onions must be stored at a temperature of 0°C and a relative humidity of 90–95 per cent.

LONG WHITE RADISH
(LOH BAAK [Chinese], DAIKON [Japanese])

Radishes belong to the mustard family, *Brassicaceae*. They have been eaten in China since 400 BC and are still one of the more important vegetables in Asia.

The radish plant is erect, with short non-branching stems supporting leafy rosettes. It has a swollen tap root. The petioles and mid-veins are light green; the petioles are narrow and round.

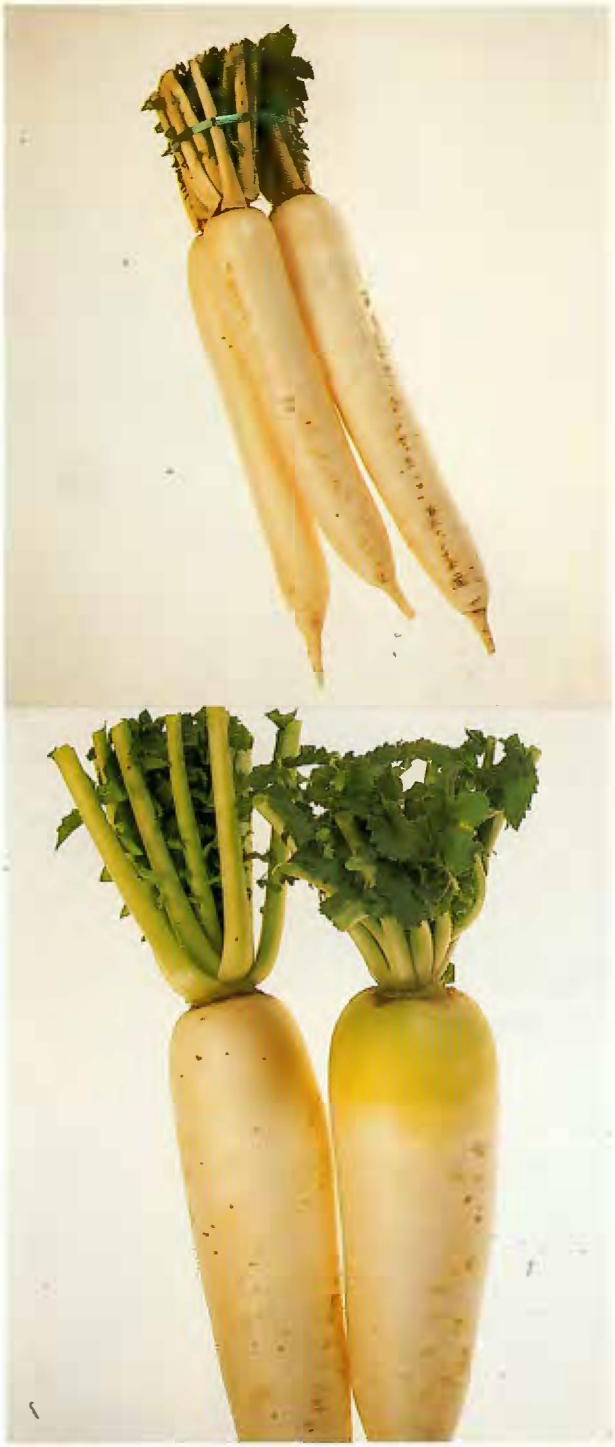
The plant is rich in carotene (pro-Vitamin A) and calcium. The radish root is a good source of Vitamin C and also has some potassium and dietary fibre. Radishes can be eaten raw, cooked, brined, fermented, pickled or dried.

Long white radish, one of the four types of radishes used in Asia, is also the most extensive crop grown there: Japan, for example, produced 1.35 million tonnes of long white radish in 1988, worth about A$1,050 million; the 1983/84 crop in the USA was worth more than US$25 million dollars.

Long white radish is sold fresh, or for processing—depending on root shape. Figure 3 shows the seven common shapes.

Pests and disease

As a member of the Brassica family, radishes are attacked by the same pests that attack other family members such as cabbages, cauliflowers and lettuce. The most serious pests found in the State's radish crops are cabbage white butterfly and aphids; nematodes and black beetle sometimes cause root damage.



Long white radish (*Raphanus sativus* L.). Japanese and Korean consumers prefer green-necked varieties.

The most important disease is bacterial soft rot (*Erwinia carotovora*), which is also found on other Brassica species. The bacteria are commonly found in decaying vegetable matter in the soil. They invade damaged tissue, often following other diseases. Hot, wet weather favours soft rot. A soft, mushy decay develops from the root 'neck' (near the ground) and eventually the entire root is affected by a soft rot with a very smelly odour.

It is also a postharvest problem.

The disease is controlled by avoiding damage to the plant during side-dressing or harvest, destroying diseased crop residues, and rotating the crop every three or four years.

Radishes are sometimes attacked by yellows (*Fusarium oxysporum*). The fungus survives for long periods in the soil, infecting the plant through the roots and growing in the water-conducting tissues. Warm weather favours the disease.

Affected plants lose vigour and the lower leaves on one side of the plant turn yellow; a brown discolouring develops under the skin of the root. The disease is controlled by using resistant varieties, and rotating crops every three or four years.

Harvesting and marketing

Radishes are harvested in spring and autumn, about eight to ten weeks after sowing. The roots are mature when they reach a 5–10 cm diameter at the 'neck'. Radishes are hand-harvested and tied in bunches of two or three roots, or sold individually. Radishes sold on the market have full foliage or are trimmed to leave 10 cm of foliage.

The root should have smooth white skin without blemishes. The internal root should have compact flesh with no signs of pithiness or hollowness.

Radishes are susceptible to wilting. Harvest them in the cool, and keep them cool and moist until they are put into cool storage at a temperature of 0°C and a relative humidity of 90 per cent. The radish will have a short shelf-life if pithiness develops inside the root.

Varieties of long white radish

There are several varieties of long white radish grown in New South Wales. The main differences between them are size, root shape and root neck colour. The main root shape grown is triangular with a white neck.

When selecting a radish variety, also check shape and colour, since market requirements vary with ethnic groups. The Chinese and Indo-Chinese require a white-necked, thin (5 cm diameter) root growing to 25 cm long. But the Japanese fresh market prefers the green-necked, fat (7–10 cm diameter) radish grown to 30–35 cm long; they find the all-white types too hot.

Radishes are susceptible to bolting, so to successfully grow them in autumn and winter you must select slow-bolting cultivars—those that are less susceptible to bolting; see Table 3 for recommended slow-bolting cultivars.

When autumn air temperatures fall below 12°C and the days become 'shorter' the plant starts forming flower buds; then, with the warmer temperatures and increasing daylight hours of spring, bolting occurs. Roots of bolted plants are hard, pithy, sometimes hollow—and unmarketable.

For processing, the root shape is not as important but the flesh must be crunchy, and low in water content for faster drying. It must not be pithy. Radishes are marketed when the root mass is about 300–600 g, but depending on the type and market, they can be grown to even greater weights; a special Japanese variety called 'Sakurajima' can grow up to 15 kilograms.

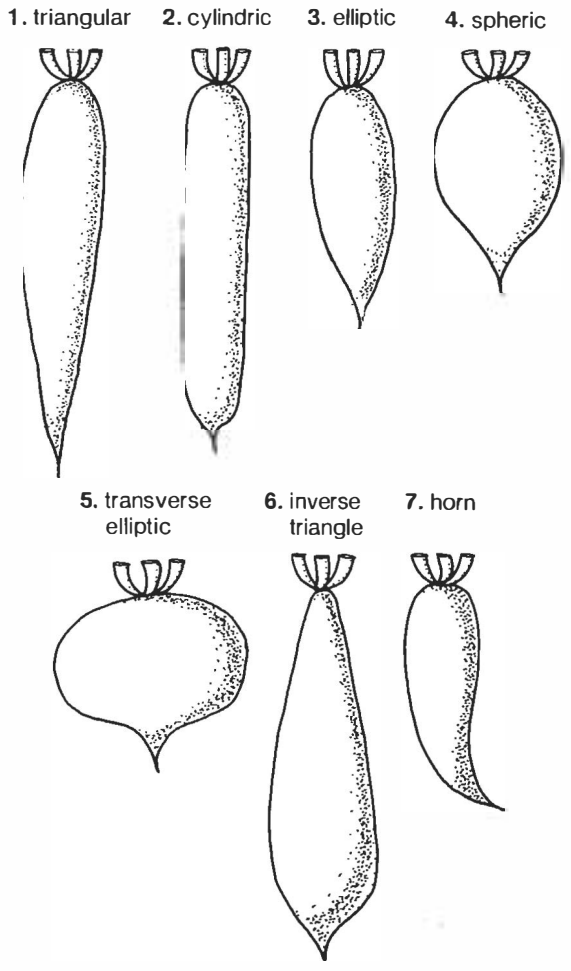
Other types of radish used in Asia

The three other types of radish used in Asia are:

Twenty day radish. The most commonly cultivated radish in Australia and other Western countries. There are several varieties, differing in size and shape, but they all produce relatively small roots of about 30–40 g, and are coloured red, white or red/white. They are very fast-growing, maturing in about 30 days in summer, and 45 days in winter.

For further information on growing methods see Agfact H8.1.32, *Radish growing.*

Figure 3. Root shapes of radishes. Shapes 1 and 2 are fresh market types; the others are mainly for processing.



Leafy radish. Grown as a leafy vegetable, this radish has big foliage and small roots. The plant is harvested when it has grown ten to fifteen leaves, each measuring 25 cm in length. The growing method is similar to twenty day radish.

Sprout radish. A specific variety that grows long, white stems. The seeds are sprouted in moist, dark conditions at about 20–25°C. The sprouts grow to about 15 cm over ten days and are marketed after the roots are removed.



Table 3. Evaluation of radish cultivars grown in spring (NSW Central Coast).

Cultivar	Source[a]	Root shape[b]	Root diam. (cm)	Root length (cm)	Root weight fresh (g)	Neck colour	Leaf hair	Aphids on leaves
Very slow bolting								
Haruyoshi	TH	1+3	7	26	840	green	yes	less susceptible
Narumi	M,H	2	7	32	830	light green	yes	susceptible
White Ball	TH	5	7	10	460	green	yes	susceptible
Slow bolting								
Aokubi Haruyoshi	TH	1	6	26	480	green	yes	susceptible
Aoyutaka	M,H	1	6	32	540	green	yes	resistant
Haruisami	TH	1+3	6	36	630	light green	yes	resistant
Haruyoshi No.2	TH	1+3	6	28	750	light green	yes	less susceptible
Oshin	T,NW	1	7	36	790	light green	yes	susceptible
Seishun	A	1+3	7	30	830	light green	yes	less susceptible
Tomas	TO	1	7	27	840	green	yes	resistant
Summer crop								
Natsusakari	TH	1	6	37	660	white	yes	susceptible
Summer cross No.3	T,NW	1	5	34	650	light green	yes	susceptible
Summer and autumn crop								
Aosakari	M,H	1	6	31	630	dark green	no	less susceptible
Azuma 6363	TH	6	5	32	540	white	yes	susceptible
Azuma Miyako	TH	6	5	26	330	white	yes	susceptible
Berimaru	TH	4	8	9	230	red	yes	susceptible
Taiyakushin	TH	1	6	34	710	green	no	susceptible
Fukumi	M,H	1	7	34	750	green	no	susceptible
Green summit	A	1	7	31	500	dark green	no	susceptible
Hybrid long white	H,NW,Y	1	6	45	800	white	no	susceptible
Relish cross	T,NW	1	7	36	890	green	no	resistant
Senshinriso	TH	1	4	33	310	white	yes	susceptible
Vitamin	TH	7	4	13	110	dark green	no	susceptible
Wase Shogoin	TH	4	7	12	320	green	no	susceptible
Wase Zumari	TH	1	6	35	660	white	yes	susceptible

[a]TH:Tohoku Seed, Japan H: Henderson, Australia A: At Seed, Japan Y: Yates, Australia
M: Mikado, Japan T: Takii, Japan TO: Tomas Food, Australia NW: New World, Australia
[b]See Figure 3 (previous page)

JAPANESE TURNIP (KABU [Japanese])



Japanese turnip (*Brassica rapa* L.). This is a kokabu (small turnip) variety.

Turnip belongs to the mustard family, *Brassicaceae*. There are many turnip groups on the world market, but the Japanese turnip has a smaller number of chromosomes (10) than the Chinese or European varieties (18 and 19, respectively).

The Japanese turnip plant is erect, with bulbous-like roots and very short branching stems forming a leafy crown.

Turnips suit a large range of soil types, including heavy soils (where radishes cannot be grown). Turnips prefer milder temperatures.

The leaves and roots are used; the leaves are rich in vitamins and minerals, especially carotene (pro Vitamin A) and calcium.

Pests and disease

Japanese turnip and long white radish are affected by the same pests and diseases (see *long white radish*).

Harvesting and marketing

Turnips are hand-harvested, and the whole plant is kept. Plants with small roots are tied in bunches of three to five; large roots are sold individually.

Harvest in the early morning. Turnips wilt quickly after harvest so they need prompt attention or the bottom leaves will turn yellow, making the whole turnip unmarketable. Keep them cool and moist until they are put in cool storage at 0–5°C and 90 per cent humidity.

Varieties

There are several varieties of turnip grown in the State. They vary in colour (white, green, red, purple and golden) and root shape (globe, oblate, bell and conical). They all belong to two main groups—small root or large root turnips.

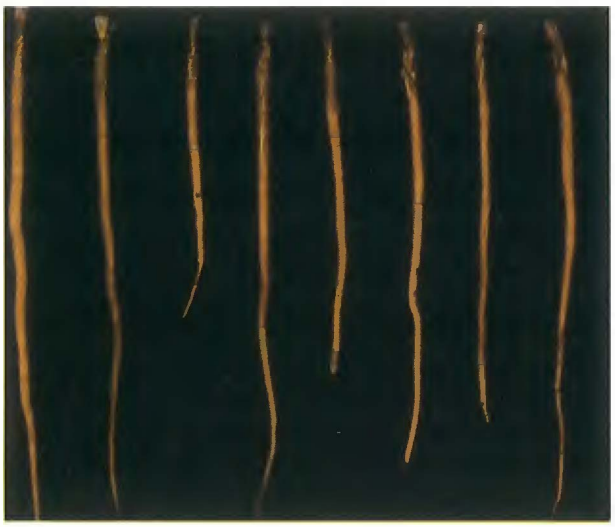
Small turnip (Kokabu). These varieties are harvested 35–45 days after sowing, when root weight reaches about 100–150 g. Cultivars such as Tokyo Cross, Ping Pong and Express White are slow-bolting and produce excellent round-shaped roots with smooth, white skins.

Large turnip (Okabu). These varieties are harvested either at about 90–100 days after sowing, when the mature root is more than 15 cm in diameter; or at 55–60 days, when the root is half that diameter (7–8 cm) and 350–400 g in weight. Cultivars such as Shogoin and Just Right are grown only in spring and autumn; in the other seasons they may bolt.

BURDOCK (GOBO [Japanese])

Burdock belongs to the chrysanthemum family, *Asteraceae*. The root contains starch, potash, inulin, volatile oil, resin and several antibiotic substances. In Japan, where burdock is commercially grown as a vegetable, 1988 production was about 212,000 tonnes, worth A$500 million. Burdock is used in herbal medicine in Europe and North America, where the wild plant grows on wastelands and by roadsides.

Burdock (*Arctium lappa* L.)



Climate and soil

Burdock is a perennial, with a vertical root 60–100 cm in length. Burdock prefers warm weather during the growing period; a 20–25°C temperature range is best. Spring sowing is suited to all areas, but autumn sowing is only feasible if the plants are established before winter.

Burdock for sale as a vegetable is harvested from first year plants, normally at four or five months' growth if planted in spring, or seven to eight months' growth if planted in autumn. The foliage stops growing in winter, but young shoots start growing in the following spring. The root survives air temperatures as low as -20°C.

Burdock does not like acid soils; a pH of 6.5–7.5 is best. It grows best in very deep, fertile, friable, well-drained soil.

Light-textured sandy soils or sandy loam make planting easier but the roots tend to lack flavour even though they are 'better looking'—clean, and free of lateral roots.

Land preparation

Land preparation is very important because the market demands that the burdock root be a particular size: about 60–100 cm long.

About six weeks before planting, apply a basal fertiliser of manure or compost, to build up the soil's waterholding capacity and nutrient supply. Two or three side dressings with artificial fertilisers containing nitrogen and potassium keep plants growing well.

Deep ripping, to a 60–80 cm depth, helps the plant grow longer roots (see Figure 4).

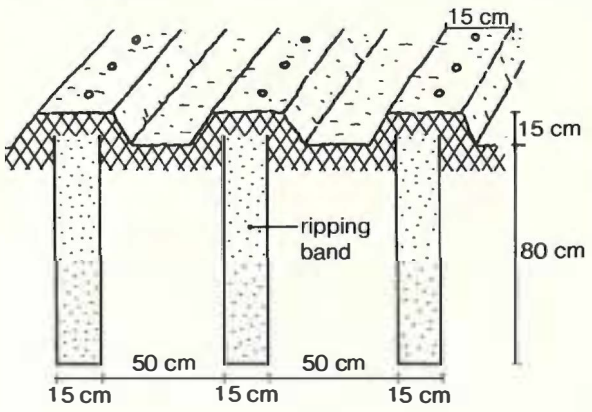
Sow the seed on top of well-prepared rows; the seedlings germinate about ten days later. Thin the seedlings at the 'two true leaves' stage. A second thinning is sometimes necessary to keep plant spacing at 5–10 cm or to eliminate seedlings that are too big or too small.

Pests and disease

Nematodes and aphids are the more serious pests found in burdock. Occasionally, green looper caterpillars and leaf-eating ladybirds damage leaves.

Powdery mildew is a common leaf disease, particularly in dry weather in late summer. Black root is caused by the fungus *Aphanomyces raphani*, which grows in the soil and may persist for a long time. Warm or hot weather favours the disease. Dark, irregular patches appear on the root, gradually merging to cover it completely. The disease is controlled by improved soil drainage, and rotation of crops every three or four years.

Figure 4. Preparation for burdock sowing: deep ripping (60–80 cm deep) to encourage roots to grow longer.



Harvesting and marketing

Burdock grown on the Central Coast is harvested four to five months after a spring planting, and seven to eight months after an autumn planting. These times allow the roots to reach a satisfactory size; a 2–4 cm diameter at the 'shoulder' and 60–100 cm long.

Harvesting is laborious, as the market requires the full length of root. Cut the foliage to a 10–20 cm length, then dig out the root, either by hand or with a special mechanical digger. Wash all the roots thoroughly, cut their foliage again (leaving just 2 cm), then either tie them in bunches of two or three, or in bulk—in cartons of 5 or 10 kilograms.

Burdock is susceptible to wilting. Keep it cool and moist until it is put into cool storage at a temperature of 0°C and a relative humidity of 90–95 per cent.

Varieties

Japan grows several varieties of burdock. These differ mainly in the colour, length and shape of the root, and stem colour and maturity.

Of the four groups of burdock sold in Japan (Takinogawa, Oura, Aki and Etsuzenshirokei), Takinogawa is the most popular. Its long, thin roots are ideal for the fresh market. The other groups are unsuited to the fresh market. They are elliptical-shaped (Oura and Aki) or short with many laterals (Etsuzenshirokei), or both.

Takinogawa cultivars include Tohokuriso, Takigawa, Takigawa White, Yamada Early, Watanabe Early, Yanagawa, Kunpu and Takimasari.

Demand for the burdock leaf is very small. It is taken from small plants with just two or three months' growth, and sold for both leaf and root.

Bolting has not been a problem on the NSW Central Coast or in the Hunter Valley.

MARKET POTENTIAL

Asian vegetables are increasingly popular with non-Asian consumers.

Asian restaurants and cookbooks have shown how these vegetables offer flavour, nutrition and versatility. Suburban supermarkets and greengrocers now provide a selection of Asian vegetables, such as bok choy, Chinese cabbage and snowpeas.

NSW growers are concentrated in small holdings on Sydney's outskirts. They sell direct to restaurants or to the Sydney markets in Haymarket, Cabramatta, Marrickville and Bankstown.

Domestic and export sales

Growers in Australia earn A$25–30 million annually from domestic sales (1992).

NSW Agriculture is working to increase domestic sales so we are less dependent on imported vegetables; in 1983–4, Australia's total vegetable imports cost A$280 million.

There is a strong export market for Asian vegetables. Our growers can supply the Asian markets outside their growing season, when demand is at a peak.

Currently, our biggest potential customers are Singapore, Malaysia, Hong Kong and Japan. These countries annually import a total A$2 billion worth of oriental vegetables from around the world. The imports are supplied fresh, frozen, salted, and canned. Vegetable seed is also imported.

In 1985, Singapore and Hong Kong paid out a total A$74 million for their vegetable imports, which included Chinese cabbage, bok choy, shallots and turnip; and in 1988, Japan imported A$120 million worth of bunching onion, turnip, green soybean, spinach, mustards and Japanese pumpkin.

With careful planning and monitoring, our export share in Asian vegetables can only increase.

FURTHER INFORMATION

This Agfact is the first and, to date, the only English-language publication to comprehensively cover Asian vegetable growing in this country. But useful support material is available, detailed as follows. (See 'Related Agfacts', this page, for ordering details.)

- *Chinese vegetables*, full colour poster, 'Fresh is Best' series, order no. Z.19.4, $1.00 (RRP). There are so many! This quality poster features colour prints of numerous vegetables used in Chinese cooking. Includes nutritional details and a shoppers' guide to selecting healthy specimens.
- *The Fresh Vegetable Cookbook* (1984), order no. Z.22.3, $10.00 (RRP). Asian vegetables are featured in many of the recipes in this lavishly illustrated book. They are covered in greater detail in the section headed 'Unusual Vegetables'.
- *The Home Vegetable Garden* (1991), $15.50 (RRP). This bestseller discusses all aspects of home cultivation, including reference to a wide range of Asian vegetables and herbs. Comprehensively illustrated.
- See also 'Related Agfacts' (this page).
- Contact the author, Dr Vong Nguyen, at the Gosford Horticultural Research and Advisory Station (PO Box 581, Gosford, NSW 2250, phone 043-280 327).

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RELATED AGFACTS

A number of Agfacts related to this topic are available from offices of NSW Agriculture. The Publications Catalogue (free of charge) includes an order form and a full list of all Agfacts in print. You may also phone an order (008 028374) or write to: Publication Sales, NSW Agriculture, Locked Bag 21, Orange 2800. When ordering, you must quote the order number.

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