

Cabbage growing

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Introduction

Cabbages belong to the Cruciferae family and are related to turnips, cauliflowers and brussels sprouts. The origin of the cabbage is rather obscure as it is one of the oldest vegetables grown, being well known by the ancient Greeks. Cabbages are easily grown under a wide variety of conditions and are adaptable to most areas of the state. Although cool moist weather results in the best quality heads, some varieties produce acceptable heads during the warmer period of the year. Therefore cabbages can be grown on a continuous basis in some districts. In cooler areas, such as the tablelands, production is limited by winter.

Establishment

Soil types

Cabbages grow well on a wide range of soils from light sand to heavier clays. Soils with high organic matter content give the best yields. The soil pH should be in the range 6.0–6.5 for ideal growth. Cabbages are less demanding than cauliflowers, and good crops can be produced on most soils.

Alluvial soils on major river flats are excellent for cabbage production, provided drainage is satisfactory.

Good drainage is important, and soils that become waterlogged after heavy rain or irrigation are unsuitable.

Varieties

Cabbages are sold by type, shape and colour of head rather than by individual variety. Green-coloured cabbages are the most common, with

red cabbages available. The shape of the cabbage head can be classified in three groups:

- **Ballhead** (or roundhead). This is the most common type in NSW. It has a soccer-ball-sized head, and smooth white-veined leaves tightly packed together.
- **Conical** (or sugarloaf). This type has a smaller pointed head.
- **Large drumhead** types. These are a larger cabbage with a flatter head shape.

Savoy cabbages are distinguished by their wrinkly leaves with sawtooth-like leaf margins. Savoy cabbages range in colour from light green to grey-green to bluish-green with a reddish tint. The shape varies too, from rounded, soccer-ball size to cylinder-like.

Chinese cabbages (also known as 'wong bok') are increasingly grown in NSW. Chinese cabbages are usually more elongated than other cabbage types with broad, very pale green leaves which have white veins that are often less tightly packed than in other types of cabbages.

There is a wide range of varieties available and their suitability for a particular area can only be judged by growing them in the region. Some varieties are:

- **Corinth** is suitable for processing and has good disease tolerance. It is similar to Green Coronet but with a larger frame (average weight 4 kg).
- **Green Coronet** is a good sized variety (average weight 3 kg) which has performed well in all areas of the state. It is partially tolerant to black rot and is grown in small amounts during summer. It has a cream-green colour and a good flavour. Harvesting is about 12 weeks from seeding.
- **Greengold** (hybrid) is an early (12 weeks), slightly conical-headed cabbage, weighing about 3–4 kg. This type is a uniformly attractive, light green cabbage, but the heads do not hold as with the ballhead types.
- **Hiyield** or **Beauty** (hybrid) is a large cabbage of drumhead type, maturing in about 13 weeks and weighing about 3.5–4.5 kg. The variety



has some resistance to black rot. The colour is grey-green and the leaves are heavily veined.

- **Kameron** is a uniform cabbage with large size for cool-season production. Produces large, flattened, globe-shaped heads and has excellent holding ability.
- **Red Ruby Ball** (hybrid) is an early-maturing cabbage with purple-red leaves. The head is a very tight ball type weighing just over 1 kg.
- **Savoy King** (hybrid) is an early-maturing (12 weeks) Savoy-type cabbage used mainly in coleslaw. Its dark green leaves are coarsely blistered but the head (which weighs about 3 kg) is lighter green and is a flattened ball shape. The variety hearts during the summer in many areas.
- **Savoy Prince** (hybrid) is larger than Savoy King with reasonably good holding capacity. It matures a couple of weeks after Savoy King. It is more susceptible to black rot. The head tends to be flatter than that of Savoy King.
- **Sugarloaf** produces heads about 2 months after transplanting. The conical heads weigh about 2 kg.
- **Warrior** is a medium to large sized variety (average 4 kg) with a round to slightly globe-shaped head. The variety has some resistance to black rot and tip burn. Warrior is a popular processing variety.
- **Cardinal Red** (hybrid) is a red cabbage with a large round head (average 1.5 to 2 kg). This variety makes better size when growing into warm season.

Districts

Cabbage planting varies from district to district. Year-round production is prevented by unsuitable weather conditions in some districts.

Bathurst/Cowra/Canowindra

This is one of the main producing areas in the state. Cabbages are grown for both processing and for the Sydney fresh market. Green Coronet is the main fresh variety, and Warrior is the main processing variety. In the Bathurst district, cabbage crops are planted from September to March, and harvested from January to August. In the Cowra and Canowindra districts, the cabbages are planted from January to March, and picked from April to August.

Mudgee/Wellington/Dubbo

The varieties favoured in this area are Green Coronet, Ballhead and Savoy King. Production is limited to the cool periods of the year and transplanting starts in March and finishes in late April. Crops are cut until October.

Murrumbidgee Irrigation Area (MIA)

Only small areas of the MIA are planted to cabbages, which are usually sold on the Sydney and Melbourne markets. The varieties grown are Green Coronet and Savoy King. Transplanting commences when the weather begins to cool down in March, and continues until late April. Care needs to be taken, as late sowings may result in the crop bolting. Harvesting starts in July and continues until October when the hot weather makes growing difficult.

North Coast

Cabbages for sale locally and to Brisbane are grown in the Dorrigo, Grafton and Murwillumbah areas. Most crops are produced in winter and spring. Hot humid conditions in summer make cabbage growing difficult. Black rot is a major problem in summer. Varieties grown are Green Coronet and Savoy King. Transplanting commences in March and continues through until May. The crop is harvested from June through until November.

Windsor/Sydney/Hunter Valley

Cabbages are grown throughout the year in this region, which is one of the chief producing areas in New South Wales. The disease black rot is worse in summer and quality is usually poor. For this reason, varieties tolerant to black rot are favoured for planting from November to January. Transplanting for the main planting commences during March and continues until early May. A later planting is then made in September. Smaller plantings are made as the weather gets hotter.

Cell-grown transplants

The production of seedlings in cells, or individual pots, is the major method of raising transplants. Plants grown by this system are available from commercial nurseries or they can be raised on the farm. Transplants from this system suffer little transplanting shock and grow rapidly once transplanted into the field. Management of the young plants is easier than with bare-rooted seedlings.

Direct sowing

Direct sowing is still an option but is not practised much any more. When cabbage crops are sown directly into the field with a precision planter, they may still need to be thinned to the desired spacing. Good seedbed preparation is essential if this system is used. The young plants are easily damaged by heavy rain and wind and need to be irrigated regularly. Rates for direct sowing are given later.

Cultural practices

Soil management

A well-prepared seedbed is important and preparation must commence well before transplanting. Cabbages require a soil with a pH of 6.0–6.5 for best growth. This can be achieved by applying dolomite or lime at a rate of 2–5 t/ha when cultivation is commenced. In most areas cabbages are transplanted into raised beds to reduce the effect of heavy rain, which would waterlog the soil. Beds should be formed as soon as possible to allow them to stabilise before transplanting.

Transplanting

Transplanting is carried out by machines. Transplanters can be as simple as a furrow opener and press wheel which ensures the plant is firmly bedded into the soil. More advanced machines can apply water and fertiliser to the root zone at transplanting. Transplanters require a tractor driver and at least one other operator. One hectare per hour is a good rate for cell-grown transplants.

A good watering immediately after transplanting is essential to ensure that the young plants become well established.

Spacing

Spacing depends on soil type, cultural methods, and the district.

Where two rows are planted per bed, a plant spacing of 75 cm is used on a 1.2 m bed.

A spacing of 40–60 cm is used on single-row plantings where the rows are 1 m apart.

Narrower plantings are used where smaller sized cabbages are produced. A favoured density is 20,000 plants/ha.

Direct sowing rates

There are about 100 seeds/g but the purity of the seed and the resultant germination percentage are critical for success with direct seeding. Cabbage seed loses its viability quickly, and fresh seed must be used each year unless proper storage facilities are available. Do not sow seed deeper than 2 cm.

The quantity of seed required for direct sowing can be accurately assessed by using the Bleasdale formula. According to this, the seed required (in kilograms per hectare) is equal to:

$$\frac{(1000 \times \text{No. plants/m}^2) \div (\text{No. seeds/g} \times \text{lab. germ.\%} \times \text{field factor})}$$

In the formula, 1000 is constant. The field factor varies, from 0.5 where seedbed conditions are poor, to 0.8 for a good seedbed condition.

For example, suppose that the seed supplied by the merchant has a stated laboratory germination of 85% and contains 100 seeds/g, and that the grower has a precision-belt drill and intends planting in rows 70 cm apart with plants every 60 cm in the row. Then each plant will have 4200 cm² (70 cm × 60 cm) of space and there will be about 2.4 plants/m² (10 000 cm² ÷ 4200). We will assume a good seedbed, and a field factor of 0.8.

$$\begin{aligned} \text{Seed required} &= (1000 \times 2.4) \div (100 \times 85 \times 0.8) \\ &= 0.3 \text{ kg/ha} \end{aligned}$$

Nutrition

Soil analysis prior to applying fertilisers is strongly advisable. Cabbages require large amounts of fertiliser but are not as demanding as cauliflowers. As cabbages benefit from high levels of organic matter, it is suggested that animal manure (if available) be the basis of the fertiliser program.

Broiler manure is ideal, as the sawdust and poultry manure are well mixed. A rate of 20 m³/ha is recommended, with the manure well cultivated into the soil. Phosphorus (as superphosphate) is essential and must be applied in the root zone before transplanting. Use about 300 kg/ha superphosphate.

Where poultry manure is not available adopt a program based on chemical fertilisers, using 60–80 kg/ha phosphorus (equivalent to 600–800 kg/ha superphosphate); 60–85 kg/ha nitrogen (equivalent to 180–225 kg/ha Nitram®); and 30–90 kg/ha potash (equivalent to 60–180 kg/ha muriate of potash). Apply this as a base dressing.

At least one side-dressing before head formation is needed, and in lighter soils crops would benefit from a second side-dressing shortly after the head forms. Side-dressing rates suggested are 40 kg/ha nitrogen (equivalent to 120 kg/ha Nitram®) and 30 kg/ha potassium (equivalent to 60 kg/ha muriate of potash). No benefit will be obtained from the superphosphate content of pre-mixed fertilisers applied as side-dressings.

Molybdenum deficiency could occur even though seedlings were treated in the nursery to give added protection against this problem. A follow-up spray of:

$$500 \text{ g sodium molybdate} / 500 \text{ L water} / \text{ha}$$

is recommended when the plants have become established in the field.

Irrigation

Cabbages need regular irrigation to ensure rapid growth and evenness of maturity. They can be irrigated by moveable spray lines, travelling irrigators or solid set, or, if the soil is suitable and water available, flood irrigation.

Cabbages grown in beds will require more irrigation than those grown on the flat. Soil type and weather will also influence the frequency of irrigation. The use of tensiometers or other measuring equipment will improve yields and reduce water costs.

Weed control

A range of herbicides is registered in New South Wales for weed control in cabbages, and good control will result if the directions on the package are followed. Consult a horticulturist for advice on the herbicides registered for use on the main grasses and broadleaf weeds.

Pest and disease control

Diseases

Black rot (*Xanthomonas campestris*) occurs in all areas of New South Wales and affects both seedlings and adult plants. It is the major disease of cabbages and prevents the production of good quality heads during the warmer months of the year. Areas such as Bathurst, which are much cooler than coastal regions, become important suppliers during the summer.

- **Symptoms:** Infection occurs on the leaves through marginal waterpores or wounds. The bacteria move down the leaf veins into the stem and then invade other leaves. The movement of the bacteria causes the leaf to turn yellow, then brown and finally dry out. Movement is usually in a V-shape. Black rot is encouraged by warm, moist weather and rapidly growing soft tissue. It is carried both in and on the seed, and in crop debris. It can survive from year to year in the soil on leaves from diseased crops. Older plants carry the infection and it is transferred to young plants. Insects, water droplets, drainage water and windblown dust help spread this disease.
- **Control:** Treat seed with hot water. Sterilise the seedbed. Avoid using seedbeds where crucifers have been grown before. Remove infected plants, and rotate crucifer crops on a 4 year pattern. Bury all crop residues as deeply as possible. Control biting and sucking insects, which can spread the disease.

Rhizoctonia disease (*Rhizoctonia* spp.) occurs throughout New South Wales and affects all stages of growth.

- **Symptoms:** Rhizoctonia causes damping-off in young seedlings, while older seedlings become stunted and the soft tissue at ground level dies, leaving the symptom known as 'wire stem'. Older plants are prone to stem rot and root rot. Leaves usually take on a purplish red colour. The disease is favoured by cool, wet conditions and is spread by wind-carried spores. Contaminated soil is a source of infection.
- **Control:** Seedbed sterilisation. Wire stem can be checked in the seedbed by drenching the base of the plant with a registered chemical. Crop rotation of 4 years also assists.

Club root (*Plasmodiophora brassicae*) occurs mostly in the Sydney metropolitan area and Bathurst district but is also present in other districts. It is the most important disease of crucifer crops.

- **Symptoms:** Swellings develop on the tap root, secondary roots and even parts of the underground portions of the stem. Roots are often spindle-shaped with thick centres and tapered ends. Diseased roots often decay before the end of harvest. Plants are usually stunted and wilt on hotter days. Plant collapse occurs with advanced decay and enlargement of roots. High soil moisture, acid soil and temperatures between 18.5°C and 25.5°C favour the disease. The fungus survives for long periods in the soil and on diseased crop trash. Club root is spread by infected seedlings, windblown soil and contaminated farm machinery.
- **Control:** Use disease-free seedlings and rotate crops so that crucifers are not grown for 3–4 years in the same ground. Lightly infested soil can be treated with lime, which reduces the symptoms in the plant. Drenching the root zone at transplanting with a suitable registered fungicide is also effective.

Turnip mosaic virus or ringspot virus disease is caused by turnip mosaic virus transmitted on seed and by green peach aphids (*Myzus persicae*). The problem is serious in the Maitland area and also important in the Sydney metropolitan area, around Windsor, the Central and Southern Tablelands, and the Central Western Slopes.

- **Symptoms:** There is a yellow ringspotting of the younger leaves, which later become mottled with light and dark green rings and blotches. These symptoms are most prominent in temperatures over 18°C. In lower temperatures the virus shows a definite black ringspotting of the outer leaves. The disease is spread by the green peach aphid feeding on infected plants and weeds then

transmitting the disease to healthy plants. Aphids acquire the turnip mosaic virus after 10 seconds of feeding on infected plants, and transmit it after 5 seconds of feeding on healthy plants.

- **Control:** Plant disease-free seedlings, produce seedlings away from infected plants, avoid planting near diseased crops or residue, and remove all cruciferous weeds as these carry the virus. Regular spraying will help control green peach aphid populations and reduce the spread of the virus. The manufacturer's directions regarding rates and the interval between last application and harvest must be observed.

Sclerotinia rot (*Sclerotinia sclerotiorum*) is mostly a problem of coastal areas but can occur in all districts, with greatest losses as plants approach maturity.

- **Symptoms:** A soft, rapidly spreading, light brown, watery rot develops. Under humid conditions this rotted area becomes covered with a white growth of mycelium in which irregular-shaped bodies similar to seeds develop. These are the sclerotia and are the means by which the disease survives in the soil for several years. Cool, moist conditions favour the development of the disease. Sclerotinia attacks almost all vegetables and a wide range of other plants.
- **Control:** Removal and destruction of diseased plants prevents the sclerotia from developing. Regular cultivations reduce the humidity, kill the weeds and any apothecia — light brown saucer-shaped bodies which develop from sclerotia under suitable weather conditions. If the ground is heavily infected and the weather cool and humid, spraying as often as every 14 days is suggested.

Insect pests

Cutworms (*Agrotis* spp.) are stout, uniformly coloured, black, grey or reddish-brown caterpillars about 40 mm long when fully grown. They feed at night on the stems and foliage of plants.

They are found in the top 25 mm of soil and close to the damaged plant. Seedling plants may be destroyed and parts of crops may have to be replanted. Cutworms are often more prevalent in low-lying areas after rain.

- **Control:** Spraying the soil at the base of the plants with a registered chemical.

Black beetles (*Heteronychus arator*) are shiny black beetles, about 13 mm long, which may attack seedlings at about ground level, making ragged tears in the stem tissue. They are normally found in grasslands, and most damage is sustained when crops are planted into ground previously under pasture. They are found only in coastal areas and are active mainly in spring and early summer.

- **Control:** There are two methods of control: baiting before transplanting, or spraying the soil at the base of the plants at planting and then 2–3 weeks later with a registered insecticide.

Aphids: Grey cabbage aphid (*Brevicoryne brassicae*) and green peach aphid (*Myzus persicae*). The grey cabbage aphid may occur in very large numbers and its feeding can cause distortion of leaves and stunting of the plants. The green peach aphid does not occur in large numbers, but it is important as the vector of the virus diseases cabbage ringspot and cauliflower mosaic.

- **Control:** Regular spraying. To prevent the insect from transmitting virus disease to plants by feeding, spray the insects when populations are building up. The disease is transmitted within 5 seconds of the commencement of feeding.

Cabbage white butterflies (*Pieris rapae*) are probably the principal pest of crucifer crops, and are most active during spring and autumn. The yellow eggs are laid on the underside of the leaves, and the young, velvety green larvae (caterpillars) feed here. The fully grown larvae, which are about 30 mm long, are usually found on the upper leaf surfaces. The green or brown pupae are usually found attached to the leaves.

- **Control:** A program of rotating chemicals and avoiding the use of a chemical from the same chemical family in succession is essential for the control of this insect and *Plutella* species. The publication *Integrated Management of Diamondback Moth in Crucifers — The Handbook*, by the National Diamondback Moth Project Team, is essential reading for better control of cabbage white butterfly and diamondback moth.

Diamondback or cabbage moths (*Plutella xylostella*) are a major pest of crucifers. The adult is a small brown moth, active at night and hiding by day in the leaf litter at the base of the plants. The small yellow eggs are laid in clusters along the ribs and the lower parts of the plants.

The first instar larva mines within the leaves. Later instars feed on the undersurface or in the inner leaves, often producing a windowpane effect. When fully grown the larvae are about 8 mm long and, if disturbed, fall from the leaf and hang on a thread. They pupate in silken cocoons in sheltered parts of the plant.

- **Control:** As for cabbage white butterflies.

Budworms (*Helicoverpa* spp.) may cause severe damage in some years, particularly during autumn. The buff-coloured moths lay their eggs singly on the leaves, and the larvae (budworms) bore into the heart of the cabbage. The larvae are about 40 mm long at maturity and are conspicuously striped. The basic colour may vary from brown to red, yellow or green. Their habit of feeding within the heart makes them difficult to control.

- **Control:** Regular spraying to kill the budworm just after hatching from the egg and before it has time to become established in the centre of the cabbage plant.

Other pests

The following are also occasionally found damaging cole crops:

- cabbage centre grubs (*Hellula hydralis*)
- looper caterpillars (*Chrysodeixis* spp.)
- onion thrips (*Thrips tabaci*)
- seedling maggots (*Hylemya cilicrura*)
- vegetable weevils (*Listroderes costirostris*).

Quality control

Cabbage growers aim to harvest their crop with the least possible number of cuts. To achieve this, good cultural methods are necessary at all stages of production. Careful attention to size of transplants, fertilising, irrigation, and pest and disease control help to ensure even maturity. Cell-produced transplants are more uniform in their maturing than are seedbed-produced plants. This is one of the major reasons growers are using this method of producing seedlings.

Harvesting and marketing

A cabbage is mature when the head is firm to the touch. Heads firm gradually until they become hard. After a period they will split and the

cabbage is then not suitable for sale. With some varieties the head can split when touched or after being cut. Earlier harvesting overcomes this problem.

Cutting is usually carried out in the morning when the cabbage is at its coolest — cabbage will travel better than if cut in the heat of the day. Cut so that a few wrapper leaves are present to protect the heart.

Infield conveyor belts and forklifts have streamlined cabbage harvesting on larger farms. On smaller properties cabbages are still cut and carried or thrown to the edge of the field. Harvested cabbages are put into collapsible wire crates or wooden crates, or stacked on pallets on the back of a truck.

Cabbages grown through the coolest period of the year and exposed to short days begin to form seed heads during late August and September. While this is not a desirable characteristic, all growers face the same problem and cabbages for sale are conical in shape. Breeders are trying to produce cabbages not so susceptible to this condition.

Cabbages can be stored successfully for up to 3 months at 0°C and at a relative humidity of 90%–95%.

Grading

At present there are no grading regulations for cabbages in New South Wales, but the market demands a good product — medium to large firm cabbages with disease-free outer leaves and a solid heart. As retailers cut most cabbages into halves and quarters, a pleasing internal appearance is important.

Cabbages are usually in plentiful supply so that buyers can purchase good quality produce at reasonable prices. The cost of producing cabbage is estimated to be about 60 cents/head (*Farm Budget Handbook for Vegetables*, 2001).

Processing

Some cabbages are grown for processing, and this industry is based on the variety Warrior. Considerable quantities of cabbage are used for coleslaw. Growers from a number of areas are supplying small processors who manufacture the product for use in the catering trade. Many of these small processors purchase their cabbage at the Flemington fresh fruit and vegetable market.

Disclaimer

The product trade names in this publication are supplied on the understanding that no preference between equivalent products is intended and that the inclusion of a product does not imply endorsement by NSW Department of Primary Industries over any other equivalent product from another manufacturer.

Always read the label

Users of agricultural (or veterinary) chemical products must always read the label and any Permit before using the product, and strictly comply with the directions on the label and the conditions of any Permit. Users are not absolved from compliance with the directions on the label or the conditions of the Permit by reason of any statement made or not made in this publication.

Warning

Pesticide residues may occur in animals treated with pesticides, or fed any crop product, including crop waste, that has been sprayed with pesticides.

It is the responsibility of the person applying a pesticide to do all things necessary to avoid spray drift onto adjoining land or waterways.

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