NSW GOVERNMENT Department of Primary Industries

primefact

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 in NSW. Although cool moist weather results in the best quality heads, some varieties produce acceptable heads during warmer seasons. Therefore, cabbages can be grown continuously 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 between 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; soils that become waterlogged after heavy rain or irrigation are unsuitable.

Varieties

Cabbages are sold by type, shape and head colour rather than by variety. Green cabbages are the most common, although red cabbages are readily available. Cabbage head shape is classified into three groups:

1. **Ballhead** (or roundhead) is the most common type in NSW. It has a soccer-ball-sized head and smooth white-veined leaves that are tightly packed together.
2. **Conical** (or sugarloaf) types have a smaller pointed head.
3. **Drumhead** types are larger and have a flatter head shape.

Savoy cabbages are distinguished by their wrinkly leaves with sawtooth-like leaf margins. Savoy cabbages range from light green to grey-green to bluish-green with a reddish tint. The shape varies from being rounded to cylinder-shaped.

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 (Figure 1).

Figure 1. Wong bok cabbage.

Several varieties are available including:

- **Corinth** is suitable for processing and has good disease tolerance. It is similar to the Green Coronet but with a larger frame (average weight 4 kg).

- **Green Coronet** is a good-sized variety (average weight 3 kg) that performs well in all areas of NSW. It is partially tolerant to black rot and is grown in small amounts during summer. It is cream to green and has 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 well as the ballhead types.
- **Hiyield** or **Beauty** (hybrid) is a large drumhead cabbage, maturing in about 13 weeks and weighing 3.5–4.5 kg. It is grey-green, the leaves are heavily veined and it has some resistance to black rot.
- **Kameron** is a uniform large cabbage for cool-season production. It produces large, flattened, globe-shaped heads and has excellent holding ability.
- **Red Ruby Ball** (hybrid) is an early-maturing cabbage with purple–red leaves. It has a very tight ball head 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 a lighter green and a flattened ball shape. The variety forms a heart during summer in many areas.
- **Savoy Prince** (hybrid) is larger, later maturing and has a flatter head than the Savoy King. It has reasonably good holding capacity but is more susceptible to black rot.
- **Sugarloaf** produces conical heads that weigh about 2 kg around 2 months after transplanting.
- **Warrior** is a medium to large-sized variety (average 4 kg) with a round to slightly globe-shaped head. It is a popular processing variety that has some resistance to black rot and tip burn.
- **Cardinal Red** (hybrid) is a red cabbage with a large round head (average 1.5 to 2 kg) that prefers a warm growing 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 NSW. Cabbages are grown for both processing and the Sydney fresh market. Warrior is the main processing variety and Green Coronet is the main fresh 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, however, care needs to be taken with later sowings as they can 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. Varieties grown are Green Coronet and Savoy King. Most crops are produced in winter and spring because the hot humid conditions in summer make cabbage growing difficult and are favourable for black rot. Transplanting commences in March and continues through until May. The crop is harvested from June through until November.

Windsor/Sydney/Hunter Valley

This is one of the main cabbage producing areas of NSW and cabbages are grown throughout the year. However, black rot is worse in summer and quality is usually poor, therefore 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

Producing seedlings in cells, or individual pots, is the main method for raising transplants. Seedlings 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. Managing the young plants is easier than with bare-rooted seedlings.

Direct sowing

Direct sowing is still an option but is not practised much anymore. 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 with this system. 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

Managing soil

A well-prepared seedbed is important and preparation must commence well before transplanting. Cabbages require a soil pH between 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 (Figure 2) 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.

Figure 2. Establishing cabbages in raised beds.

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 the young plants become well established.

Spacing

Spacing depends on soil type, cultural methods and 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 (Figure 3). A favoured density is 20,000 plants/ha (Figure 4).

Figure 3. Narrower plantings are used with smaller cabbages.

Figure 4. 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:

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

In the formula, 1000 is constant but 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 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 4,200 cm^2 (70 cm × 60 cm) of space and there will be about 2.4 plants/m^2 (10,000 cm^2 ÷ 4,200). We will assume a good seedbed and a field factor of 0.8.

Seed required:

$$\frac{1000 \times 2.4}{100 \times 85 \times 0.8} = 0.3 \text{ kg/ha}$$

Nutrition

Soil analysis before 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 m^3/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 g sodium molybdate/500 L water/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, traveling 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 irrigation frequency. Using tensiometers or other measuring equipment will improve yields and reduce water costs.

Weed control

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

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, preventing good quality heads from being produced during the warmer months. Areas such as Bathurst, which are much cooler than coastal regions, become important suppliers during summer.

Symptoms: infection occurs on the leaves through marginal water pores or wounds. The bacteria move down the leaf veins into the stem and then invade other leaves. The movement of the bacteria, which is usually in a V-shape, causes the leaf to turn yellow, then brown and finally dry out. 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 and avoid using seedbeds where cruciferous plants have been grown before. Remove infected plants and rotate cruciferous crops on a 4-year pattern. Bury all crop residues as deeply as possible. Control biting and sucking insects as these can spread the disease.

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 cruciferous crops.

Symptoms: swellings develop on the taproot, secondary roots and even parts of the underground portions of the stem (Figure 5). 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 (Figure 6). High soil moisture, acid soil and temperatures between 18.5 and 25.5 °C favour the disease. The fungus survives for long periods in the soil and on diseased crop debris. Club root is spread by infected seedlings, windblown soil and contaminated farm machinery.

Figure 5. Cauliflower with club root.

Figure 6. Wong bok with club root.

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.

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

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 become purplish–red. The disease is favoured by cool, wet conditions and is spread by wind-carried spores. Contaminated soil is also an infection source.

Control: sterilise the seedbed. Wire stem can be checked in the seedbed by drenching the base of the plant with a registered chemical. Rotating cruciferous crops on a 4-year pattern also helps prevent the disease.

Sclerotinia rot (*Sclerotinia sclerotiorum*) is mostly a problem in 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 (Figure 7) in which irregular-shaped bodies similar to seeds develop. These are the sclerotia and are how the disease survives in the soil for several years. Cool, moist conditions favour the development of the disease. Sclerotinia attacks almost all vegetables and many other plants.

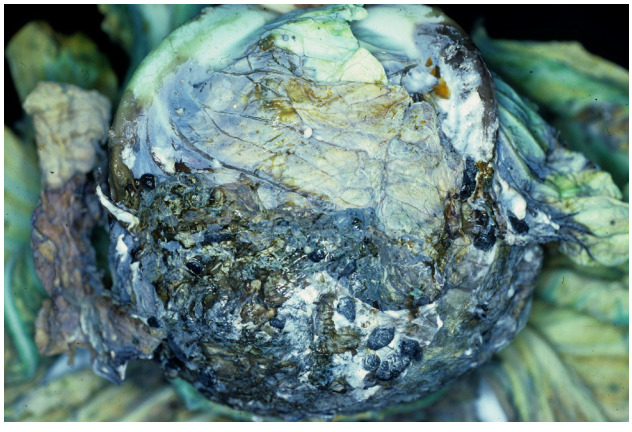

Figure 7. Cabbage sclerotinia.

Control: removing and destroying diseased plants prevents sclerotia rot 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 might be required.

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 many growing areas.

Symptoms: there is a yellow ringspotting of the younger leaves (Figure 8 and Figure 9), which later become mottled with light and dark green rings and blotches (Figure 10). 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.

Figure 8. Bok choy with turnip mosaic virus.

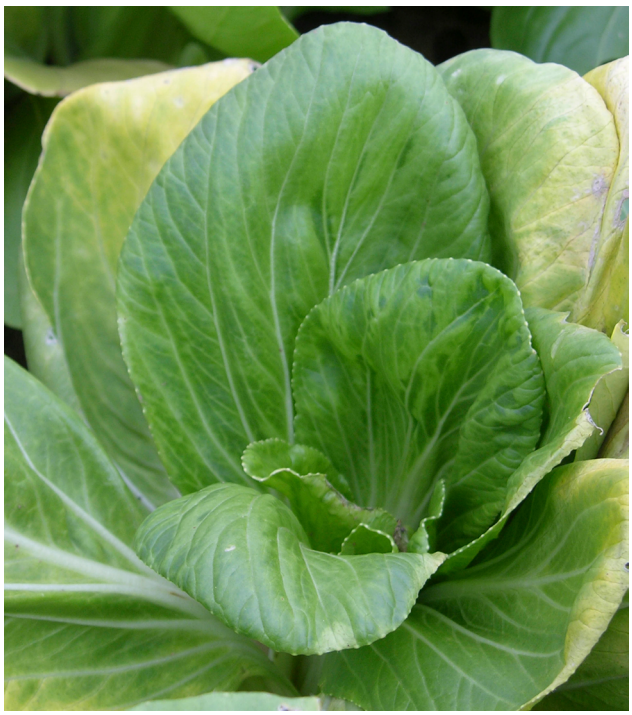

Figure 9. Brassica with turnip mosaic virus.

Figure 10. Brassica with turnip mosaic virus.

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. It is also recommended to check your spray coverage (Figure 11).

Figure 11. Spray coverage test cards.

Insect pests

Aphids

The grey cabbage aphid (*Brevicoryne brassicae*) can occur in large numbers and its feeding can distort the leaves and stunt the plants (Figure 12). The green peach aphid (*Myzus persicae*) does not occur in large numbers (Figure 13), but it is important as the vector of the virus diseases cabbage ringspot and cauliflower mosaic.

Figure 12. Cabbage aphids.

Figure 13. Green peach aphids.

Control: 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 from when feeding starts.

Black beetles

The shiny black beetles (*Heteronychus arator;* Figure 14), are about 13 mm long and attack seedlings at 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: the two main control methods are 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.

Figure 14. Black beetle.

Budworms

Budworms (*Helicoverpa* spp.) can cause severe damage in some years, particularly during autumn. The buff-coloured moths (Figure 15) 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 (Figure 16). 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.

Figure 15. Heliothis moth.

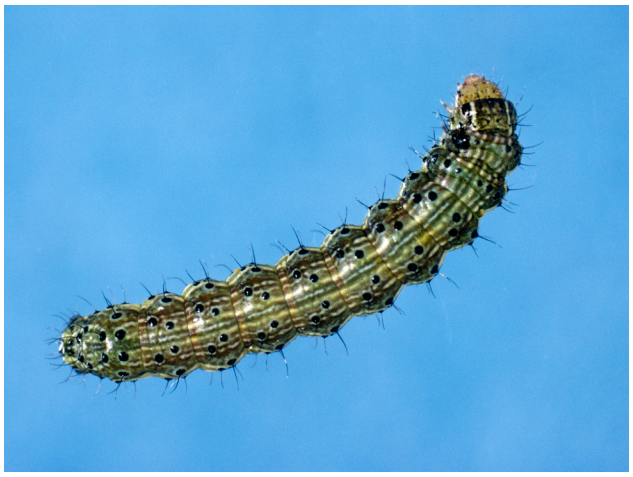

Figure 16. Heliothis caterpillar.

Cabbage white butterflies

Cabbage white butterflies (*Pieris rapae*; Figure 17) are probably the principal pest of cruciferous crops and are most active during spring and autumn. The yellow eggs are laid on the underside of the leaves, where the young, velvety green larvae (caterpillars) feed (Figure 18). 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: chemical rotation and not using chemicals from the same chemical family in succession are essential to control this insect and *Plutella* species.

Figure 17. Cabbage white butterfly.

Figure 18. Cabbage white caterpillar.

Cutworms

Cutworms (*Agrotis* spp.) are stout, uniformly coloured, black, grey or reddish-brown caterpillars about 40 mm long when fully grown (Figure 19). They feed at night on plant stems and foliage. They are found in the top 25 mm of soil and close to the damaged plant. Seedlings may be destroyed and parts of crops may have to be replanted. Cutworms are often more prevalent in low-lying areas after rain.

Adult cutworms are moths with have dark brown to grey wings with markings (Figure 20). They are usually about 20–30 mm long with a wingspan of about 40–50 mm.

Control: spraying the soil at the base of the plants with a registered chemical.

Figure 19. Common cutworm.

Figure 20. Common cutworm moth.

Diamondback or cabbage moths

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 (Figure 21).

The first instar larva mines within the leaves (Figure 22). Later instars feed on the under surface 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.

Figure 21. Cabbage moth eggs.

Figure 22. Cabbage moth caterpillars.

Other pests

The following are also occasionally found damaging cole crops:

- cabbage centre grubs (*Hellula hydralis*; Figure 23 and Figure 24)
- looper caterpillars (*Chrysodeixis* spp.; Figure 25)
- onion thrips (*Thrips tabaci*; Figure 26)
- seedling maggots (*Hylemya cilicrura*)
- vegetable weevils (*Listroderes costirostris;* Figure 27).

Figure 23. Cabbage centre grub moth.

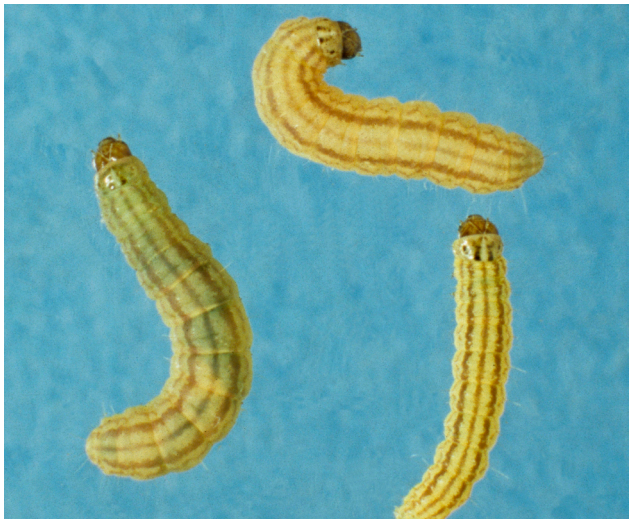

Figure 24. Cabbage centre grubs.

Figure 25. Cabbage looper. Photo: RJ Reynolds Tobacco Company, Bugwood.org.

Figure 26. Onion thrips.

Figure 27. Vegetable weevil larvae.

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 production stages. Careful attention to transplant size, fertilising, irrigation, and pest and disease control help to ensure even maturity. Cell-produced transplants mature more uniformly than 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 touch. Heads develop 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, 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 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.

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 several 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 Sydney fresh fruit and vegetable market.

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