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Pumpkin production

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Introduction

Pumpkins and grammas are members of the cucurbit (*Cucurbitaceae*) family that also includes cucumbers, gourds, melons, squash and zucchinis. Traditionally *Cucurbita maxima* have been known as pumpkins and *Cucurbita moschata* have been known as grammas. In recent years, many people have called both these species pumpkins. For this Primefact both *Cucurbita maxima* and *Cucurbita moschata* will be referred to as pumpkins.

Cucurbita maxima have strong round stems with large roundish to kidney-shaped leaves that are slightly scalloped. The fruit stalk is round and fleshy when mature and the skin is hard. Jarrahdale is probably the best known pumpkin from this species. *Cucurbita maxima* are thought to have originated in the tropics of South America.

Figure 1. Japanese pumpkins harvested into plastic bins.

Cucurbita moschata has angular stems with deeply lobed leaves that usually have white blotches at the vein intersections. The fruit stalk is also angular and usually flares out on all sides where it joins the fruit. Most are hard-skinned. They are thought to have originated from either China or Central America. Butternut and Japanese are the best known gramma types in Australia.

Pumpkins are a vigorous, prostrate, annual vine with an extensive root system. They are able to put down peg roots to support the plant and their tendrils twine around other plants to prevent them from being blown around. Pumpkins have separate male and female flowers on the same plant.

NSW has the second largest pumpkin crop in Australia with 40,718 t produced in 2007–08. The Murrumbidgee Irrigation Area (MIA) is the largest production area for pumpkins in NSW. In 2007–08 the MIA produced 22,197 t of pumpkins which is 54.5% of NSW production.

Table 1. Australian pumpkin industry 2007–08.

State	Area hectares	Production tonnes
Qld	2,751	43,783
NSW	2,057	40,718
WA	876	17,303
Vic	369	6,775
SA	188	2,586
Tas	102	1,478
NT	52	1,775
Aust	6,395	114,417

Source: 2007–08 Australian Bureau of Statistics (ABS).

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Climate

Pumpkins and other members of the *Cucurbitaceae* family are frost sensitive and need frost-free growing periods of 4 to 5 months. High temperatures (above 35^{o}C) and low humidity are not conducive to high yields. Temperatures of 20^{o}C to 35^{o}C are ideal for maximum production. Soil temperatures above 16^{o}C are required for seeds to germinate and it can take up to 14 days for plants to emerge at this temperature. When the soil temperature rises to 20^{o}C, seeds emerge within a week, and at 25^{o}C, within four days of planting.

Soil and land preparation

Pumpkins can be grown on a wide range of soil types. As roots can penetrate up to a metre deep, a well-drained soil is preferred. Pumpkins grow best on well-drained fertile soils with a pH_{water} between 6.0 and 6.5, although they will tolerate both slightly acid and slightly alkaline soils. (The pH level is a measure of the soil's acidity or alkalinity on a scale from 1 to 14, with 7 being neutral.) Where soil pH is low (too acid), the application of lime or dolomite is necessary to allow better uptake of nutrients. For optimum results, incorporate the lime or dolomite into the soil at least six weeks before planting.

A crop rotation should be used so that pumpkin crops do not follow one another. Rotating with other crop types will reduce the risk of soil-borne diseases. If sowing successive cucurbit crops, it is best to follow with pumpkins as the second crop, as they have higher disease tolerance than some of the other cucurbits (e.g. melons). A green manure crop will improve soil structure and productivity, and when combined with other soil conservation practices will reduce erosion and help protect the soil.

Figure 2. Pumpkins are vigorous prostrate plants in the cucurbit family.

Good ground preparation is essential for high yields. Ripping is necessary if the soil has been compacted. The soil should then be ploughed 20 to 25 cm deep and worked to a fine tilth for planting. All organic matter should be incorporated into the soil well before planting to allow complete decomposition, otherwise there can be serious losses from damping-off diseases. Weed control is also important; with good preparation, many weeds can be controlled before sowing.

Pumpkins are sensitive to soil salinity and yield will be reduced if levels are too high. Salinity is usually measured as electrical conductivity of water or soil solution and is a good indication of total dissolved salts. Pumpkins can tolerate a soil salinity level of 1.5 deciSiemens per metre (dS/m) before yield is affected. If soil salinity reaches a level of 3.5 dS/m, a yield loss of 20 to 30% may be expected.

Plant density and sowing

Pumpkin crops are usually established by direct seeding but they can be sown as transplants. Transplants are usually only considered when trying to establish a very early season crop or when using permanent beds.

Figure 3. Direct seeded crop sown on raised beds.

Plant density will affect fruit size, fruit yield and the number of fruit per plant. Higher plant densities generally result in smaller average fruit size, higher total yields and fewer fruit per plant. Under intensive irrigated cropping, pumpkins are generally sown in the middle of raised beds with plant spacing along these beds depending on the vigour of the variety of pumpkin grown. Jarrahdale and Japanese pumpkins are very vigorous plants and are generally sown at a density of 4,500 to 7,000 plants/ha. On 1.8 m wide beds this is a plant spacing of 0.8 to 1.2 m between plants. Butternut pumpkins are less vigorous and are generally sown at a higher density of 9,000 to 11,000 plants/ha. On 1.8 m wide beds this is a plant spacing of 0.5 to 0.6 m between plants.

Under less intensive and dryland cropping situations, pumpkins are generally sown at lower plant densities. Jarrahdale pumpkins are often sown at a density of 2,000 to 4,000 plants/ha. The crop is sown in rows 2.0 to 3.0 m apart with a plant spacing of 1.0 to 1.5 m between plants.

Seeds should be treated (or dusted with a fungicide) to control disease organisms, such as bacterial spot, fusarium root rot and damping-off, which may be on the seed surface. Seeds are usually sown directly into the soil by a mechanical seed drill once soil temperatures are over 16°C. In the MIA, soil temperature is usually warm enough to start sowing by the end of September. Shorter season pumpkin varieties are sown as late as mid-December. Later planted crops are at risk from cold if the autumn is earlier than normal. Under these conditions, crops can fail to mature and the vines will stop growing. Pumpkins can take about 13 to 25 weeks from planting to maturity, depending on variety and climate.

Irrigation

To achieve a consistent maximum yield of high quality pumpkins, growers need to irrigate their crops. Furrow irrigation of pumpkins is the preferred option for most inland growers. Furrow irrigation requires an even, gentle slope and a soil type that allows water to spread laterally, without penetrating too deep into the soil. Drip irrigation is used in NSW in permanent bed systems and is often used in conjunction with plastic mulch, which helps to minimise weed infestation in fields. Overhead irrigation is another option in undulating country and can be applied by travelling irrigators, centre pivots, lateral moves or fixed sprinkler systems.

A pumpkin crop requires about 4 to 8 megalitres per hectare of irrigation water from sowing to harvest. The quantity of water required varies with the soil type, method of irrigation and weather conditions (e.g. hot, dry winds). Irrigation is crucial during times of flowering, fruit set and fruit fill. If plants are stressed at these times, flowers and young fruit will fall off. Irrigation should be reduced as the fruit reach maturity. Irrigation should be timed with the use of scheduling aids. Tensiometers are the most common and cost efficient scheduling aids used. If no scheduling aids are used, 25 to 40 mm per week should be applied during warm weather and crops should be irrigated at least once a week during critical periods.

Figure 4. Drip irrigation is often used in conjunction with plastic mulch.

The crop is sensitive to *water salinity* and plant growth may be affected if levels are too high. The recommended threshold to avoid yield loss is when the conductivity of the irrigation water reaches 1.0 dS/m. When levels increase to 2.5 dS/m, a yield loss of 20 to 30% may be expected. These values are a guide only and vary with soil type, leaching potential, irrigation method and age of plant.

Fertiliser

The correct amount of fertiliser is important, as too much can result in excessive plant and foliage growth at the expense of fruit yield. Also, female flowers can fail to set if there are excessive levels of nitrogen early in the growing period. A soil test will help to determine the soil nutrient status and should be the basis of any fertiliser program. A full soil test costs around $200 per sample and analysis results are generally received a few weeks after sending. The following recommendations are based on the nutrient requirements to produce a high yielding crop.

Nitrogen (N)

A soil test measures nitrate nitrogen and where levels are very low a maximum fertiliser rate of 160 kg/ha of N is recommended. As soil nitrate levels increase, the fertiliser rate should be reduced. When soil nitrate levels are high (50 ppm or more), fertiliser applications should be no more than 50 kg/ha of N. Nitrogen is easily leached from the soil by irrigation and rain and it is recommended that not all nitrogen should be applied as a base application. As a general guide, apply one third as a base application and the remainder applied just before vine growth starts. Care needs to be taken not to apply excess nitrogen to avoid excessive vegetative growth with minimal fruit production.

Phosphorus (P)

Where a soil test shows very low phosphorus levels, a maximum fertiliser rate of 100 kg/ha of P is recommended. As soil phosphorus levels increase, the fertiliser rate should be reduced. A rate of only 20 kg/ha of P is required when soil tests show high levels of phosphorus. Phosphorus is stable in the soil and does not move far after it has been applied, so it can be applied several weeks before the crop is planted. The entire recommended rate should be applied as a base dressing. Broadcasting phosphorus fertilisers is common, but banding it below the seed line is preferable, allowing roots to quickly find it. There is little value in applying phosphorus fertilisers as a side dressing after a crop has already been established as it will not become available to the crop in time.

Potassium (K)

Where a soil test shows very low potassium levels, a maximum fertiliser rate of 60 kg/ha of K is recommended. As soil potassium levels increase, the fertiliser rate should be reduced. A rate of nil to 20 kg/ha is required when soil tests indicate high levels of potassium. Potassium is more stable in the soil than nitrogen but can still be leached over the season. Application recommendations are the same as nitrogen with one third as a base application and the remainder applied just before vine growth starts.

Other nutrients

Calcium, magnesium and molybdenum become less available to plants as the soil pH decreases. The amount of lime needed to correct pH varies with soil type. Soil testing will help with this decision making. Heavier soil types will need higher rates of lime to increase pH than will lighter soils.

Animal manure

Animal manure can be used for growing pumpkins and should be incorporated into the soil at least four to six weeks before sowing. It is recommended that fresh manure be cured (dried) before use to avoid plant burn and rhizoctonia disease problems. Animal manures help to increase the soil's organic matter, improving soil structure and water and nutrient holding capacity. Animal manures are generally low in N:P:K content, but fowl manure is generally the highest at approximately 2.1% N, 1.6% P and 1.0% K. An application rate of about 5 t/ha (approximately 15 m^3 = 5 t) makes a useful base dressing for vegetable crops.

Common fertiliser program for intensive irrigated crops

The base fertiliser application rate will depend on soil fertility and plant density. A pre-plant soil nutrient analysis will assist in deciding the best fertiliser options. In the absence of a soil test, a base application of 200 to 400 kg/ha of Nitrophoska® Blue (NPK of 12.0:5.2:14.1) may be required, depending on soil fertility. A side dressing of nitrogen at approximately six weeks after emergence will be required. A sap test will help decide actual nitrogen requirements. A side dressing of around 100 kg/ha of urea is commonly applied.

Molybdenum is often needed by pumpkins, especially when grown on acid soils. A few sprays of molybdenum is ideal. Apply sodium molybdate as a foliar spray when plants are at the 3–4 leaf stage.

Varieties

There are numerous varieties of pumpkins grown in NSW. For the most current list of available varieties, contact the seed companies supplying vegetable seeds. The following is a list of some of the major varieties currently grown in the MIA.

Grey types

Jarrahdale and Jarrahdale Large are the most popular open pollinated varieties grown in the MIA. They produce large fruit with an average weight of 6to 8 kg. They have prominent ribbing and have been the standard grey type for many years. Grey pumpkins generally take about 18 to 20 weeks from sowing to harvest.

Figure 5. Jarrahdale pumpkins.

Grey hybrid pumpkins are also produced in large numbers in the MIA. They have the advantage of having extra vigour; some have less ribbing and tend to hold their grey colour much longer. The size of the fruit depends on what hybrid variety is grown. Some hybrids produce large fruit (similar to the Jarrahdale) whereas other hybrids produce a smaller fruit. Some examples of grey hybrid pumpkins grown in the MIA include Sampson, Early Jarragrey, Gunsynd, Sweet Slice and Sweet Grey. Sugar content in grey pumpkins varies from about 5% to 9% total soluble solids (TSS).

Figure 6. Typical example of a large hybrid grey variety with less prominent ribbing than the Jarrahdale.

Butternut types

Butternut Large is an open pollinated pumpkin that produces a fruit with a yellowish beige skin and an average size of 2 kg. Butternut Large was previously the standard butternut variety grown in the MIA but Sunset QHI is now the most widely grown butternut in the MIA. Sunset QHI has a very similar fruit to the Butternut Large but with the advantages of hybrid vigour. Butternut pumpkins are quicker maturing and sweeter than the grey types, and take about 15 to 18 weeks from sowing to harvest, and average about 9% TSS.

Figure 7. Butternut pumpkins.

Japanese types

The two most widely grown Japanese types in the MIA are Kens Special Hybrid and OOAK. These pumpkins produce an average fruit size of 4 kg with medium ribbing and a mottled dark-green and yellow skin. Japanese pumpkins are the longest maturing type and can take about 20 to 25 weeks from sowing to harvest. Japanese pumpkins are also sweet and average about 10% TSS.

Figure 8. Japanese pumpkins.

Flowering and pollination

Both male and female flowers are produced on the same plant. Environmental factors and various management factors affect the ratio of male to female flowers. Temperature, light, humidity and soil moisture are all involved in determining numbers of female to male flowers. The first flowers on the vine are male, after which three to four female flowers appear. Conditions of high temperature, low humidity and long day-length encourages the development of male flowers. Female flowers are encouraged by the reverse of these conditions.

Pollination is vital for good fruit set and the use of bees in pumpkin production is required for high yields. Two to three hives per hectare is recommended. Good fruit set and development needs 500 to 1,000 live pollen grains on the stigma of the female flower. Practices such as spraying pesticides and fertilisers, particularly the selection of products and timing of applications, need careful management to avoid harm to bees. Temperature is important with pollination, as high and low temperatures can cause death or low production of pollen. In windy, dry conditions, much of the pollen rapidly dies. This can result in the crop not setting, or the fruit aborting when they reach golf ball size.

Cross-pollination can take place between different species of *Cucurbitaceae*, but this will not affect yield or the shape of crop set on the vine. However, seed from the resulting cross will produce genetically different plants to the parents and should not be saved.

Kabocha types

Kabocha belong to the species *Cucurbita maxima* and are often called Buttercup Squash. The best known Kabocha is Delica. It produces a small flattish, round fruit with a distinctive dark green skin with light green stripes. The average fruit size is about 1.2 to 2.0 kg with a maturity time ranging from 13 to 17 weeks.

Kabocha hybrid crosses have also been developed by crossing *Cucurbita maxima* and *Cucurbita moschata* pumpkins. The best known Kabocha cross is the Tetsukabuto which is also known as Late Potkin. These produce deeply ribbed fruit and take up to four weeks longer to mature than Delica.

Weed control

Adequate weed control helps reduce insect and disease infestation and minimises competition for moisture and nutrients. At the time of publication, there are two residual herbicides registered for use on pumpkins in NSW that can be applied post-seeding and before emergence. Care needs to be taken with these chemicals as pumpkins are very susceptible to damage by residual herbicides. These chemicals should not be used on sandy soils (check the label for directions and constraints of use).

At the time of publication, there are four group-A herbicides registered for use on pumpkins in NSW that can be applied post-emergent for the control of grass weeds only. These herbicides can be sprayed over the plants and have a long withholding period.

Figure 9. Cultivating between the plants with a manually operated three row cultivator.

Single plant lines down the centre of beds allow for inter-row cultivation up to runner stage of the crop. Plants should then be capable of suppressing most weeds due to their vigorous growth. The weeds in the plant row can be controlled by mechanical means such as manually operated between-row cultivators.

Insect pests

Pumpkins are affected by few insect pests. The best known pest, the pumpkin beetle, can cause problems by feeding on leaves of young plants. Once the plant begins to run and grow rapidly, economic damage is rarely significant. The twenty-eight spotted ladybird and its larvae cause similar problems as the pumpkin beetle.

Figure 10. Pumpkin beetles can quickly defoliate and kill seedlings.

Other pests include the melon aphid (*Aphis gossypii)*, cutworms (*Agrotis spp.*), heliothis grubs (*Helicoverpa spp.*) and spider mites (*Teranuchus spp.*). Insecticides are available to control all these pests if necessary. More detailed information on these and other cucurbit pests can be found in Primefact 883 *Insect pests of cucurbit vegetables*.

Diseases

Foliar diseases are the major problem of pumpkins in humid weather. When conditions are warm and moist early in the season, downy mildew (*Pseudoperenospora cubensis*) is the most common disease. This shows up as yellow spots on the top surface of leaves. Inspection of the under-surface of the leaf will also reveal the white growth of the fungus.

Powdery mildew *(Podosphaera axanthi)* is a disease in drier conditions that occur later in the season. With this disease, a white, powdery growth occurs on the under-side of leaves first, then spreads rapidly to cover both sides of the leaves. If not treated with the correct fungicides, both diseases can result in the premature death of foliage and, in extreme cases, death of the plant.

Figure 11. Powdery mildew is first seen on the under-side of leaves (photo courtesy of David Commens, South Pacific Seeds).

There are three important mosaic viruses that affect pumpkins: papaya ringspot virus and zucchini yellow mosaic virus, both of which cause severe fruit distortion, and watermelon mosaic virus. Infected butternut and Japanese types do not show as much fruit distortion as grey pumpkins. These viruses are spread by aphids and losses are greatest if infection occurs early. Infection can be reduced by good farm hygiene, avoiding overlapping cucurbit crops and using super reflective plastic mulch and/or weekly spray applications of a mineral oil insecticide.

Damping-off (*Pythium spp*. and *Rhizoctonia solani*) can be a problem in young plants under cool damp conditions. Symptoms are brown lesions on roots and stems and wilting on the leaves. The best solution to the problem is avoiding planting in soil conditions which encourage the disease.

Other diseases include bacterial leaf spot (*Xanthomonas campestris*), brown etch of grammas (*Fusarium spp.* and *Didymella bryoniae*), and Fusarium foot rot (*Fusarium solani*). More detailed information on these and other cucurbit diseases can be found in Primefact 882, *Diseases of cucurbit vegetables*.

Yields

Yields vary between pumpkin types and varieties. The 2007–08 ABS figures (shown on page one) give the average yield for all pumpkins across Australia at about 18 t/ha. Yields can be much higher than this under intensive irrigated cropping systems.

Grey pumpkins are a higher yielding type of pumpkin than Japanese or butternut pumpkins. Under irrigation, experience has shown that a good yield for grey pumpkins is between 30 and 40 t/ha. Higher yields can often be achieved with hybrid types. A good yield for butternuts is about 25 t/ha whereas a good yield for Japanese pumpkins is about 30 t/ha. Limited experience with Kabocha pumpkins makes estimation difficult but variety trials have indicated that 25 to 30 t/ha would be a good yield.

Figure 12. A good yield for grey pumpkins is between 30 and 40 t/ha.

Harvesting

Pumpkins are ready for harvest once the stalk becomes cracked and corky. The skin (rind) should also resist entry of thumb or finger nail and make a ‘crisp’ sound when it breaks the skin. Rind colour of the Jarrahdale type changes from dark glossy green to a dull grey. Inspection of the internal quality of a representative sample will give a good idea of the crop’s maturity. Butternuts that are mature can be recognised when fruit are fully coloured and any green colour has disappeared from the skin. The green stripes of Japanese pumpkins lose their gloss and become dull green when mature.

If pumpkins are harvested when immature they do not store well and have less flavour when cooked and eaten. When mature, the fruit are cut from the vine using large secateurs. Pumpkins can be picked two or three times while the plants are still green but they are often left until all the fruit are mature and the vines have died off. Early in the season when temperatures are high, the fruit need to be harvested as soon as they mature to avoid sunburn damage. Pumpkins can be harvested and loaded directly into bins in the field, or harvested onto trailers and then sorted and loaded back at the shed.

Pumpkins can be stored, although some varieties store much better than others. If storing, ensure the fruit are free of sunburn and blemishes, as these defects are where fruit breakdown can commence. Leaving a section of stalk on the pumpkin or squash can also improve storage life. When storing a crop, regular inspection is needed to locate and remove any rotting fruit which can cause subsequent breakdown of adjacent pumpkins. Good storage conditions that provide ventilation and minimise exposure of fruit to dust or rain helps to maintain the pumpkins in good condition for longer. Occasionally, if long term storage is planned, treating fruit by spraying or dipping with a protective fungicide is practised.

Figure 13. Harvesting grey pumpkins.

Marketing

Pumpkins are usually sold on a price per tonne or kilogram basis to either the fresh market or a processor.

If growing pumpkins for the fresh market, a farmer can sell the fruit to a local packer or pack the fruit and send them directly to the market. Pumpkins can be sold in bulk containers, cartons or netted bags. All pumpkin types are sold in bulk containers such as plastic bins, collapsible cardboard containers or wire crates based on standard pallets. Butternut pumpkins are also sold in cartons that hold 16–20 kg.

Figure 14. Japanese pumpkins being moved from half tonne plastic bins to cardboard octabins for transport to market.

If selling to a processor, the fruit are delivered in bulk containers. The grower and processor may agree on a contract price at the beginning of the season or accept the market price at harvest time. Transport is usually in non-refrigerated open trucks. Produce in bins may be transported in refrigerated trucks but the temperature should not be lower than 13^{o}C.

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Further reading

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