GROWING ZUCCHINIS, BUTTON SQUASH AND CUCUMBERS

in Queensland

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CONTENTS

IS ZUCCHINI, BUTTON SQUASH OR CUCUMBER GROWING FOR YOU ?

Purpose of handbook
This handbook aims to provide details on the growing of zucchini, button squash and cucumbers. These are three of the cucurbit group. Other cucurbits include pumpkins, rockmelons and watermelons.

The information on cucumbers in this handbook will mainly relate to the slicing green and white types grown for the fresh market. Other minor cucumber types grown in Queensland but not specifically covered here include lebanese, continental and pickling cucumbers.

Important facts for new growers
There are several important points that new growers should be aware of before growing zucchinis, button squash or cucumbers. These crops have:

- a high labour requirement particularly during harvest
- large variations in market prices
- lengthy periods of oversupply in the markets, resulting in low prices
- a need for careful disease management, and
- a highly perishable nature of the harvested product.

Crop opportunities in Queensland
The main markets for these crops are the Sydney and Melbourne wholesale markets. Markets for these crops are adequately supplied throughout the year. Any significant increase in production would depress prices in the market. High returns are achieved when there are unexpected crop failures in one of the major production centres caused by wet weather.

Zucchini. button squash and cucumbers are grown all year round in Queensland. The Bowen-Burdekin and Bundaberg districts are the main production areas. There are small quantities grown over the summer months in the Granite Belt. The production in the southern states of Australia is restricted to the summer months

Checklist for new growers

Financial requirements
In order for a new or prospective grower to make a decision regarding the business of growing cucurbits, there are several aspects which must be investigated.

Expected yields
Yields are extremely variable, depending on weather conditions and management. Average yields of zucchinis and button squash are approximately 750 × 10 kg

cartons per hectare but yields well in excess of 1000 × 10 kg cartons per hectare are often achieved when grown on plastic mulch. Average yields of green cucumbers are 1500 × 10 kg cartons and 2000 × 10 kg cartons of apple cucumbers.

Production costs

Table 1 is an example of a break-even prices for zucchinis and cucumbers based on production in Bundaberg in 1991. This is the market price required for a grower to cover costs. It does not cover the costs of the grower's labour and machinery depreciation during the land tillage operations. The growing system used in this example involves trickle irrigation without plastic mulch. The zucchinis and cucumbers are sold at the Sydney and Brisbane markets respectively. The break-even prices are derived from a gross margin which is available upon request from the authors. The production, harvesting and marketing costs for zucchini, button squash and cucumber are approximately $7000 per hectare.

Table 1 Break-even prices for zucchini and cucumber production in Bundaberg in 1991.

	Break-even prices ($/ctn)	
Yield (10kg ctn/ha)	Zucchini	Cucumber
1000	9.13	6.92
1250	8.50	6.32
1500	8.08	5.92
1750	7.78	5.64
2000	7.55	5.43

New growers should now use these figures together with the following market prices to evaluate the likely profitability of cucurbit production based on the average of last three years prices.

Monthly average market prices

The market prices received are variable and have a huge impact on profitability. The prices illustrated in figures 1, 2 and 3 are taken from *Prices and market throughput on the Brisbane market, Rocklea* (see further reading section).

On any one day, a range of prices will be paid depending on the quality, presentation and size. Check with your agent or merchant regarding these factors in order to receive the best price possible at that market.

The profitability of growing any crop depends on your receiving more at the markets than the break-even price. The profit represents the return on capital invested. This is usually less than 5 percent for cucurbit production.

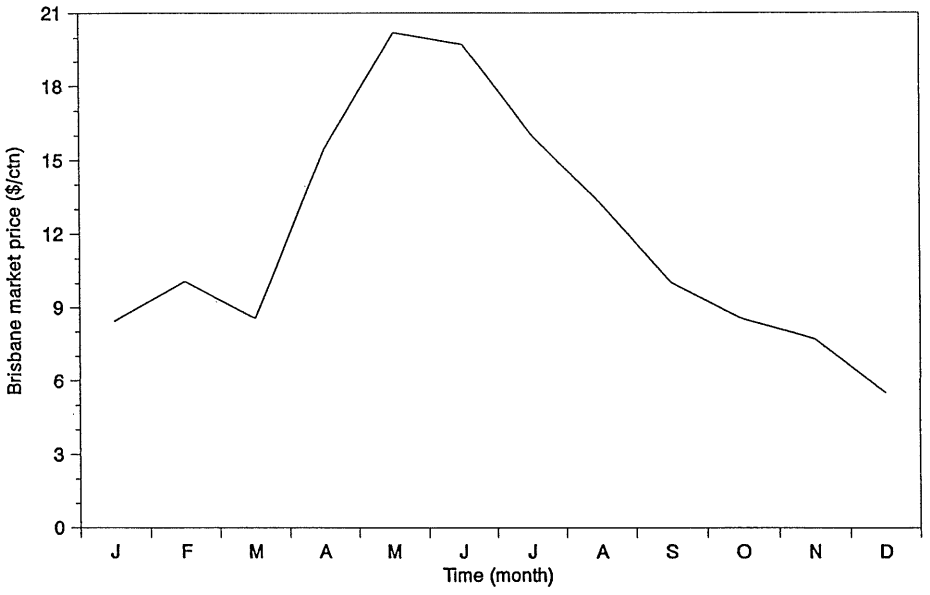

Figure 1 Zucchini prices averaged over 1988, 1989 and 1990.

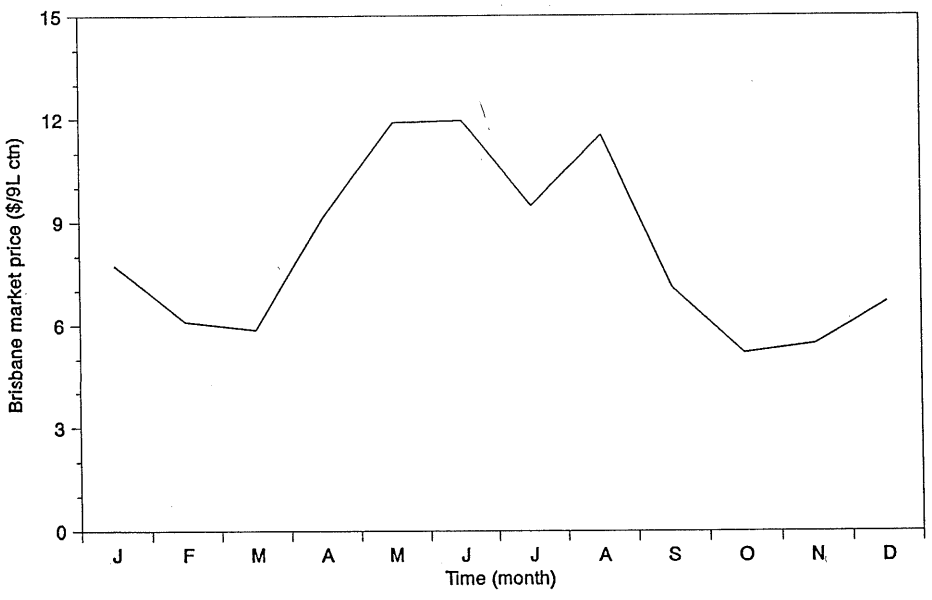

Figure 2 Button squash prices averaged over 1988, 1989 and 1990.

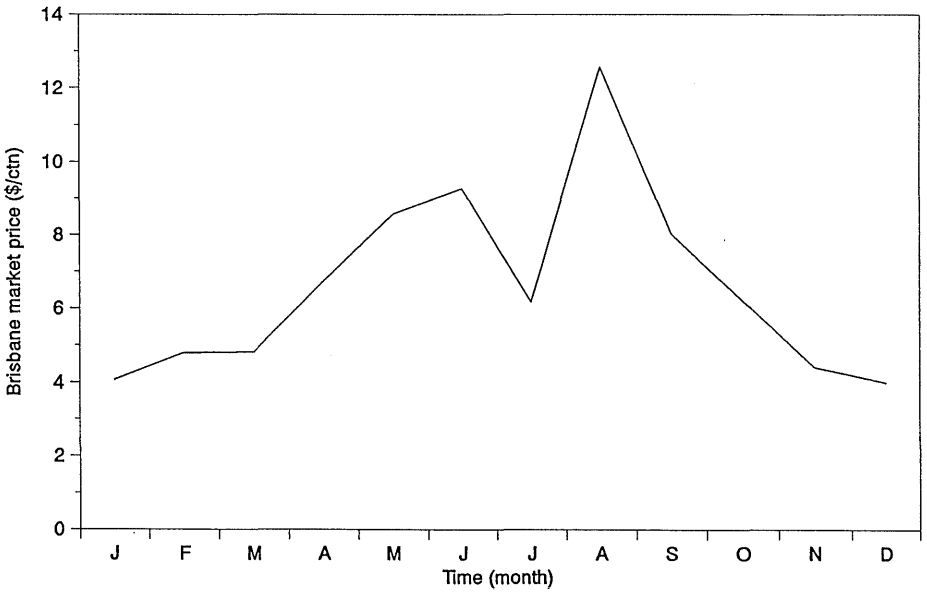

Figure 3 Green cucumber prices averaged over 1988, 1989 and 1990.

Capital required

The capital required for a new grower to 'set up' will depend on size of production and location. Without the cost of house and land, at least $50 000 is required to establish a 10 ha business. This would cover the equipment required for preparation, production, harvesting and marketing in a relatively simple enterprise.

Capital items covered would include:

- tractor
- cultivating equipment such as chisel plough, scuffle tynes and rotary hoe
- fertiliser spreader or drill
- planter
- appropriate irrigators
- tractor mounted hydraulic air blast sprayer for crop protection
- sorting table and dipping facilities, and
- packing and storage shed.

Much of this could be hired, borrowed or contracted to reduce initial capital outlay. Some of the equipment may be bought second hand to further reduce costs.

Further mechanisation or capital investment in larger cucurbit enterprises is limited by the need to hand harvest. Additional capital items may include:

- coolroom/forced air cooling, and
- pallet jack or fork lift.

Labour requirements

Zucchinis, button squash and cucumbers are all labour intensive crops, particularly during harvest. During cold winter conditions, one person can handle all operations on about one hectare. During warm periods, due to their increased rate of production, one person would only be able to handle all operations on half a hectare.

Site selection

Aspect

During winter in frost prone areas, a north to north-easterly slope is preferred free from frost and protected from damaging winds. This will result in warmer soil temperatures promoting faster more vigorous growth and an earlier crop.

Soil

Soil depth of at least 25 cm is required. Light textured soils such as sandy loams are best for early cropping, but a wide range of soil types is suitable. Heavier loams produce good crops, but are later maturing. Good drainage is essential. Waterlogged soils lead to poor growth, plant death and ground rots on fruit.

Wind

Strong winds twist plants causing the loss of or damage to flowers and young fruit. Stems may also crack allowing disease infections. Wind also increases water loss through plant transpiration. Water stress can result in flower drop, fruit shedding and blossom end rot. Bees are less likely to work in windy conditions.

Windbreaks such as Bana grass, or artificial windbreaks greatly reduce these problems. Permanent tree windbreaks may be practical in some situations.

Crop rotation

Zucchinis, button squash and cucumbers should not follow each other, nor should they follow pumpkins, rockmelons or watermelons. The use of a cover crop in rotation improves soil structure and productivity and reduces pest and disease problems. Cover cropping combined with other soil conservation methods, such as contour banks will reduce erosion and help maintain your most valuable asset.

Slope

Select the flattest land which suit trickle irrigation. This makes it easier to maintain even pressure and irrigation over the entire block. Where the crop must be planted on a slope, an angle of 8% or less is best for machinery safety and to minimise soil erosion. Cultivation and management of steep land is more expensive.

Irrigation

A reserve of up to 4 megalitres per hectare is necessary during hot dry conditions. Cucurbits are moderately tolerant of poor water quality. Cucurbits can tolerate salinity of up to 1700 microsiemens per cm (1100 ppm) before growth suffers.

ESTABLISHING THE CROP

Land preparation

The damage and loss of soil should be avoided. Vegetation cover should be maintained continuously for as long as possible. This is especially important on erosion-prone sites. Soil conservation measures may have to be put in place before cultivating some sites. Check with your local QDPI soil conservation officer.

Cover crops

Cover crops help to build up soil organic matter and reduce weeds in the following crop. Increasing organic matter in the soil helps retain moisture and plant nutrients. It also promotes micro-organism activity in the soil. The soil's structure is improved by the addition of organic matter. Cover crops minimise the risk of soil erosion.

Fertilise cover crops to ensure an even, well grown stand to provide more organic matter and help smother weeds. Broadcast 300kg/ha superphosphate (30kgP/ha) before sowing, then 100kg/ha of nitram (30kgN/ha) or an equivalent amount of nitrogen after emergence. Extra nitrogen may be required if the crop is slashed several times.

Cover crops are usually grown on a fairly short term basis, but long term cover crops should be grown if the land is not to be cropped for many months or years. The suggested cover crops are:

Short term

Summer growing. Use hybrid forage sorghums planted at 40 kg/ha. Zulu and Sudax are fast growing and can be ratooned up to six times by slashing. Slash back to a height of 20 to 30 cm before seed heads develop and the stems get too fibrous to decompose rapidly. Maize at 30 kg/ha and Millet at 20 kg/ha may also be used.

Winter growing. Lupins (a legume), sown at 80 to 100 kg/ha with a specific lupin inoculant such as WV425 is suitable in some areas. Cereals such as oats, triticale or barley at 75 kg/ha are also suitable.

Long term

A cover crop such as siratro (a legume) with green panic (a grass) would be suitable in warmer areas. However siratro produces hard seed which can cause problems with seeds germinating in future crops.

Organic additives

Organic additives such as filter press (15t/ha), deep litter fowl manure (5t/ha) or cattle feedlot manure (10t/ha) may be used as alternative to cover crops. This must be applied before a cover crop is planted.

Cultivation

All organic matter, whether from a cover crop, weed growth or added organic material should be incorporated into the soil well before planting. This will allow complete decomposition to occur. If organic matter is not well broken down, there can be severe losses from damping-off diseases. Decomposition takes about four weeks in moist soil under warm conditions, and eight weeks or longer in cold or dry weather. In very dry conditions it may be necessary to irrigate to encourage decomposition. Otherwise decomposition occurs when the crop is first irrigated and results in heavy seed and plant losses.

Plough the organic matter into a depth of 25 cm, then work the soil to a fine tilth for planting. Diversion banks and cross-drains should now be installed within the crop to control erosion.

Ripping

In some soils the regular use of a rotary hoe can result in a "plough pan" or compaction layer being formed. If you suspect that this may have occurred, dig a hole and check. If there is a compacted layer at 10 to 15 cm depth (see figure 4), deep ripping is a solution. Compaction layers can restrict plant growth and cause water-logging in some situations. Deep ripping in both directions will break this compaction layer and should be done regularly.

Do not rip or cultivate through obvious depressions in the paddock as these carry run-off water during storms. Maintain existing cover or replant these areas to an easily maintained, vigorous grass species such as carpet grass (*Anoxopus affinis*).

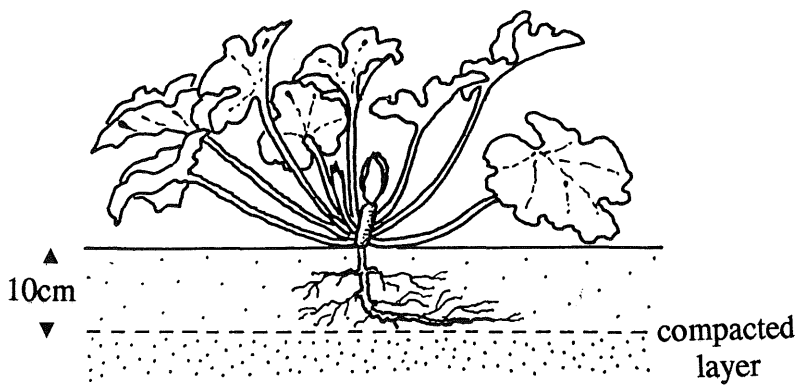

Figure 4 Root system affected by compaction layer.

Soil analysis

A complete soil analysis takes a lot of guess work out of fertilising and is available through several analytical laboratories and fertiliser companies (eg Incitec). This analysis will show the amount of major and trace elements in the soil, as well as the soil's pH and conductivity. A fertiliser recommendation can then be made for the crop. Trace elements are best applied to the soil prior to planting. Nutrient imbalances which could cause growth problems can also be corrected.

Take a soil sample ten weeks prior to the desired planting date. This will allow time for the analysis and for the recommended treatments to be fully incorporated into the soil. Sampling directions are provided in the soil analysis kit.

Soil pH

This is a measure of the soils acidity or alkalinity on a scale from 0 to 14, with 7 being neutral. Cucurbits prefer a slightly acid soil, around 6.0 to 6.5. In this range, most nutrients present in the soil are available to the plants, without being at toxic levels.

Coastal Queensland soils tend to be acidic and need lime or dolomite to raise the pH to between 6.0 and 6.5. Dolomite will add magnesium and calcium to the soil, while lime will add only calcium. A complete fertiliser analysis will show which form is most suitable. If magnesium levels are adequate, the cost of the analysis may be recouped by using lime which is cheaper than dolomite.

Field layout

Fields are subdivided into cropping areas (commonly called lands) which are usually twice the working width of the spray equipment. Rows are spaced 1.2 to 1.8 m apart. Leave roadways 3 to 4 m wide between lands. This allows the easy movement of spray equipment and harvesting trailers. Access within the crop and to the packing shed is very important to the efficient management of small cropping operations. Field design and layout must provide access to all cropping areas.

Where slopes of up to 10% are used, field design is important for efficient erosion control. Some methods for achieving this control are:

- Construct a diversion bank above any cultivation areas. Water flowing from above will greatly increase crop damage and complicate water disposal problems further down the slope. Diversion bank slopes should not exceed 2% to 3% and should empty into a grassed waterway or stable drainage line away from cultivated areas (see figure 5).
- Locate roadways on ridgelines if possible. Major roadways can be easily maintained if the water is shed away from the roadway.
- When planting up and down on slopes of 2% to 10%, contour banks can be constructed across the slopes to divide the field into segments. These permanent structures intercept and divert runoff water out of the cultivation into a stable grassed watercourse. Survey contour banks before construction with a grade between 2% and 3% and are generally located mid slope or where the slope angle changes. Distances between banks should never exceed 50 m. Consult your local QDPI land conservation officer for further advice.

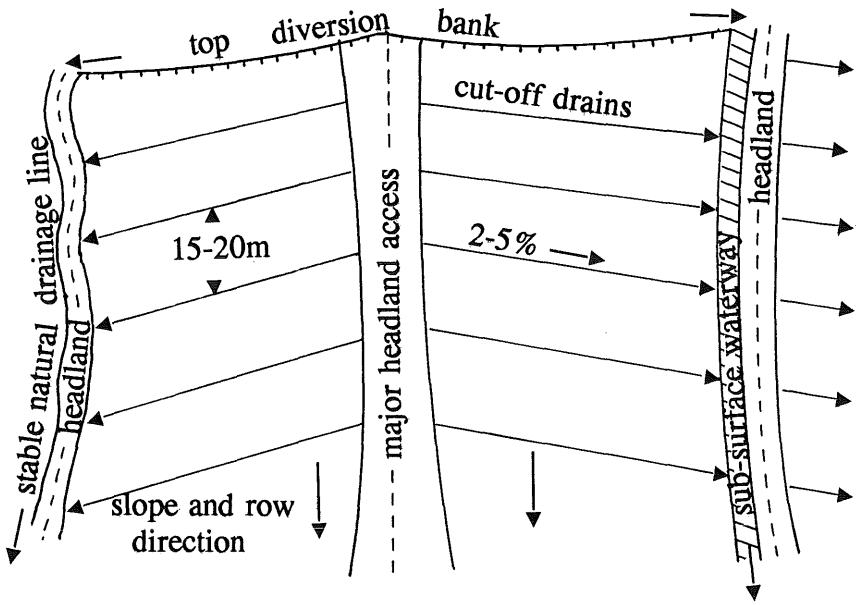

Figure 5 Field design and layout for sloping ground.

Cut-off drains

Where cucurbits are planted on slopes, the use of cut-off drains will reduce the risk of erosion. These drains are temporary structures built after the crop is planted using a single pass of a disk or mouldboard implement.

Cut-off drains will provide control of erosive water during the early stages of the crop before the canopy is sufficiently developed to protect the soil surface. Cultivation within the early stages of the crop is possible by working-over the drains, however this reduces their capacity to control erosion. Chemical control of weeds within the crop is preferred.

Drains are located every 15 to 20 m down the slope with the closest spacing used on the steepest slopes (see figure 5). The fall along drains is between 2% and 3% (3% equals a 3 m fall in 100 m). Drains which are too steep can wash out and form gullies.

Bedding

In shallow soils form rows into low (15 cm high), broad (60 cm wide) hills to increase soil depth and reduce the risk of waterlogging. Narrow, steep hills dry out too quickly and stress the plants. Form beds like those in figure 6.

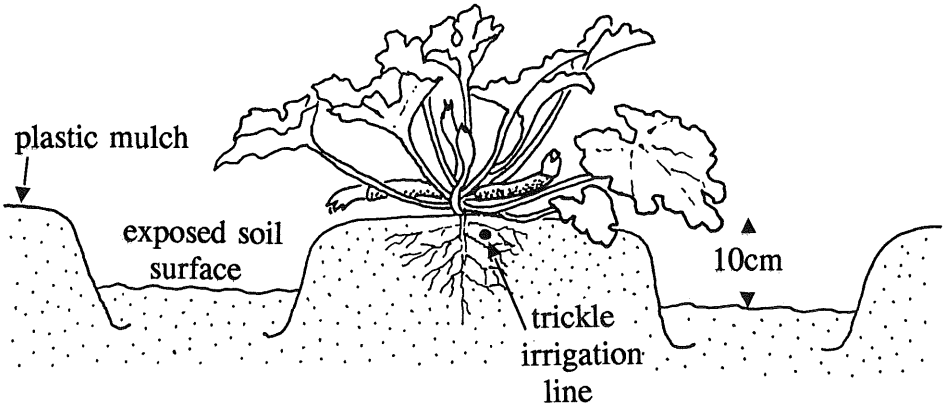

Figure 6 Zucchini plant with plastic mulch.

Nematode treatment

Nematodes, particularly rootknot nematode, can be a serious problem in cucurbits. This is especially true in sandy soils and soils that have previously grown susceptible crops or weeds. Nematode counts on soils can be misleading, especially in dry soils. When soils are wet thousands of nematode eggs will hatch.

A nematicide is often used as insurance against future losses, because once damage to plant growth is noticed, it is too late to control the nematodes. The nematicide Nemacur 400 is registered for use on cucurbits, at 24 L/ha. It can be applied as an overall treatment, but is more often applied as a 60 cm band over the intended plant row. Apply at low pressure (150 to 200 kPa) to moist soil 1 to 7 days before planting. Use at the rate of 160 mL in 1.4 to 2.8 L of water per 100 m of row. Incorporate to a depth of 10 cm with discs or a rotary hoe quickly.

There are also soil fumigants such as methyl-bromide which will control nematodes. These chemicals are more expensive and dangerous to apply, but have the advantage of also controlling a range of weeds and soil-borne fungi.

Plastic mulch

Plastic mulch is a thin layer of plastic usually 0.9 to 1.2 m wide, placed over the plant row. Seed or seedlings are planted through holes made in the mulch. These crops are sometimes planted into plastic-covered rows which had previously grown another crop eg. tomatoes but not cucurbits. Plastic mulch is well suited to the growing of button squash, cucumbers and zucchinis. Plastic mulch should be laid tightly over rows that are firm, mounded up and slightly higher in the middle, so that water runs off the plastic preventing fruit from sitting in water (see figure 6).

Plastic mulch has many advantages. Plastic mulch:

- reduces water demand by preventing evaporation from the soil
- reduces risk of fruit drop and blossom end rot because of even water availability
- prevents weed growth
- super-reflective mulch delays infection with watermelon mosaic virus, by deterring aphids from landing until plant growth covers the plastic
- reduces fruit losses from soil borne diseases
- warms soil giving quicker growth for winter planting and less risk of frost damage
- potential yields are much higher, and
- fruit remains clean.

Disadvantages of plastic mulch include:

- higher initial costs
- the need for trickle irrigation
- a mulch laying machine must be used to satisfactorily lay the plastic
- the plastic must be removed from the field after the crop
- the need to plant either container grown seedlings, or plant seeds through holes made in the plastic
- unless tensiometers are used, it is more difficult to estimate soil moisture, and
- it may harbour pests such as mice and soil insects which attack seedlings.

Trickle irrigation

Although expensive to install initially, trickle irrigation in zucchinis and button squash is more efficient than overhead systems. Advantages are that running costs and labour costs are reduced, water is used more efficiently, disease incidence is reduced, fruit set and quality are improved, and the tubing can be used again before requiring replacement. Trickle systems need to be properly designed to work, especially on sloping ground.

Whether a grower can use trickle irrigation will depend on the slope of the land. Land must have a slope of 8% or less to maintain equal pressures and output through trickle irrigation systems. Consult your local irrigation supplier for more detailed advice.

Planting

Cultivars and planting times

The planting times for green zucchini and cucumber cultivars for the main growing areas in Queensland are illustrated in table 2.

Zucchini (yellow): Goldfinger, Aztec gold
Button squash (green): Greenbuttons, Starbuttons
(yellow): Sunburst, Yellow ruffles
Cucumbers (white slicing): Redlands long white, Crystal apple
(lebanese): Dominus, Hylares, Amira II, Jade
(continental): Pepinova, Burpless tasty green, Sofia
(pickling): Calypso, Pixie

Table 2 Cultivars and planting times for green zucchinis and cucumbers in the main cucurbit growing districts of Queensland.

District	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
GREEN ZUCCHINIS												
Bowen/ Burdekin					Regal black Black belt Blackjack							
Bundaberg/ Gympie		Arlesa Nightrider			Regal black Black belt	Blackjack	Nightrider					
Granite Belt	Blackjack Regal black										Blackjack Regal black	
GREEN CUCUMBERS												
Bowen/ Burdekin					Verino Black prince Sprint 440S							
Bundaberg/ Gympie						Black prince Monarch Sprint 440S						
Granite Belt	Sprint 440S Black prince										Sprint 440S Black prince	

Dry seed

Planting methods

Seed can be planted straight into the ground with machine seeders. In bare soil, seeds are often planted closer in the row than required and then thinned. Planting several seeds at each plant site and then thinning out the clumps can damage the seedlings. If plastic mulch is used, water wheel or pocket type planters work well. Alternatively, seed may be hand planted through holes made through the plastic. Poor germination often results when seeds are planted into cool, wet soil.

Seed treatment
Before planting, seeds can be treated to control disease organisms which may be on the seed surface. These diseases include damping off, anthracnose and gummy stem blight. The following treatments are recommended:

- dust seed with Thiram before planting and screen off excess dust.
- treat seed with a slurry containing 100 g benomyl per 200 mL water. Mix the seed thoroughly with the slurry, drain off excess liquid and dry before planting.

Pre-germinated seed

Planting method
Pre-germinated seed will ensure more uniform and earlier plant emergence. It will also overcome problems of dry seed scavengers such as mice. Pre-germinated seed is normally hand planted but the soil must be moist at planting. Planting on the northern side of raised rows will encourage faster emergence in winter.

Pre-germination of seed
To pre-germinate seed, place them between clean damp hessian bags. Hold at 25 to 28°C until the pointed end of the seed opens and the white tip of the root is visible. This takes up to three days. Pre-germinating seed results in emergence a week earlier than dry seed. Machine planting damages pre-germinated seed, so they must be hand planted into moist soil.

Seed treatment
Pre-germinated seeds can be treated before planting to control disease organisms which may be on the seed surface. These diseases include damping off, anthracnose and gummy stem blight. Dip seed for 30 seconds just prior to planting in a suspension of 5 g benomyl in 1L of water.

Mice
Mice have a taste for cucurbit seeds and will dig out and eat large quantities of seed. This results in having to replant crops, sometimes several times, leading to late crops and lower prices. Growers have tried many different seed coatings to prevent mice finding and eating the seed, but all proved ineffective .
Pre-germinating seed will reduce the risk of loss from mouse attack as will planting container grown transplants. Mice will also take seed from seedling trays. Mouse baits will have some effect in keeping mouse numbers down. The baits should be placed around the outside of the field and within the field. If baits are placed under a sheet of corrugated iron or something similar, it will provide shelter for the mice, and lure them to the baits. It also prevents birds from getting at the baits.

Container grown seedlings

Container grown transplants have several advantages:

- they result in more even growth and cropping, and are earlier maturing
- they are raised in a sheltered environment
- seedlings for a spring crop can be planted out after the risk of frosts have gone, giving them a 'head start'
- less water is required in establishment
- better weed control is possible
- less seed is used, which is important if more expensive hybrids are grown
- more time is available for land preparation, and
- there are no losses from mice eating seed.

However transplants can be costly in terms of the time required to nurture seedlings and specialised equipment is required to produce the seedlings.

Planting methods

Seedlings can be hand or machine planted into bare soil or through plastic mulch. Plants are started in trays which consist of a large number of cells. Seed are planted in a seedling mix in the individual cells. Seedlings are transplanted into the field once they will pull cleanly out of the tray, when the roots have fully penetrated the mix.

Seedling production

Seedlings are best grown by nurserymen who have the right equipment and expertise to grow plants well. Poorly grown seedlings yield less than well-grown, sturdy plants. However some growers prefer to grow their own seedlings.

To grow healthy seedlings, it is essential to use an open, well-drained, sterile potting mix with sufficient nutrients to give the seedlings a good start. A mix that has been used very successfully is shown in Table 3.

Table 3 Suggested seedling mix.

Ingredient	Quantity
Peat	20 L
Vermiculite (Grade 3)	20 L
Dolomite	300 g
Superphosphate-fine mill preferred	300 g
5:6:5 (N:P:K) fertiliser	300 g

Mix ingredients together thoroughly and then add water (about 5 L) and mix again. This dampens the peat so that water penetrates into the filled trays more easily. Ingredients should be mixed for 3 minutes. Over-mixing will damage the vermiculite and reduce the aeration and water-holding ability of the mix.

There is a wide range of trays used, but the polystyrene inverted pyramid Speedling type trays seem to give the best results. The larger the cell, the more space is available for plants and shorter, sturdier plants are the result. The 64-cell speedling tray is commonly used for cucurbits.

Foliar fertilisers with a high nitrogen content (eg potassium nitrate, Aquasol or Thrive) are applied as a spray when plants are about one week old. Continue sprays once or twice weekly until plants are hardened off. Aquasol or Thrive will supply most trace elements. When seedlings are to be planted into a soil known to be low in a particular element (eg. molybdenum, zinc or boron) special foliar applications should be made prior to transplanting. Don't add trace elements to the potting mix. It is difficult to get even mixing, so some cells contain toxic quantities while others miss out.

Remember:

- sterilise trays before re-use
- don't over-compact mix in trays
- keep potting mix moist. Low output sprinklers which give an even cover of all trays should be used. Cells on the outside of trays tend to dry out faster. Water until all cells in trays start to drip
- drain water out of pipes before watering, as it may be hot and scald plants
- trays should be kept level to prevent low spots being over-watered and high spots left dry
- trays should be on wire based raised benches to allow "air pruning" of roots. Air-pruning prevents root growth out of the bottom of trays. The air dries them out if they come out of the mix
- maintain a regular spray program to restrict disease development
- protect plants from wind and heavy rain
- warm conditions in winter (eg. a plastic growing house) will result in better plants grown in a shorter time. Heating will allow more accurate scheduling of seeding and planting
- further information is in farmnote titled 'Containerised seedling production' Agdex 250/27

Hardening off seedlings

The greatest cause of losses in seedlings is the planting out of "soft" plants which haven't been hardened off. They are unable to survive the sudden change from the growing house to the field. Too much protection for too long, particularly if plants are in small cells and over fertilised, will result in soft spindly plants.

One week before planting out, nutrient applications should cease and the trays should be moved to an area which provides less protection and acclimatises the plants to field conditions.

Transplanting
A nutrient drench immediately prior to planting out will assist plant establishment. The drench is similar to nutrient sprays, but is applied at a heavier rate to drench the potting mix as well. Discard any weak or diseased plants as they are unlikely to establish and produce well in the field.

Where an insect pest or disease poses a threat in the seedling area or adjacent to the intended planting area, a precautionary spray may be necessary. The appropriate spray should be applied immediately before transplanting. This is cheaper and easier than spraying shortly after they're planted out into the field.

Transplant into moist soil and irrigate as soon as possible afterwards. Water wheel planters are very suitable for planting container grown transplants. Ensure that the potting mix is covered with soil. If cutworms are likely to be a problem once the seedlings have been transplanted, spray the soil at the base of the seedlings before nightfall (with Dipterex at 80 mL/100 L).

Establishment
One frequent cause of poor establishment is insufficient irrigation after transplanting. If the potting mix is not kept moist, it will shrink, forming a small layer of air between the mix and the soil. The plant roots cannot cross this air barrier and the plants will not grow. The mix is hard to re-wet once dried out, so keep it moist until the roots are well established in the soil. Irrigate regularly and thoroughly.

Row spacing
1.2 to 1.8 m

Plant spacing
Cucumbers : 20 to 25 cm at planting but thinned to 40 to 50 cm after running
Zucchinis and button squash : 45 to 60 cm between plants.

Seeding rate
Cucumbers : 1.0 to 1.5 kg of seed per hectare
Zucchinis and button squash : 1.6 to 2.2 kg of seed per hectare.

Planting depth
Plant 3 cm deep. If soil is cool, plant shallow at 1.5 to 2 cm.

MANAGING THE CROP

Fertilisers

Soil analysis gives the best guide to fertiliser requirement. It gives a guide to the amounts of the major nutrients such as nitrogen (N), phosphorus (P) and potassium (K) required, and highlights any trace element deficiencies such as molybdenum (Mo), boron (B) or zinc (Zn). It also gives an important indication whether lime or dolomite should be used to correct soil pH.

Pre-plant fertiliser

Fertilise before planting. Apply fertiliser either as a band 5 to 7.5 cm below and/or to the side of the sowing position. Alternately, spread on the surface in a 30 to 40 cm band and rotary hoe into the surface of the row.

Unless recommended otherwise by a soil analysis, apply N, P and K as set out in Table 4.

Table 4 Pre-plant fertiliser recommendations for cucurbits.

		Rate	
Nutrient	**Suggested Fertiliser**	**kg/ha**	**kg/20m of row**
Nitrogen (N), plus	Urea	110	0.3
Phosphorus (P), plus	Superphosphate	680	2.0
Potassium (K)	Muriate of potash	100	0.3
OR			
N P K mixtures	8:9:8	650	2.0
	5:6:5	1000	3.0

Side dressing

Cucurbits have high water and nitrogen needs, particularly from the start of fruiting. Potassium is required for fruit quality.

Overhead irrigated crops

Apply side dressing at first fruit set (zucchini and button squash) or when the plants have runners 30 to 50 cm long (cucumbers). Band fertiliser on the soil surface, or drill in 3 to 5 cm deep, 30 cm from the plants on either side. Apply approximately 100 kg urea or 150 kg nitram per hectare. Repeat every 2 weeks of harvesting to maintain active growth and healthy leaf colour. Urea must be watered-in well to avoid loss by vaporisation or burning the plant. To maintain fruit quality, 20 kg of potassium per hectare must also be applied every 2 weeks from first harvest onwards. This is equivalent to 50 kg of potassium nitrate or sulphate of potash or 40 kg of muriate of potash per hectare.

Trickle irrigated crops
Apply fertiliser through the trickle irrigation system. Apply potassium nitrate (at 35 to 50 kg/ha) or urea (at 10 to 15 kg/ha) at each irrigation starting when the first fruit are set (zucchini and button squash) or when the vines begin to run (cucumbers).

Foliar fertiliser
Molybdenum deficiency is common in zucchinis, button squash and cucumbers. Apply sodium molybdate at 1 g/L of water plus 5 g/L Urea as a foliar spray when the plants have three true leaves. This does not include the oval-shaped cotyledons (seed leaves). Apply a second spray 2 weeks later. A light spray which wets the tops of the leaves is all that is necessary.

These crops can benefit from a foliar spray of urea at 5 g/L, particularly if the plants are recovering from a stressed period such as waterlogging. This assists the plant in establishing new roots.

Weed control

Zucchinis, button squash and cucumbers are very susceptible to herbicide damage. Do not use residual herbicides. Two knockdown herbicides are registered for grass control in cucurbits. They are Fusilade (at 0.5 to 1 L per ha with Agral 60 at 200 mL/100 L), and Sertin (at 1 L per ha with 2 L of Ampol D-C-Tron). These herbicides have no effect on broad-leafed weeds or zucchini and button squash plants. Do not apply before the five true leaf stage of the crop. Fusilade and Sertin must not be sprayed 20 and 28 days respectively before harvest.

Pre-plant fumigation with methyl bromide will control nutgrass, plus any nematodes and damping-off fungi present.

Plastic mulch gives excellent weed control over the row area. Weeds in the narrow, unmulched inter-row strips can be controlled in the early stages by spraying at low pressure with paraquat (Gramoxone), using shielded fan nozzles. When the plants are mature the risk of accidentally spraying the crop is too great.

Where plastic mulch is not used, weeds can be controlled by inter-row cultivation. This involves hand chipping or scuffling (light shallow cultivation) of weeds left in the narrow strip along the planting row. Plant thinning can be carried out during this operation.

Irrigation

Zucchinis, button squash and cucumbers require ample water. If relying on stored water a reserve of 4 ML/ha/year is required for overhead irrigation. If bore water is the main source, make regular quality checks. If the conductivity (salinity) of the water rises above 1700 mS/cm then yield reductions are likely.

Initially apply approximately 12 mm (0.12 ML/ha) of water each day or two as necessary to germinate seeds or establish seedlings. Less frequent, but increasing quantities of irrigation water are needed as the plants grow and temperatures increase. Use tensiometers to guide the timing of irrigations and the

quantity of water to apply. Available soil moisture is vital during flowering, fruit setting and early fruit filling. If water is in short supply, ensure these periods get preference. Low available soil moisture during this stage, even for short periods will result in blossom drop, poor fruit set and fruit shedding.

Zucchinis, button squash and cucumbers require about 25 mm of irrigation per week in winter and up to 40 mm per week in summer. If overhead irrigation is used, it should be timed so that plants are dry before nightfall to prevent disease.

Pollination

Zucchini, button squash and cucumbers bear separate male and female flowers. The female flowers are the only ones that produce fruit (see figure 7).

Pollination of zucchini, button squash and cucumber flowers needs bees. With poor pollination the developing fruit yellow and fall from the plant. When partial pollination occurs the fruit will be uneven. Zucchinis are often tapered and won't fill out properly. Several "bee visits" per flower are required to give adequate pollination.

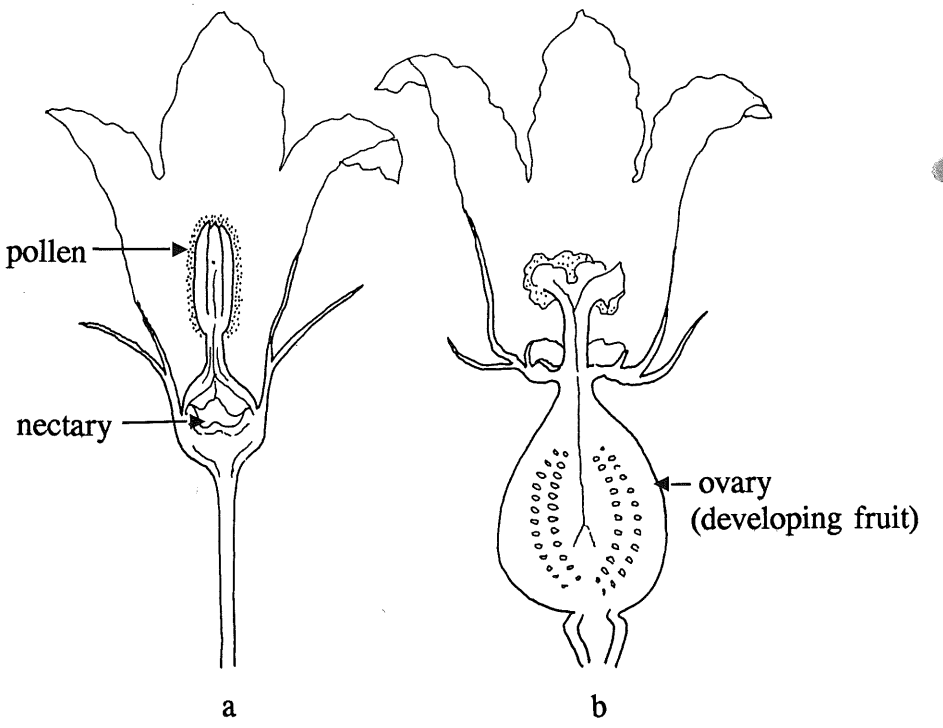

Figure 7 Male(a) and female(b) cucurbit flowers.

Bees

Where there are no beehives close to the crop, hives must be brought into the area. Overseas trials suggest that at least 2 hives per ha is necessary for pollination of cucurbit crops. Hives should be double-deck hives with six to twelve frames of brood. If growing more than 13 ha, place four to eight hives every 300 m around the edge of the crop. Place hives so they have to fly over the crop to get to the food sources. Introduce the hives when flowering begins, so that they are not distracted by other flowering plants (eg Eucalypts). Destroy flowering weeds.

Spraying should be carried out late in the afternoon after bees have returned to the hive. Hives should not be located in the crop where they may be sprayed with chemicals toxic to bees (eg carbaryl). If toxic chemicals must be used, bees can be excluded from the crop for 24 hours by placing damp hessian covers over the hives.

Bee keepers often lease hives for pollination. Draw up a contract which clearly outlines conditions on both the beekeeper and the grower

Crop protection

The modern approach to crop protection is to manage diseases and pests so they do not cause economic damage to the crop. By diseases, we mean fungi, bacteria, viruses and nematodes. The pests are insects and mites. The first step in crop protection is correct identification of the disease or pest. Descriptions are presented in tables 5 and 6 respectively. For more detail, refer to the further reading section in this book.

Heavy spraying to destroy all pests and diseases is not efficient or desirable. Unsuitable pesticides may even create problems by killing the parasites or predators of other insects.

Today, integrated pest management is the preferred approach for crop protection because it uses preventative measures and biological control in conjunction with the appropriate use of pesticides. It involves the following techniques:

- inspecting the crop regularly for pests, diseases and their effects on the crop
- spraying only when the pest or disease level demands it
- avoiding pesticides which may kill predators, parasites or bees
- using only registered pesticides (see tables 7 and 8) and observe the withholding periods. Details in *Infopest:chemicals for the protection of vegetable crops* (see further reading list)
- spraying at the stage in the pest life cycle when it is most susceptible
- targeting spray at the plant part affected
- destroying old crop residues that are a reservoir of pests and diseases

Care with pesticides

When spraying is required, read the label before use. Use the product as directed and always dispose of waste correctly.

Application of sprays

The control you will get will only be as good as your application equipment. Use a power sprayer calibrated and set correctly to produce good results. A hand operated knapsack sprayer is generally not capable of sufficient coverage. Recommended equipment includes hydraulic sprayers (most common), air assisted machines and controlled droplet applicators. It is important that these are set up to provide maximum coverage. Further information on efficient spray application is presented in the QDPI publication *Pesticide application manual(2nd edition)*(see further reading list).

Table 5 Disease descriptions for zucchini, button squash and cucumbers.

Disease	Plant part affected	Description
Anthracnose	Leaf	Small brown circular areas with a yellowish halo. Enlarge to form dark brown to black spots. Can be seed borne or survive in crop residues. Worse in wet weather.
Damping-off	Stem and root	Seedlings collapse with stem rot at or below ground level. Roots turn brown
Bacterial soft rot	Fruit	Rapid breakdown of fruit at wounds, or via retained dead flowers. Worse in wet, showery weather.
Bacterial leaf spot	Leaf	Greasy water-soaked spots that dry out, turn brown and the centres drop out. Worse in warm weather.
Downy mildew	Leaf	Pale yellow, usually angular spots which turn brown. Leaves curl, shrivel and die. Spread by wind. Worse in warm weather.
Powdery mildew	Leaf and stem	Circular, white, powdery patches on both sides of leaves, stalks and stem. Leaves shrivel and die. Older leaves usually affected first. Spores spread by wind. Worse in dry weather.
Watermelon mosaic virus	Whole plant	Light and dark green mosaic pattern on leaves. Severely affected leaves are claw like and fruit often lumpy. Fruit set reduced. Yellow fruit get green patches and lumps on them.
Fusarium wilt	Whole plant	Plant wilts and dies. Crown and root tissue turns orange-brown.
Gummy stem blight	Stems	Lesions may cover crown and girdle stems. Stems split with reddish gum oozing from cracks. Minute black dots on infected area.

Table 6 Pest descriptions for zucchini, button squash and cucumbers.

Pest	Description
Aphid	Soft bodied, green, brown or black. Can cause stunting, leaf distortion and spread mosaic virus.
Cucumber fly	Yellowish to brown wasp-like fruit fly (6-9 mm long) with yellow stripe along its back. Lays eggs in fruit. Larvae tunnel through fruit. Fruit breaks down where stung.
Cutworm	Larvae chew through seedling stems. Larvae curl up when touched and shelter in soil by day.
Heliothis spp.	Larvae 4 cm long, light-green to brown. Chew young fruit, particularly at flower end. Zucchinis bend around scars.
Leaf eating beetle	Pumpkin beetles or 28-spotted ladybird. Adults and larvae attack plants from seedling stage onwards.
Mites	Yellow-green two-spotted form and a red spider form. Produce web-like mat under leaf surface. Leaf turns yellow.

Fungicide resistance

Powdery mildew

Fungicide resistance may develop to the systemic fungicides which are now available to control powdery mildew. Resistance occurs when these products are used exclusively. To reduce resistance problems, the following program should be followed:

1 Spray with oxythioquinox (Morestan), at 7 to 10 day intervals, from planting until fruit set. Good coverage of this contact fungicide is essential. Do not use oxythioquinox closer than two weeks before or three weeks after oil sprays for aphids.

2 After fruit set, alternate or tank mix oxythioquinox with a registered systemic fungicide such as Milcurb, Afugan, Bayleton or Rubigan at 7 to 10 day intervals. It is best to include more than one systemic fungicide in this program.

Downy mildew

To avoid resistance to systemic fungicides (Galben M, Recoil, Ridomil MZ 720), use only during high humidity conditions. They should be applied twice, one week apart. At other times use a protectant fungicide such as mancozeb, propineb or zineb.

Table 7 Chemicals to control zucchini, button squash and cucumber diseases.

Disease	Chemical	Trade names	Rate per 100 L	WHP*	Remarks
Anthracnose	mancozeb	Mancozeb	150 g	7	
	propineb	Antracol	200 g	7	Zucchinis only
	zineb	Zineb	150 g	7	
	metalaxyl plus mancozeb	Ridomil MZ 720 WP	250 g	7	
	benalaxyl plus mancozeb	Galben M	250 g	7	
Bacterial soft rot	sodium hypochlorite	White King	1L	-	Post harvest dip, and dry before packing.
	chlorine	Various	125 mL of 10% soln	-	
Bacterial leaf spot	copper hydroxide	Champion WP or Kocide	200 g	1	
Damping-off	thiram	Thiram	2 g/kg seed	-	Dust as seed treatment
	metalaxyl	Ridomil 50G	2.5g/L pot.mix	-	Incorporate into potting mix
Downy mildew	mancozeb	Mancozeb	150 g	7	
	metalaxyl plus mancozeb	Ridomil MZ 720 WP	250 g	7	
	zineb benalaxyl	Zineb	150 g	7	
	plus mancozeb oxadixyl	Galben M	250 g	7	
	plus mancozeb	Recoil	250 g	7	
Gummy stem blight	mancozeb	Mancozeb	150 g	7	
	mancozeb plus metalaxyl	Ridomil MZ 720 WP	250 g	7	
	metiram	Polyram2000	2.2 kg/ha	2	Cucumbers only.
Powdery mildew	dimethirimol	Milcurb	1-2L/ha	1	
	fenarimol	Rubigan 120 EC	20 mL	3	
	oxythioquinox	Morestan mit/fung	30 g	7	Apply min. 1000 L/ha
	pyrazophos	Afugan or Curamil	50 mL	1	
	triadimefon	Bayleton 50 WP	100 g	1	
	triadimenol	Bayfidan 250 EC	40 mL	1	
Watermelon mosaic virus					See aphid control. Super reflective plastic mulch deters aphids landing.

* Withholding Period (days): The time which must pass between spraying and harvest

Table 8 Chemicals to control zucchini, button squash and cucumber insect and mite pests.

Pests	Chemical	Trade Names	Rate per 100 L	WHP[a]	Remarks
Aphid	demeton-s-methyl	Metasystox	100 mL	21	Add oil to deter aphid feeding. Use low viscosity oils such as white, miscible, summer or narrow range oil.
	dimethoate	Dimethoate, Perfekthion EC 400 or Rogor 400	75 mL	7	
	endosulfan	Endosulfan or Thiodan	190 mL	1	
	pirimicarb plus oil	Pirimor plus oil	100 g plus 1 L	2	
Cucumber fly	dimethoate	Perfekthion EC 400 or Rogor Diostop EC	75 mL	7	
Cutworm	diazinon	Diazinon 800 or Gesapon 800	0.7 L/ha	14	Cucumbers only.
	chlorpyrifos	Lorsban 500EC	70 mL	-	Spray soil at planting.
	trichlorfon	Lepidex	80 mL	2	
Heliothis spp.	carbaryl	Carbaryl 800 WP	130 g	3	Toxic to bees.
	endosulfan	Endosan	200 mL	1	
Leaf eating beetle	carbaryl	Carbaryl 800 WP	130 g	3	Toxic to bees.
Mites	dicofol	Kelthane Red Spider	660 mL	7	
	propargite	Omite 300 W	100 g	7	

[a] Withholding Period (days): The time which must pass between spraying and harvest.

HARVESTING, POST-HARVEST HANDLING AND MARKETING

Harvesting

Maturity

Zucchinis are harvested when 10 to 20 cm long and button squash when 3 to 6 cm across. Regular harvesting will increase fruit production. Large fruit should not be left on the bushes. Cucumber harvest commences when the fruit fill out to a full cylindrical shape and the prickles on the fruit surface 'pop'. A fruit length of 20 cm is desirable for green slicing types, and 30 to 40 cm for continental cucumbers. Thin skinned lebanese cucumbers are picked when they reach a length of 10 cm.

Time to harvest

Zucchinis and button squash harvesting normally starts 6 weeks after planting seed, and can continue for up to 12 weeks. This depends on the plants being kept free of pests, diseases and weeds and being regularly fertilised and irrigated. Most cucumber types reach maturity 8 weeks after planting and continue picking for 6 weeks.

Frequency

Zucchini and button squash need to be picked every 2 days to maintain fruit size in the desirable range. Cucumbers can usually be picked every 3 to 4 days in summer, and up to every 7 days in winter (depending on bush health and weather conditions).

Harvesting techniques

Harvest zucchinis and button squash carefully. The skin is very soft and easily damaged. Fruit can be cut or snapped off. Snapping is faster but results in more fruit damage.

Zucchinis, button squash and cucumbers are usually picked into buckets for transport to the packing shed. Keep buckets clean to reduce fruit damage. The filled buckets should be kept in the shade or covered. Fruit should not be left for more than one hour in the field before transport to the shed.

Post-harvest treatments

Transit and storage rots

Harvested zucchinis, button squash and cucumbers are subject to fungal (*Botrytis, Sclerotinia* or *Pythium*) or bacterial (*Erwinia*) rots. These occur under hot, wet conditions. The infection usually starts from the flower end of the fruit.

Cooling

Zucchinis, button squash and cucumbers are very perishable fruit and should be cooled to 7°C as soon as possible after harvest. The most efficient way to do this is by using forced-air cooling (for more information see *Forced air cooling 2nd edition* in the further reading section). If the fruit are not cooled, they will rapidly build up heat and start to break down. Optimum storage conditions are 7°C and 95% relative humidity.

Transport to market should also be in refrigerated vans. Cucumbers should not be transported with ethylene-producing fruit such as tomatoes, as ethylene causes yellowing of cucumbers.

Packing method

If fruit are damp or dirty, they should be wiped prior to grading. It is usually only worthwhile packing the small size zucchinis when prices are high. The diagrams in figure 8 show the usual packing arrangements for zucchinis. Button squash are volume filled into 9 L cartons.

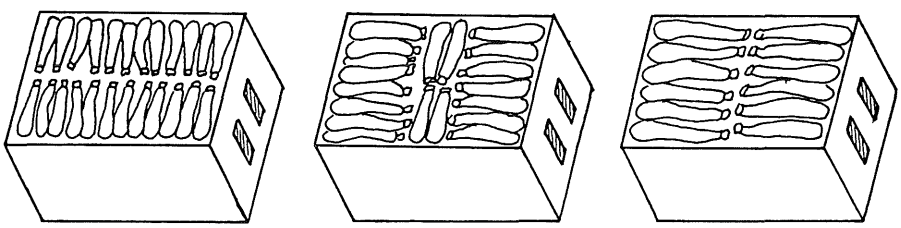

Figure 8 Packing arrangements for small(a), small-medium(b) and medium(c) zucchinis.

Carton types

The following approved packages are most commonly used for marketing zucchinis, button squash and cucumbers. Both are suited to forced-air cooling.

18 L (T35) Internal dimensions: 365 × 270 × 185 mm
9 L Internal dimensions: 365 × 270 × 95 mm

These packages may be made from either fibreboard or polystyrene.

Palletisation

A grower can stack 7 layers of 18 L cartons or 14 layers of 9L cartons on a standard Chep pallet. A standard Chep pallet can fit 12 cartons of either type per layer.

Marketing

Grade standards

Zucchini
Fruit must be sound, clean, fresh, firm, well-formed and of similar varieties. Pack uniformly within a grade size. Label the carton correctly. Suggested grading sizes are:

Fruit length	Grade size
10 - 12.5 cm	small
12.5 - 15 cm	small-medium
15 - 17.5 cm	medium
17.5 - 20 cm	large
20 cm +	marrows

Button squash
Fruit must be sound, clean, fresh, well formed and of similar varieties. Pack uniformly within a grade size. Label the carton correctly. Suggested grade sizes are:

Fruit diameter	Grade size
3 - 4 cm	small
4 - 6 cm	mediujm
6 cm +	large

Cucumbers
The fruit must be sound, clean, fresh, firm, well-formed, of similar varieties, and not over mature or discoloured. Pack uniformly within a grade size. Label the box correctly. Green slicing cucumbers are usually on one size (about 20 cm length).

Marking of packages

Zucchinis
Legibly and durably stamp, stencil or print on the end of the carton:
- the growers name and address
- the word 'zucchini' or 'zucc'
- the words 'small', 'small-medium', 'medium' or 'large'.

Button squash
Legibly and durably stamp, stencil or print on the end of the carton:
- the growers name and address
- the words 'button squash' or 'B. squash'
- the words 'small', 'medium' or 'large'.

Cucumbers
Legibly and durably stamp, stencil or print on the end of the carton:
- the growers name and address
- the word 'cucumbers' or 'cucs'.

Interstate quarantine requirements
Zucchinis, button squash and cucumbers are not considered host material for Queensland fruit fly. There is no restriction on interstate movement during any time of the year, except:
Western Australia :Certification of freedom from European red mite is required
Western Australia and
Northern Territory :EDB fumigation under QDPI supervision for cucumber fly control

Export opportunities
It is possible to export cucurbits subject to export requirements. These requirements are in place to ensure that the exported produce is free of Queensland fruit fly and other pests and diseases. Details of these requirements are contained in "Exporting cucurbits to New Zealand - a handbook for growers and packers". Copies of this publication are available for $5 from the Horticulture Postharvest Group, 19 Hercules St., Hamilton Qld 4007.

Information on export requirements to other countries can be obtained from the Australian Quarantine and Inspection Service, Locked Bag 10, Hamilton Q 4007.

GROWER SERVICE ORGANISATIONS

Contact your local grower association through C.O.D. PO Box 19, BRISBANE MARKET QLD 4106 Telephone (07 - 379 0222)

FURTHER READING

QDPI Books

These can be ordered from:

QDPI Publications
Queensland Department of Primary Industries
GPO Box 46
BRISBANE Q 4001
(07) 2393100
or can be purchased from your local QDPI bookshop

Forced air cooling, 2nd edition, Watkins, J.B.(1990), Queensland Department of Primary Industries,Brisbane.

Infopest: chemicals for the protection of vegetable crops (2nd edition), Beavis, C., Simpson, P., Syme, J., and Ryan, C.(1991), Queensland Department of Primary Industries,Brisbane.

Insect pests of fruit and vegetables in colour, Swaine, G., Ironside, D.A., and Yarrow,W.H.T. (1985), Queensland Department of Primary Industries,Brisbane.

Pesticide application manual,2nd edition, Banks, A. et al.(1990), Queensland Department of Primary Industries,Brisbane.

Prices and market throughput on the Brisbane market, Rocklea, Rutherford, A. and Hurse, M. (1989), Queensland Department of Primary Industries,Brisbane.

Vegetable crops: a disease management guide, Persley, D. M., O'Brien, R. and Syme, J. R. (1989), Queensland Department of Primary Industries,Brisbane.

Other publications

Cucurbit diseases: a practical guide for seedsmen, growers and agricultural advisors, Bernhardt, E., Dodson, J. and Watterson, J.(1988) Petoseed Co.Inc.(available from South Pacific Seeds,Brisbane,Phone 07 3933766).

Fruit and Vegetable News, Official journal of the Committee of Direction of Fruit Marketing, posted free on request to all Queensland fruit and vegetable growers. Mailing list requests to C.O.D., PO Box 19, Brisbane Markets, ROCKLEA Q 4106, or phone (07) 379 0325.

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