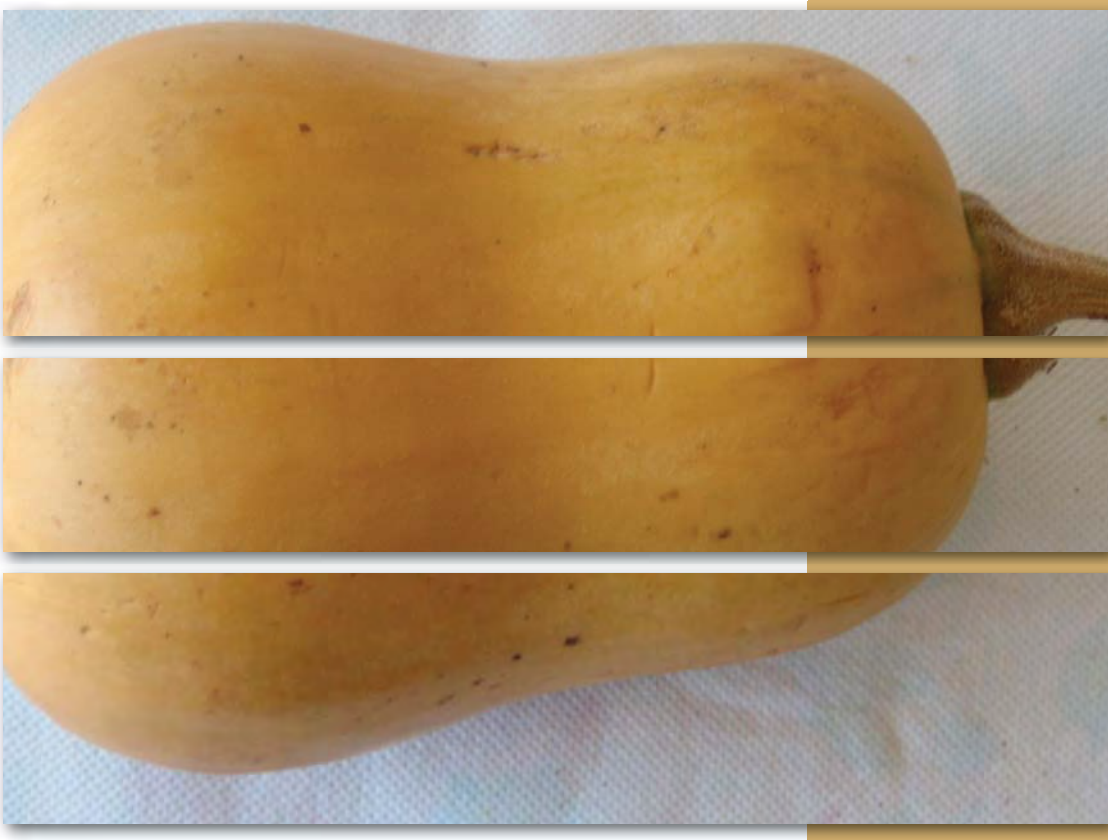
Squash (*cucurbita moschata*) production



Guide

agriculture,
forestry & fisheries

Department:
Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

Squash (*cucurbita moschata*) production

Directorate: Plant Production

Department of Agriculture, Forestry and Fisheries

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PART 1: General aspects

The taxonomy of the Cucurbit family varies with three different cucurbit species, namely *Cucurbita maxima*, commonly known as pumpkins, *Cucurbita pepo*, known as squashes and *Cucurbita moschata* which comprise butternut squashes.

Squash or “kalabasa” is a viny, creeping and trailing crop producing fruit and considered to be one of the most delicious vegetables. It is the most commonly and regularly grown among the cucurbits because it is a rich source of vitamin A, phosphorus and calcium. The young and tender shoots make good vegetable salads.

1. CLASSIFICATION

Scientific name:	*Cucurbita moschata*
Common names:	English common names include winter squash, zucchini, butternut, pumpkin, gourd, cushaw and marrow.
South African common names:	leputshe (Setswana), botterskorsie (Afrikaans),
Family name:	*Cucurbitaceae*

2. ORIGIN AND DISTRIBUTION

Cucurbita were originally domesticated in Mexico, South America, and the eastern U.S. *C. maxima* and especially *C. ficifolia* are more cold tolerant than the other species and are thought to have been domesticated in the tropical highlands of North and South America.

3. MAJOR PRODUCTION AREAS IN SOUTH AFRICA

Butternut (*Cucurbit moschata*) is an important summer crop grown by smallholder irrigation farmers in South Africa and is a type of winter squash. Butternut squashes are increasing in popularity because production and keeping quality are good and sunburn is not a major problem. The harvested fruit is hardy and can be left on the land for a month or two.

It has a sweet, nutty taste similar to that of a pumpkin. It has yellow skin and orange fleshy pulp. When ripe, it turns increasingly deep orange, and becomes sweeter and richer. It grows on a vine.

3.1 South Africa

Squash is mainly grown in the Mpumalanga Highveld, Mpumalanga Lowveld, and Gauteng (in the Vaal region).

4. DESCRIPTION OF THE PLANT

4.1 Botany

Squash is a tender tendril-bearing and viny-like plant belonging to the family Cucurbitaceae of gourd family. The fruit is large and variable in shape, size, colour and markings with a peduncle that is large, soft and corky on the surface at maturity.

4.1.1 Roots

Rooting commonly occurs at the stem nodes, which may improve plant vigour. Adventitious roots are also commonly formed at its nodes.

4.1.2 Stem

It has a very course, prostrate or climbing annual, herbaceous vine, reaching a length of 4 m or more and flowering throughout the year. Some varieties produce tendrils that help secure vines, limit wind damage and improve vine growth across weedy and uneven ground.

4.1.3 Leaves

The leaves are broadly rounded and heart shaped. The leaf occurring at the node where a fruit is developing is called the “feeder” leaf because photosynthates from the leaf are preferentially translocated to the adjacent fruit. If present, tendrils indicate ripeness in mature squashes when they begin to brown.

4.1.4 Flowers

Flowers are erect, lemon yellow to deep orange in colour, about 12 cm long, the male flowers with longer peduncles than the female ones—15 to 30 cm in diameter.

Flowers are generally large with separate male and female flowers borne on the same plant (monoecious). Male flowers form first.

4.1.5 Seeds

Seeds are large (up to 3 cm long). Numerous seeds are embedded in the tissue of the placenta which lies at the centre of the fruit.

4.1.6 Fruit shape

Fruit varies in shape (flattened, elongated, smooth, and ribbed) and size (0,25 to 6 kg or more). After pollination, fruit develops from the preformed ovary at the base of female flowers. The shape of the ovary prior to pollination is indicative of the mature fruit shape.

5. CULTIVARS

There are several types of winter squash based primarily on fruit shape and texture.

- Acorn—Acorn squashes are deeply ridged and tapered at one end. They have a dark green rind and a firm yellow flesh. They weigh between 0,45 kg and 1,4 kg. Both bush and vining types are available.
- Butternut and Waltham butternut—these have cylindrical fruit that often bulges around the seed cavity. They have light tan rinds with orange flesh and are vining in growth habit.
- Buttercup and Turk's Turban—these turban-shaped squashes have rinds that can be multicoloured with green, orange, or grey stripes. The flesh is medium orange.
- Spaghetti Squash—this squash is also called vegetable spaghetti. The cylindrical (20 to 23 cm long) fruit has a yellow flesh that is stringy.
- Hubbard—these are round in general shape but taper to a point at the blossom end. The rind is rough bluish-grey to green with occasional grey stripes. The flesh is orange-yellow in colour.

Table 5.1 *Cucurbita* genus

Cucurbita pepo* **(variety melopepo)**	***Cucurbita pepo* (variety pepo)**	***Cucurbita maxima***	**Cucurbita moschata**	**Cucurbita argyosperma***
Zucchini (summer variety)	Acorn squash (winter variety)	Buttercup squash (winter variety)	Butternut squash (winter va-riety)	Cushaw squash (summer variety)
Yellow crooknook squash (summer variety)	Delicata squash (winter variety)	Hubbard squash (winter variety)	Winter crookneck squash	Cushaw squash
Scallop squash (summer variety)	Spaghetti squash (winter variety)	Banana squash (winter variety)		
		Boston marrow squash (winter variety)		

*Cucurbita pepo** (variety melopepo)	*Cucurbita pepo* (variety pepo)	*Cucurbita maxima*	Cucurbita moschata	Cucurbita argyosperma*
		Turk's turban squash (winter variety)		

6. CLIMATIC REQUIREMENTS

All cucurbits are warm-season crops. They grow best during hot weather and cannot tolerate frost.

6.1 Temperature

Squash can be grown in both the wet and dry season. It has been reported that environment can have a marked influence on development and quality of the fruit. The optimum monthly average temperature for good growth is from about 18^0C to 27^0C. Likewise, warm temperature and low relative humidity favour good fruit-setting development and quality of the fruit.

Seeds will germinate at 15°C, but germinate best at 29°C to 32°C. Squashes grow best at temperatures of 23°C to 29°C (day) and 15°C to 21°C (night). Growth virtually stops at temperatures below 10°C and the plants may be severely damaged and maturity could be delayed by temperatures below 5°C for several days.

Plants are usually killed by one hour or more of frost (temperature below 0°C). Therefore, plant cucurbits in the field when soil temperatures are high enough for good germination and all chances of frost have passed. For early summer squash production, plastic mulch and/or row covers will raise soil temperatures and provide some frost protection.

Low temperatures also have an adverse effect on flowering and fruit set. Cucurbits are monoecious plants—that is, each plant produces both male and female flowers. Normally, several male flowers form before female flowers develop. During the periods of cool temperatures (below 22°C) most pumpkin and squash cultivars respond by producing primarily male flowers. Male flowers do not form fruit. By contrast, some cultivars of summer squash appear to form mostly female flowers in response to cool temperatures. However, without male flowers to provide pollen the female flowers do not form fruit.

7. SOIL REQUIREMENTS

7.1 Site and soil

It thrives on many types of soil but it grows well on an organic-rich medium and is often found on compost or refuse heaps. A soil pH range of 5,6 to 6,5 is recommended.

Squashes grow well on most well-drained soils. Sandy loams are ideal. They also grow well on clay soils, but harvesting is difficult when soils are wet and the fruit often becomes dirty and difficult to clean. Avoid production on low-lying or muck fields where plants are subject to late spring or early autumn frosts.

PART 2: Cultivation practices

1. PROPAGATION

Cucurbita is easily and almost exclusively propagated by seed. However, plants can be reproduced vegetatively *via* cuttings. Vegetative reproduction is generally not difficult, but ease of propagation is dependent on rooting conditions and plant health. Cuttings of one to three nodes from healthy, vigorous plants with a small feeder leaf will root readily in moist and well-drained media. Time to fruiting may be quicker from rooted cuttings than with plants generated from seed.

Summer squash is usually directly seeded or planted by transplants for early markets. The use of black plastic and transplants also increases early yields in cool springs.

2. SOIL PREPARATION

Squash can be grown with minimum tillage. Clear the area and dig holes at appropriate distances. In an open field, a distance of 2 m to 3 m between hills is recommended.

Field preparation for squash should be done by plowing twice and harrowing, then furrow the field at 2 m apart. Furrows are made with a native plow or machine tractor to a depth of 15 cm.

3. PLANTING

3.1 Planting period

Cucurbits are good rotational crops with other vegetables. Because they are usually grown for autumn harvest, they can be planted in late May or early June, and therefore fit in well in a planting schedule.

3.2 Spacing

Seed pumpkins and squashes with corn planters, using plates designed specifically for these crops, or with vacuum seeders. Plant seed 2,5 cm to 3,75 cm deep in moist soil.

Traditionally, medium-vined squashes and pumpkins are planted in rows 2 m to 2,5 m apart, with plants spaced 0,5 m to 0,6 m apart in rows. However, many growers use a 2 m x 2 m spacing to allow for cross-cultivation. Where late season application of pesticides is anticipated, leave spray and harvest aisles.

For larger varieties with fruit-size expectations of 9 kg or more, plants require a minimum of 3 m^2 to 3,6 m^2 each. Overcrowding stresses plants, creating smaller fruit size.

In addition to fruit set problems, close spacing causes vine growth to become “air-borne”—meaning that vines that would normally root in the soil at the nodes will not be able to do so as the vine growth is not situated along the soil surface where it belongs.

The volume of seed needed per hectare varies with type, cultivar and spacing. Large-seeded cultivars (most pumpkins and winter squashes) require 0,5 kg to1 kg of seed per hectare. For larger-sized varieties, there are approximately 6 600 seeds per kilogramme.

3.4 Transplanting

Transplants should be grown in large 8 cm cells or containers. The roots should not be disturbed at transplanting. Summer squash tends to develop female flowers before male flowers, especially during cool weather. The fruit enlarges for a short time and then aborts. This is a concern of growers, but it remedies itself once growing conditions become favourable.

Transplanting is also recommended, especially for F1 varieties (to saved seeds and insured seedlings establishment). Sow seeds in the seedbed and prick individually in the pot-let. Transplanting is done 3 weeks after sowing.

Incorporate animal manure and other compost materials into the soil to improve soil structure.

3.5 Seeding rate

To plant a hectare needs about 2 to 4 kg of good seeds. Squashes are directly planted at the rate of 2 to 5 seeds per hill, with a space of 2 m to 3 m between rows and 1 m between hills.

4. FERTILISATION

4.1 Field fertilisation

The rate of fertiliser depends on soil analysis. For general recommendation, fertilise at planting time, early vegetal growth, flowering and fruiting stages. Apply four (4) bags of complete fertiliser at planting time (band placement) together with animal manure. It must be mixed will the soil at the rate of 1 to 2 kg per hill, respectively.

As the runners are about 30 cm long (approximately 2 to 3 weeks after planting), side-dress with 3 bags of urea (45-0-0) at the rate of 1 to 2 tablespoons per plant. When the vine of the plant reaches 90 cm (1 month after planting), side-dress 1 bag of muriate of potash (0-0-60) in 1 to 2 tbsp per plant. Additional urea and potash may be applied every 15 days whenever necessary.

5. IRRIGATION

Vine crops (like squash) require an abundant supply of moisture for their maximum plant and fruit development. Although it is tolerant to drought, regular irrigation during dry seasons is highly recommended to obtain a higher yield. Furrow irrigation ofthe field should be applied after every 7 to10 day interval, especially during the critical stages such as at planting, vegetative, flowering and early productive stages. Do not irrigate when the fruit is already mature.

Squashes are relatively deep rooted (1,2 to 1,8 m) and can tolerate dry conditions fairly well. However, extended dry periods will result in poor fruit set and/or poor fruit development and size. Plants tolerate wet conditions fairly well, but foliar diseases and fruit rots increase. Plants also form adventitious roots at the notes and these help with water uptake.

Summer squashes are especially susceptible to drought because the fruit develops and is harvested within a few days of pollination. Lack of sufficient moisture often results in poor or irregular fruit development.

Pumpkins and squashes are usually grown without irrigation, but it is a great benefit if irrigation is available. If it is available, apply 2,5 cm to 3,75 cm of water per week during flowering and fruit development. Summer squashes usually benefit from regular irrigation throughout production.

6. WEED CONTROL

Weed management has been identified as the most important limiting factor in production of this crop in South Africa and elsewhere (Infante-Casella, 2003; Mossler & Nesheim, 2003; Department of Agriculture, 2005; Fanadzo, 2007; Fanadzo *et al*., 2010). The effect of weeds on the butternut crop is greatest during the period from emergence to the time before vine spreading (Mossler & Nesheim, 2003).

Monitoring studies in the Zanyokwe irrigation scheme in the Eastern Cape indicated that poor weed management led to poor crop stands and, in many cases, total abandonment of crops to weeds (Fanadzo, 2007; Fanadzo *et al*., 2010).

The most common methods of weeding and cultivation are hand pulling and hoeing. Cultivation starts when the plants are two weeks old in order to control weed growth. Use an animal-drawn plow to lessen the cost of weeding. Shallow cultivation is necessary before the vines cover the ground to keep the soil in good tilth, moist and free from weeds.

Control weeds through frequent, shallow cultivation. Although pumpkins and squash are deep rooted, most roots are near the surface. Deep cultivation is very harmful, destroying many of the fine roots near the soil surface. Hand-weeding and hoeing are usually required. As the plants cover the ground, they shade out many weeds.

7. PEST CONTROL

7.1 Striped cucumber beetle

The most serious insect pest of pumpkins is the striped cucumber beetle. This insect is destructive in all of its life stages and to all parts of the pumpkin and squash. As extensive and damaging as feeding is by these insects, the aspect which makes them such a devastating pest is their ability to spread bacterial wilt.

Unmated adult beetles spend the winter in the shelter of fencerows, debris and leaf litter in surrounding wooded areas. These adults emerge from cover early in the spring and can be found on dandelions, wild cucumber and wild plum before vine crops are planted. If they have fed on plants, in autumn, that were infected with bacterial wilt, the bacteria will pass the winter in the intestines of the beetle, and will be ready to enter vine crops when the beetle starts feeding on them in the spring. There is no control for bacterial wilt. The only way to control this wilt is by controlling the beetle.

These beetles are strongly attracted by the scent of vine crops and will move to fields of cucumber, melons and pumpkins as soon as plantings begin to emerge. Research projects are investigating the possibility of using specially designed scents to attract the beetles in the spring and lure them away from crops. Cucumber beetles must be controlled when they are first noticed in the spring. They will continue to migrate into cucurbit fields over a period of a few weeks. Daily vigilance is essential during the emergence and early life of the crop while the plant is small and susceptible.

After appearing in the spring, the beetles mate, lay eggs near emerging seedlings and continue to feed on young plants while the eggs hatch and larvae damage underground plant parts. As the season progresses, new adults emerge from the soil in midsummer and feed on developing vines. If they feed on plants that are infected with bacterial wilt, the bacteria are taken up into the insect's intestines and transferred to other plants during feeding or when the insect leaves droppings.

Cucumber beetles can also cause feeding damage on blossoms, and late-season feeding can occur on mature and maturing fruit.

Cucumber beetles prefer cucumber, muskmelon, winter squash and pumpkin in descending order. However, this does not mean that pumpkins are safe if they are next to a cucumber field.

1. Yellow squash beetle (Ceratia similes Oliver)

The beetles eat the leaves, resulting in defoliation of young plants. Severely infested young plants often die off while older plants are seriously affected.

Control:

- Spray any insecticides as soon as pest damage appears.

- Repeat at 7 to14 day intervals, depending on the intensity of infestation.
- Spray directly to the leavers, flowers and fruit.
- Strict sanitation is recommended.

2. Aphids (Aphis gossypii Glover)

Adults and young are tiny, green to black and soft bodied. The leaves become curled and distorted and tend to dwarf the plants.

Control:

- Spray any insecticides as soon as small colonies appear and repeat at 7 to 14 day intervals. Spray directly onto the leaves, flowers and fruit.

3. Red spider mites (Tetranychus spp.*)*

Adults and young are tiny, red or greenish red. It is found on the underside of the leaves. Yellow specks and webs on the leaves are observed;, plants become stunted which results in fruit deformation.

Control:

- Spray any insecticides as soon as the pest damage appears. Repeat at 7 to 14 day intervals, depending on the severity of infestation.
- Spray directly onto the leavers, flowers and fruit. Strict sanitation is recommended.

4. Squash vine borer (Apomecyna neglecta Pasc.)

A larva is white in colour, up to 2,5 cm in length. The larvae infest the vine, make a hole in the stem near the base of runners, resulting to runners wilting.

Control:

- To effectively control the pests, start application when runners develop and/or before the pest bores into the stem. Repeat application once at weekly intervals.

5. Squash bug

This greyish-black bug (*Anoplocnemis curvipes*) is commonly found on all vine crops but shows a marked preference for pumpkins and squash. It is slow to emerge in the spring and usually appears about the time that the vines begin to run. The adults are shy insects and usually shelter under leaves, clods of dirt or debris. Shortly after the adults are found, there may be small yellowish-brown to brick-red eggs laid on the underside of the leaves.

Damage from these insects results from a toxin that is injected into the plant when the insect feeds. This toxin can cause complete wilting of young plants. In older plants, feeding produces dried and blackened areas where the insect has been sucking.

Damage is generally confined to the foliage, and can cause wilting of plants in severe cases.

Sanitation is a good preventive strategy. Disc under plant refuse as soon as possible after the crop is harvested and remove any objects, for example field containers, wagons, or machinery that will provide shelter for these insects in order to survive the winter.

6. Squash vine borer

The squash vine borer is a pest on pumpkins, squash, marrow and gourds. The adult is an attractive clear-winged moth with black-and-orange body and orange legs fringed with long, black hairs. The larva is the destructive stage of this pest as it feeds within the vine and causes the plant to wilt and/or collapse, often causing die off. Although squash is the preferred host, butternut squash is apparently immune to this pest.

At the first signs of the sawdust-like frass, at boring sites, cut lengthwise near where the damage occurs and the borers can then be removed. The stems should be immediately covered with soil. Sanitation is also important. After harvest is complete, vines should be removed from the garden and composted to prevent the remaining borers from completing larval development. Burying a few nodes along each vine will encourage rooting at these nodes. This will lessen the impact if squash vine borers girdle the base of the vine.

8. DISEASE CONTROL

Diseases:

1. Downy mildew–*Pseudoperonospora cubensis Rostow* – fungus

Yellow spots appear on the upper surface of the leaves and purplish mildew on the lower side. The affected plant will not continue to flower and the developed fruit will not reach maturity.

This disease is less prevalent than powdery mildew but sometimes can be a problem. Downy mildew grows on the underside of leaves but yellow spots can be seen from the top. Fuzzy growth that is grey to purple is seen on the underside of leaves. The disease affects only leaves and will not transfer to fruit. The biggest problem is that the leaves die prematurely from the fungus. Airborne spores travel both short and long distances, infecting only cucurbits. The disease is controlled with fungicides as with powdery mildew.

Control:

- Spray with appropriate chemicals in controlling these diseases and follow the manufacturer's recommendation.

2. Powdery mildew–*Erysiphe cichoracearum D.C*. fungus

Powdery mildew is present in squash fields almost every year to some degree. The fungus overwinters in debris in the field or in hedgerows. It has a fairly wide host range but wild and cultivated cucurbit hosts seem to be the primary sources of spores.

Spores develop on debris, wild hosts, etc. and are windblown for long distances. The spores then land on vine crops and germinate if conditions are right. Hot, dry weather with heavy dew at night is needed to favour development of the spores. The characteristic white powder is seen on the upper surface of leaves. Leaves die down early and collapse before the fruit has reached maximum size or maturity.

The presence of talcum-like growth on the leaves surface and young stem is the first evidence of infection. Infected tissue may appear normal but later the spots will turn yellow and then dried up. The infected plants become stunted and the immature fruit is forced into ripening.

Control:

- Control must be preventative. This means that fungicides will primarily protect only uninfected leaves and stems. There are different races of the mildew fungus. Depending on the race, fungicide treatment is more or less effective. Once started, repeat fungicide applications every 7 to 10 days until vines start to die down.
- When the disease starts to develop, spraying will be at 7 to 14 day intervals.
- Use appropriate chemicals in controlling this disease by following the manufacturer's recommendation.

3. VIRUS DISEASES

A number of mosaic viruses infect squash and pumpkins, and it is often difficult to differentiate one virus from another visually. Cucumber mosaic, squash mosaic, watermelon mosaic and zucchini mosaic viruses are the most frequent.

Symptoms include mottled, crinkled leaves, warty fruit with yellow or green, raised areas and malformed fruit. These viruses are transported mainly by infected seed or insect vectors such as aphids or cucumber beetles, and therefore control measures include controlling insect vectors. Virus-infected plants should be rogued and removed from the field and destroyed. Otherwise, there are no control measures for these crops once infected.

3.1 Mosaic virus

Leaves on the older plants are mottled, distorted, wrinkled and the edges curled downward. The fruit has irregular pale green or white areas scattered with dark green spots. The younger internodes of the vines become stunted. The young tip leaves therefore form a rosette.

Control:

- Rogue the infected plants.
- Bury them or burn in an isolated place.
- Spraying with insecticides to control the insect vectors will minimise the spread of the disease.

3.2 Oedema

Oedema is caused by a physiological upset in the water balance of affected parts which occurs when the roots take in water faster than it can be transpired through the leaves. This water builds up pressure in the mesophyll cells (interior cells) of the leaves, causing them to enlarge and burst, producing water-soaked spots on the affected leaves. These spots enlarge, forming swollen blister-like areas which break through the leaf epidermis to form tan or brown wart-like, corky protuberances predominantly on the lower leaf surface. These areas harden and darken with age. In severe cases, these corky growths also form on the petioles and stems. If injury continues, the leaves will turn yellow, droop and fall from the plants. Severely affected plants become spindly and cease growth.

Oedema usually is associated with a high level of soil moisture and reduced transpiration of moisture from the leaf surfaces. Cool night-time temperatures along with high relative humidity surrounding the foliage tend to suppress transpiration. While plant roots continue to absorb water, the plant does not lose enough water through transpiration.

This is most often associated with uneven availability of moisture when immature fruit is enlarging. On pumpkin rinds the severity may be enough to make the fruit unmarketable.

The fruit surface is often raised with circular-shaped lesions that are corky or ‘‘crusty’’ in appearance and may appear irregularly over the entire surface, or be limited to, for example, the shoulder side exposed to direct sunlight. The crusty appearance is similar to the appearance of scab on hard-shelled fruit, except that the oedema lesions never appear crater-like or shrunken.

Excessive loss of foliage owing to severe powdery mildew infestation can cause plant stress, and oedema-like linear cracks can develop on the surface. On buttercup squash the corky lesions may be circular, spindle or apostrophe-shaped. On butternut squash, oedema appears as linear growth cracks, usually on the neck part of the fruit.

4. SCLEROTINIA

Another disease occurring occasionally is sclerotinia rot, sometimes called white rot. This disease can occur at any time of the season— in the field on various parts of the

plant, on the fruit in storage or in transit. Proper curing of pumpkins before storage allows injuries and scratches to scar (heal) and prevents invasion by storage disease organisms such as the white rot fungus.

On the fruit, this disease causes a soft, watery rot, and a white cottony growth covers the site of infection. Black pellet-like overwintering bodies, also known as sclerotia, appear as the disease progresses.

There are two critical conditions that determine whether white rot will develop:

- An injury is necessary for the initial development of the disease. Once disease has developed, it can spread to other plants or other parts of the same plant by contact
- Free moisture must be present for at least 3 days.

Sclerotinia is a weak pathogen and the fungus is always present in the soil. Crop rotation has no effect on its abundance. However, it has been found to be especially frequent in the soil around dandelion roots.

5. *FUSARIUM*

This disease results from infested soil. Soil can become infested by planting infected seed. The fungus *Fusarium* affects plants in two ways: either root rot develops and the plant wilts or the fruit becomes infected, resulting in dry rot or breakdown.

There appears to be actually two forms of the fungus that cause these two different symptoms. In the field, there may be a roughly circular area where breakdown of the fruit occurs. There is no way to treat this disease. Prevention is the only means of control.

This fungus can be seed-borne. Pay special attention to using disease-free seed. Hot water seed treatment, which kills the fungus, unfortunately also destroys about 33% of the seeds. If outbreaks of *Fusarium* have occurred, do not plant pumpkins in that field for 3 to 4 years.

6. FRUIT ROTS

Anthracnose, black rot, *Phytopthora*, soft rot or *Fusarium* rot organisms are often related to wet conditions as the fruit ripens—particularly where a fruit has contact with the soil. Secondary fruit rots can occur as a result of injuries to the fruit by cucumber beetles, rodents or rough handling.

Control of fruit rot diseases include: harvesting only fully ripened fruit, practising good crop rotation as many of the rots are soil and debris related, providing good drainage and water management, and controlling cucumber beetles.

7. *SEPTORIA* LEAFSPOT

This disease can show up on both the leaves and fruit of winter squash. With the fruit, small raised, whitish spots appear, giving a rash-like appearance. Ordinarily, this disease does not cause a fruit to rot. This disease is very similar to oedema, which also results in a raised, whitish corky spot of similar size. However, oedema is related to weather patterns.

To manage this disease, the infected leaves must be removed at the end of the growing season to reduce inoculum levels. Because leaf moisture is essential for infection to occur, air circulation should also be increased around the foliage by properly spacing plants (and removing volunteer seedlings) to prevent overcrowding. As with other foliar disease problems, overhead watering has to be avoided. Fungicides containing chlorothalonil or copper protect new growth and reduce the spread of the disease. Preventative applications of fungicides should begin in early to mid-June prior to the onset of symptoms.

9. OTHER CULTIVATIONS PRACTICES

9.1 Mulching

Mulching can be rice straw, grass clippings and plastic to minimise weeds and to maintain adequate soil moisture. It is spread on the surface of the ground around the plants.

9.2 Thinning

One week after emergence, weak seedlings are thinned out and only two healthy seedlings are allowed to grow.

9.3 Abiotic disorders

9.3.1 Bees and pollination/Poor pollination

Bees are an essential part of the production of all vine crops. Wild bees and other insects are normally sufficient to pollinate small fields. However, where fields exceed 1 to 2 ha, bring in beehives for pollination. One hive is needed for every 2 to 3 ha of squash.

Place hives in protected areas at edges of fields because bees normally forage as close to the hive as possible, usually within 0,25 km. Place hives around the field to obtain more complete pollination of large fields.

Blossom density for squashes is low. Therefore these crops are not very attractive to bees. In addition, each cucurbit flower has to be visited at least 15 times for complete pollination. Incomplete pollination results in small and misshapen fruit. To improve the success of pollination, place bees in fields 3 to 5 days after the first blossoms appear—at that time about 10% to 15% of the plants should have open female flowers.

Because they are unaccustomed to the area, the bees will forage close to the hive and will not stray into more attractive crops further away.

Poor pollination results in poorly shaped fruit as well as excessive blossom drop. One hive of bees is recommended per hectare.

9.3.2 Sunscald

Sunscald occurs when there is insufficient leaf cover to protect tender fruit from the sun. Papery white areas on the side of the fruit that is exposed to direct sunlight appear. This disorder generally occurs on winter squashes. The marking on the skin makes the fruit unmarketable and can cause rot to the affected area.

To prevent sunscald the plant needs to have good vine growth throughout the season. Proper fertilisation, protecting leaves from fungal diseases that cause defoliation and proper irrigation to prevent wilting are ways to promote good vine health.

9.3.3 Blossom-end rot

Blossom-end rot is associated with a calcium deficiency. Even when calcium is present in proper levels in the soil, calcium deficiencies can occur. Calcium is taken up by roots through a process called mass flow. Therefore, proper soil moisture must be present in order for the plant to absorb calcium. In squash blossom-end rot symptoms include a leathery appearance on the blossom-end of the fruit. The progression of this disorder results in a blackening and rotting at the end of the fruit.

Preventing blossom-end rot can be done by first making sure there is an adequate calcium level in the soil. In addition, the calcium/magnesium balance in the soil may have to be adjusted so that there is not an excessive level of magnesium. Magnesium and calcium can compete for an uptake in a plant. Most importantly, after making sure that adequate levels of calcium exist, proper soil moisture levels have to be assured through irrigation.

10. HARVESTING

Premature harvest of the crop reduces its fruit quality; hence, harvesting should be done at the right stage. Summer squashes, such as zucchini and pattypan, are harvested when immature, and used as a fresh vegetable stewed, boiled or fried. They develop very rapidly after their flowers have opened, and must be harvested before the rind begins to harden.

Pumpkins and winter squashes are not harvested until they are fully ripe and the skins are hard. They are either pulled or cut from the vine with a part of the stem attached to the fruit; removal of the stem leaves an injury through which decay organisms may enter. When gathering squashes or pumpkins for storage, careful handling is needed to avoid bruising, as damaged fruit soon rots.

Winter squash is only harvested once the fruit is fully mature. At this stage, the skin of the squash is hard and impervious to scratching. To mature a crop, 3 to 4 months are required and the fruit is generally ready to be picked at one time. Do not leave squash in the field when a severe frost is predicted as this predisposes the fruit to disease-rotting organisms —either in the field or storage.

10.1 Flowering and fruiting

When the fruit is harvested for consumption at an immature stage, the highest quality is achieved just after the blossom drops off the fruit. Mature fruit is harvested when the skin becomes dull and the tendrils nearest the fruit die off. The time from flowering to harvest varies with cultivar and environment. For immature fruit, this is generally 1 to 2 months after planting or as soon as a week after pollination of the female flower. Fruit generally reaches maturity 30 to 60 days after pollination.

10.2 Harvest season/period

The fruit is mature or ready to harvest 30 to 40 days after pollination or when the rind becomes hard. Another indicator of maturity is when the peduncle starts to dry up.

Winter squash varieties are usually harvested during the months of September and October. Some of the earlier maturing varieties such as the acorn type are mature in August. Although late harvests of winter squash may run into November, cool, wet weather, and heavy frosts may discolour fruit, or in more severe cases, cause fruit breakdown.

10.3 Harvesting methods

Harvest before fruit is fully ripe or when the peduncle starts to dry up. It is best to harvest the fruit with a part of the peduncle attached to prolong storage life.

Fruit for vegetables is harvested before the rind begins to harden or approximately 40 to 100 days after planting while for seed purposes, harvesting should be done when the rind becomes hard and tough or about 120 to 130 days from planting.

PART 3: POST-HARVEST HANDLING

1. SORTING AND GRADING

Squash should not be stored with ethylene producers such as ripe apples or pears, because squash will change colour, become stringy and decay. It is important to keep squash dry. Care must be taken not to injure the soft skin. Some growers require that harvesters wear gloves to prevent injury from fingernails. Injuries result in brown or discoloured areas on the fruit.

2. PACKAGING

If the thumbnail will not easily puncture the rind, the fruit is too old to be used for fresh-market purposes. Careful handling is important because the young, tender fruit bruises very easily.

The mature vegetable marrows are packed in orange bags (13 kg), sugar pockets (27 kg) and large bags (41 kg). Plastic net bags (27 kg) are also suitable. For local marketing through chain stores, the product is prepacked in small containers. For this purpose the fruit is delivered to the distributor in plastic lug boxes, where they are packed and delivered to the stores.

3. STORAGE

To maintain uniform temperature and relative humidity throughout the storage period, air movement should be kept constant by fans placed in strategic locations within the storage.

3.1 Curing and storing

Only the hard-shelled squashes are adapted for long-term storage, although pumpkins, if properly handled, can be kept until after Christmas. After the fruit has been harvested, it should be ripened or cured so that it may keep longer and in better condition in storage. Curing hardens the skin, heals superficial injuries, reduces the high water content of the fruit, and improves the eating quality. The fruit can be cured either by leaving it in small piles in the field for 10 days to 2 weeks when the weather is warm and dry, or by keeping it inside at room temperature for a month. A more reliable method is to use artificial heat at a temperature of 26°C to 29°C with a relative humidity of about 80%.

Unlike most other vegetables, squashes and pumpkins require warm, fairly dry storage conditions. After the curing period, carefully place the fruit in a single layer on shelves, leaving a small space between each fruit. Maintain a temperature of 10°C and a relative humidity of 70% to 75%. Temperatures above 15°C promote high respiration and shrinkage. Do not allow the temperature to fall below 5°C. Cold-storage

rooms are not suited to the storage of pumpkins and squashes because the high humidity encourages rot.

4. MARKET PREPARATION

Most winter squash varieties yield in the range of about 20 000 kg/ha.

Yields can vary considerably, depending upon what is considered to be marketable—which, in turn, is somewhat dependent upon supply and demand.

PART 4: Production schedule

Activities	January	February	March	April	May	June	July	August	September	October	November	December
Soil sampling												
Soil preparation												
Planting												
Fertilisation												
Irrigation												
Pest control												
Disease control												
Weed control												
Curing												
Leaf sampling												
Harvesting												
Marketing												

PART 5: Utilisation and nutritional value

5.1 Preparation

The fruit is prepared by removing the skin, stalk and seeds, which are not usually eaten or cooked. However, the seeds are edible, either raw or roasted and the skin is also edible and softens when roasted. One of the most frequent ways to prepare butternut squash is roasting. To do this, the squash is cut in half lengthwise, lightly brushed with cooking oil, and placed cut side down on a baking sheet. It is then baked for 45 minutes or until it is softened. Once roasted, it can be eaten in a variety of ways as outlined below.

5.2 Culinary/cooking

Uses

The young shoots, flowers and fruit are used as vegetables; it is palatable when cooked alone or in combination with other vegetables, fish and meat. Matured, it can be made into pies and other delicacies. In addition, seeds of mature fruit can be boiled in salted water, dried like watermelon seeds, roasted and used as snack food.

It is also frequently used in South Africa. It is often used in soup or can be baked on a grill. Grilled butternut is normally either seasoned with spices such as nutmeg and cinnamon or the deseeded centre stuffed with another vegetable, for example, spinach and Feta before being wrapped in aluminium foil and then grilled. The grilled butternut is often served as a side dish to braais (barbecues) and the soup as a starter.

5.3 Nutritional value

Squash is rich of vitamin A in a quantity comparable to the degree of the yellow colour. It is also an excellent source of fibre, vitamin E, vitamin C, manganese, magnesium and potassium.

Winter squash is a low-calorie, good source of complex vegetable carbohydrates and dietary fibre. It is also a source of niacin, iron and betacarotene. Usually, the darker the skin is, the higher the betacarotene content.

PART 6 REFERENCES

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CONTACT DETAILS

Directorate	Plant Production
Division:	Vegetable Crops
	Private Bag X 250, Pretoria, 0001
Tel No:	012 319 6072
Fax No:	012 319 6372
Email:	DPP@daff.agric.za