PRODUCTION GUIDELINES

Watermelon

(*Citrullus lanatus*)

agriculture,
forestry & fisheries

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◦ PRODUCTION GUIDELINES ◦

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(*Citrullus lanatus*)

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Compiled by

Directorate Plant Production
Private Bag X250
PRETORIA 0001

Tel +27 12 319 6072
Fax +27 12 319 6372
E-mail DPP@daff.gov.za

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Directorate Communication Services

Obtainable from

Resource Centre
Directorate Communication Services
Private Bag X144
PRETORIA
0001

CONTENT

GENERAL ASPECTS

Classification

Scientific name: *Citrullus lanatus*
Common names: Watermelon
Family name: Cucurbitaceae

Watermelon (*Citrullus lanatus*) is a warm, long-season crop. Watermelon has been marginally competitive in the 2000 to 2003 production seasons as a vegetable crop. Production has declined in the past years. Some decrease has been the result of increased yields. However, much of the decline was the result of reduced consumer demand, leading to the sale of poor-quality melons. Efforts at many research stations have helped reverse the trend toward reduced *per capita* consumption of watermelon.

To show a profit, a grower must produce good yields of high-quality melons, something that can be obtained only with careful management.

Origin and distribution

Watermelon is now widespread in all tropical and subtropical regions of the world and is mostly grown for fresh consumption of the juicy and sweet flesh of mature fruit. Locally known in the country as legapu (Setswana) it is one of the most popularly grown fruit vegetables in the country today during summer.

The culture of watermelons goes back to prehistoric times. The watermelon was cultivated in ancient Egypt and verified by David Livingstone (the noted missionary explorer) in the 1850s when he found great tracts of watermelon (called kengwe) growing wild in the Kalahari desert and semitropical regions of Africa. Even today, in semi-desert districts of Africa watermelons are cultivated as an important source of water during dry periods. Watermelon was widely distributed throughout the remainder of the world by African slaves and European colonists. It was carried to Brazil, the West Indies, Eastern North America, the islands of the Pacific, New Zealand and Australia. Written records indicate that watermelons were cultivated in Massachusetts as early as 1629, before 1664 by the Florida Indians, in 1673 in the Midwest, in 1747 in Connecticut (from seeds that originated in Russia), in 1799 by Indian tribes along the Colorado River and in 1822 in Illinois. Watermelons are currently grown on all continents throughout the warm regions of the world.

Major production areas in South Africa

Production requirements

Watermelons lend themselves well to small-scale and part-time farming operations. There are multiple markets for growers with 2 ha or less and many field operations, such as land preparation, planting and harvesting, can be custom hired.

South Africa

Locally watermelon is planted in most warm areas of the country, Mpumalanga Lowveld, Limpopo, North West and in some parts of the Eastern Cape.

Description of the plant

Watermelons are a member of the Cucurbitaceae family, which includes squash, pumpkins, cucumbers, muskmelons and gourds. Individual plants produce both male and female flowers and fruit size varies from 2 to 14 kg, depending on variety. However, seedless varieties will require pollinators.

Botany

Watermelon grows as a vine that sends out long runners along the ground.

Roots

The watermelon root system formation begins prior to emergence of cotyledons to the soil surface and reaches maximum extension by the time of flowering. Watermelon features a highly branching taproot extending up to 1 m deep into the soil. Some 15, occasionally more, lateral roots branch from the main root.

Stem

The stem is a long, trailing vine reaching, in some seasons, 5 m and more in length, highly branched; forming secondary side shoots which, in turn, branch out. The vines, especially the younger shoots, are covered with long, woolly hairs protecting the plant from overheating.

Leaves

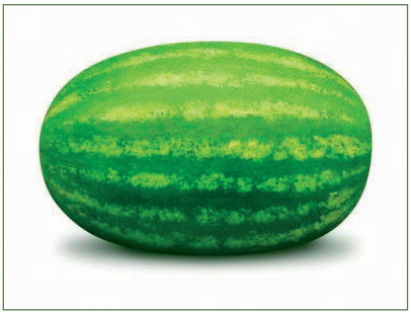
Watermelon leaves are dark green, with prominent veins. They have three large lobes, each further divided into smaller lobes. Watermelon leaves

are heart shaped with three to seven lobes per leaf and are produced on trailing vines.

Flowers

Watermelon flowers are yellow, five-petalled flowers about 1 cm in diameter (smaller than some of the other vine fruit). Watermelon vines like squash, pumpkin and cucumber have separate male and female flowers on the same plant. Plants are monoecious with yellow flowers that are approximately 3 cm in diameter.

Fruit



Fruit shape and appearance are quite varied, ranging from round to cylindrical and a single colour to various striped patterns on the fruit surface. Watermelon fruit is very large, smooth and oval to round. The skin can be solid green or green striped with yellow. The edible flesh is usually pink

with many flat, oval, black seeds throughout. Seedless varieties also exist, as well as types with orange, yellow or white flesh. Small “icebox” watermelons weigh 3 kg to 4 kg and are produced early. They are well suited for local sale and home gardens.

Cultivars

Selecting the best watermelon variety is the most important decision made by a producer. Planting a variety that is not suited for the available market and the particular production situation leads to lower profits or possibly crop failure. In addition to market acceptability, a variety must have acceptable yield, be adapted to the production area and have the highest level of needed pest resistance available.

Light-green and grey-green watermelons are less subject to sunburn injury than dark-green and striped varieties. Resistance to races of Fusarium wilt and anthracnose disease is an important varietal characteristic to consider. Most varieties have varying levels of resistance to one or more races of Fusarium wilt and/or anthracnose. Resistance to race 2 anthracnose disease, the prevailing race, is not available. Black Diamond, Texas Giant, Florida Giant, and Tendergold are not disease resistant. None of the watermelon varieties are resistant to all races of Fusarium or anthracnose, so these diseases can occur even though a variety is usually referred to as being resistant. No varieties are known to have insect or nematode resistance.

The major watermelon varieties and types produced are Charleston Gray strains, Crimson Sweet, Jubilee, Allsweet, Royal Sweet, Sangria, triploid seedless, and Black Diamond types. Brief descriptions of several varieties grouped by rind colour and fruit shape characteristics are listed below. All are red-fleshed watermelons, unless noted otherwise. The weights are average market sizes.

Climatic requirements

Temperature

Watermelons are sensitive to cold temperatures and even a mild frost can severely damage the crop. The best average temperature range for watermelon production during the growing season is between 18°C and 35°C. Temperatures above 35°C or below 10°C will slow the growth and maturation of the crop.

Soil requirements

Site and soil

Watermelons grow best on non-saline sandy loam or silt loam soils. Light-textured fields warm up faster in the spring and are therefore favoured for early production. Very sandy soils have limited water-holding capacities and must be carefully irrigated and fertilised to allow for high yield potential. Clay soils are generally avoided for watermelon culture, but they can be productive if irrigated with care to prevent prolonged saturation of the root zone (a condition that favours the development of root rot pathogens) and to allow good drainage between irrigations. The soil should have a pH of 5,8 to 6,6.

CULTIVATION PRACTICES

Propagation

Watermelon transplants can be planted into the field after all danger of frost has passed and when the soil temperature is at least 15°C. Transplants can be planted with a tractor-pulled mechanical transplanter or by hand.

Soil preparation

Fields should be prepared thoroughly by plowing and harrowing and removing the different types of plant debris. It should also be pulverised and levelled; furrows are made 2 m apart.

Watermelon is known to be sensitive to manganese toxicity, a frequent problem in low pH soils. Further research studies indicate an association between high leaf manganese concentration and poor growth and yield of watermelon. Seedling watermelons react to manganese toxicity with stunted growth and yellowish, crinkled leaves. Older plants generally ex-

hibit brown spots on older leaves that may be mistaken for symptoms of gummy stem blight.

Manganese toxicity is usually associated with soils having a pH below 5,5. However, in wet seasons the condition may occur at higher pH levels when the soil has been saturated for a period of several days. This condition has been noted in several watermelon fields with pH ranges at 5,8 or slightly higher when the crop was planted flat. Planting watermelons and other cucurbits on a bed is good insurance against manganese toxicity during a wet season.

The best solution to manganese toxicity is to apply lime in autumn at rates based on the results of a soil test. A pH of 6,0 should be maintained for maximum yields.

Planting

Planting period

In the winter rainfall area it is planted in September and October, in the Limpopo and Mpumalanga Lowveld from June to August, and in the rest of the country from August to October. The crop matures three months after planting, and the yield varies from five to 72 t/ha.

Days to maturity

It is usually 80 to 90 days for baby bush varieties and 90 to 100 days or more for the larger varieties.

Spacing

SEEDED WATERMELON

In large-scale production, few seeded varieties are currently grown. Watermelons are planted on flat beds 2 m wide and 20 cm to 30 cm high. In direct-seeded plantings, seed is placed 1,2 cm to 1,9 cm deep. After thinning and side-dressing, furrows are re-formed to the condition prior to furrow irrigation. For transplants, a single drip irrigation tape is laid 15 cm to 20 cm below the bed surface. Black plastic film, 1,8 m wide, is then laid flat on 2-m beds to heat the soil and reduce weeds. Seeds or transplants are then planted directly through the plastic. Transplants are set 60 cm to 90 cm apart. About 15 cm of the plastic is covered with soil at the edges to hold the mulch in place.

Common seedless watermelon planting configurations are 1row of the seeded variety (pollinator) for every 2 to 3 rows of the seedless variety. However, other novel configurations are being used. The most popular is the mixing of seedless and pollinator varieties within the same row. In within-row plantings, the ratio of seedless to pollinator plants ranges from 2:1 to 5:1. As the seedless to pollinator ratio increases, the number of beehives should be increased to ensure pollination.

Seeding rate

The seeding rate is 16 to 25 seeds per 10 m^2 (1,0–3,0 kg/ha).

Fertilisation

Field fertilisation

Watermelon has moderate nutrient requirements compared to other vegetable crops, and because of its deep rooting it is efficient in extracting nutrients from the soil. A high-yield watermelon crop will typically contain less than 180 kg/ha of nitrogen (N) in its biomass, and, because most soils supply some nitrogen, the application of nitrogen beyond this quantity is seldom warranted. The phosphorus (P) fertiliser requirement is a function of soil test phosphorus level and soil temperature at the time of planting. Soils with greater than 20 ppm bicarbonate extractable phosphorus require little or no phosphorus fertilisation. Soils below this level may require as much as 168 kg/ha of P_2O_5, with phosphorus requirement increasing in colder soil and with lower soil test value. Soils with more than 120 ppm exchangeable potassium (K) can support high-yield watermelon production without fertilisation, although a maintenance application of up to 168 kg/ha of K_2O can be used to maintain long-term soil fertility. Soils below 120 ppm exchangeable potassium should be fertilised with up to 68 kg/ha of K_2O to ensure peak production.

Phosphorus should be applied preplant. Potassium application can be made preplant, after planting, as a side-dress application, or delivered in irrigation water (fertigation). Nitrogen application is typically split between a small preplant and one or more in-season applications. In drip-irrigated culture, small weekly nitrogen fertigations may be used to time nitrogen delivery to crop uptake rate.

Irrigation

Although watermelon is a deep-rooted crop able to tolerate a significant degree of soil moisture stress, peak production requires timely irrigation. After crop establishment (either by seed or transplant), irrigation may be withheld for a period of several weeks to encourage deep rooting. However, irrigation should be managed to minimise water stress throughout the fruit-set and fruit-sizing periods. Water stress during early fruit development can result in small, misshapen fruit and the occurrence of blossom-end rot (a physiological disorder in which the blossom end of a fruit ceases to grow and becomes dark and leathery). As harvest time approaches care must be taken to avoid large fluctuations in soil moisture content, as heavy irrigation (or rainfall) can result in fruit splitting.

In the past, watermelon was usually irrigated by the furrow method; irrigation was applied based on soil moisture status. In recent years, many growers have adopted drip irrigation. Drip irrigation lines are typically buried in the centre of the soil beds. The irrigation system may be renovated each production season or left in place for a number of years, depending on the grower's management scheme and crop rotation. Drip irrigation scheduling is determined by potential evapotranspiration (ETo) estimates and crop growth stage; frequency of irrigation can vary from once a week early in the season to daily during times of peak water demand. Some growers use drip irrigation lines placed in every other furrow after crop establishment. While this approach may not provide the full yield potential of a buried, in-row system, it does provide improved irrigation control compared to furrow irrigation, and the system is portable, which eliminates management issues associated with crop rotation. Regardless of irrigation technique, care must be taken to minimise wetting of the bed tops. Fruit in contact with moist soil may develop unsightly ground spots and fruit rots.

Weed control

Shallow mechanical cultivation and hand hoeing are needed to control weeds before plants have vined. Pruning roots and vines with cultivating equipment slows melon development and reduces yield. Several pre-emergence herbicides are available that will control germinating broadleaf weeds and grasses in seeded and transplanted watermelons if used properly. Chemicals are economical when used as narrow-band applications in the planted row. Other chemicals can be used as a lay-by application between the rows before vines begin to run.

Herbicides are applied with shallow incorporation and transplants are placed with the roots below the treated zone. Post-emergence herbicides are used to control grasses. Methyl bromide was commonly used in the past in field fumigations, but currently metam sodium is used for preplant weed suppression.

Pest control

Seedcorn maggot

Description: The seedcorn maggot (*Hylemya platura*) is the larva of a fly that resembles a housefly. The larvae are yellowish-white, 0,25 cm long when fully grown, legless and wedge-shaped with a pointed head. The pupae are brown, 0,20 cm long, cylindrical in shape and rounded at both ends. The flies are dark grey, 0,20 cm long and their wings are held overlapping their bodies while at rest. This pest can be potentially serious every year.

Life cycle: These pests overwinter as dark pupae in the soil. The adult flies emerge in April. They are attracted to areas with high levels of organic matter where they lay their eggs. These areas include fall-seeded cover crops that have been disked within three weeks of planting. Once the eggs hatch, the pale yellowish-white, legless maggots begin tunnelling into the newly planted seeds. There are three generations a year, but the first generation larvae which feed between 13 April and 1 June are the most damaging.

Damage: Damaged seeds may fail to germinate or may produce stunted plants.

Management: If seedcorn maggots have been a problem in past years, several steps to prevent future outbreaks include the disking or plowing cover crops into the soil at least four weeks before planting. This allows the organic matter to decompose before the seeds are planted. Planting should be done in warm soils to speed up germination and to shorten the period that the crop is susceptible to damage. Insecticidal seed treatment must follow if plowing cover crops early enough is difficult and when the soil is too cool for rapid germination. Scouting is not recommended because there are no control measures once an outbreak occurs.

Striped and spotted beetles

Description: Striped cucumber beetles (*Acalymma vittatum*) and spotted cucumber beetles (*Cerotoma trifurcata*) are serious pests of watermelon

crops. Both insects are yellow-green in colour and 0,20 cm long. The striped cucumber beetle has three black stripes running the length of its back while the spotted has 12 black spots on its back. The adult striped cucumber beetle resembles the corn rootworm beetle, which can often be found feeding on the pollen of cucurbit blossoms later in the summer. The cucumber beetle has a black abdomen while the corn root worm has a yellow-green abdomen.

Life cycle: Striped cucumber beetles overwinter as adults in protected areas. They become active in mid to late May. After mating, the female lays eggs in the soil at the base of cucurbits. The beetles are attracted to the cucurbitacin produced by the plants. Once the eggs hatch, the larvae feed on plant roots for two to three weeks. They pupate in the soil. Spotted cucumber beetles do not overwinter. Adult beetles migrate into the state in early to mid-July. Because they arrive later in the season, they pose less of a problem than their striped counterparts.

Damage: Feeding damage by the striped cucumber beetle larvae can stunt or kill off seedlings or transplants. Adult beetles feed on the above-ground plant parts and fruit. More importantly, these beetles spread the bacteria that cause bacterial wilt. This disease plugs the water-conducting vessels of the plant, eventually resulting in plant die off. The adult cucumber beetles are such efficient carriers (vectors) of the bacteria that serious crop damage can occur even if only 10% of the beetles are infective.

Management: Scouting the fields two to three times a week early in the season for early migrants and the early emergence of the overwintering population is necessary. Beetles are usually localised in the field and spot treatments are effective. Some growers plant a row of vine crops near the upwind edge of the field on yellow or gold plastic mulch. This coloured mulch attracts cucumber beetles to the crops in that row where they can be killed or removed. Watermelon is not susceptible to bacterial wilt, so treatment should only be done to prevent heavy feeding damage. Insecticides kill bees, so spraying late in the day or at night protect these important pollinators. Discontinue treatments after the initial peak declines as the insecticides may reduce fruit set or cause flowers to abort.

The silverleaf whitefly

Bemisia tabaci Biotype B (also known as *B. argentifolii*) causes direct feeding damage to watermelon and fruit contamination *via* honeydew deposits that support growth of sooty moulds. Silverleaf whitefly is also a vector of

two virus diseases (Cucurbit yellow stunting disorder and Cucurbit leaf crumple) that affect watermelon yield and quality.

Control measures

In cases of serious infestations, it may be a good idea to replace infested plants with plants that are not attacked by whiteflies. Destroy infested weeds around the area. Pigweed, ground cherry, and bindweed are known to support silverleaf whiteflies. Transplants should be inspected for whiteflies before bringing them into an unaffected area. Vegetable plants should be destroyed at harvest to eliminate potential hosts.

On the mainland, planting times may be adjusted so that seasonal high populations of silverleaf whiteflies or migrating silverleaf whiteflies can be avoided.

Aphids (*primarily* Aphis gossypii)

Aphids do not cause serious direct injury to cucurbits, but various species of aphids can transmit virus diseases to cucurbits. The use of resistant varieties is the only reliable control measure for diseases caused by viruses. Aphid feeding may result in leaf distortion. Honeydew (a special name for faecal matter of aphids) may also serve as a growing medium for sooty mould, a fungus that can disfigure the fruit with black blotches.

Cultural control

- Reflective mulches may help to repel aphids while also providing horticultural benefits.
- Separate later planted fields from existing fields.
- Natural enemies will help keep aphid populations in check but will be less effective in very hot weather when aphids reproduce rapidly. Refrain from using broad-spectrum insecticides.
- Eliminate virus host plants such as burdock, pokeweed and other perennial broadleaf weeds.

Materials approved for organic production

Unless virus diseases are a problem, such as in late crops, aphid control is generally not needed. Even in this case, the best control is to eliminate virus host crops, rather than treat for aphids and cutworms.

Squash bug (Anasa tristis)

The squash bug sucks sap from the leaves and stems of squash and watermelon and causes the leaves to wilt and then turn black and crisp. This insect can also feed directly on the fruit and cause severe damage. The adults are dark grey. They live through the winter in protected areas both under debris in the fields and in buildings and lay eggs on the underside of leaves in the spring and summer. The eggs hatch into light-green or grey nymphs that congregate on leaves or fruit.

Cultural control

- Different cucurbits vary in their susceptibility.
- Crop rotation and sanitation are very important. Avoid leaving cucurbit crop debris available for overwintering sites. Till debris under in the fall and plant a cover crop. Keep headlands mowed. Next year plant cucurbits in a new field.
- During the summer, adults tend to congregate under shelter at night. Place boards on the soil surface near the squash bugs in the evening and the next morning collect and destroy the pest.
- Destroy egg masses on the underside of leaves.
- A parasitic fly, *Trichopoda pennipes*, affects adult squash bugs and several wasps parasitise the eggs. Provide a habitat for these in or near the field.
- If squash bugs are a problem on your farm, avoid heavy mulch or no-till in susceptible crops such as zucchini. Squash bugs like shelter and appear more numerous in reduced tillage or mulched crop systems.

Materials approved for organic production

- Pyrethrum on young nymphs
- Neem (two of three recent studies show good control)

Disease control

Watermelons are susceptible to several diseases that attack the roots, foliage and fruit. Disease control is essential in the production of high-quality watermelons. A preventive programme that combines the use of cultural practices, genetic resistance and chemical control as needed usually provides the best results.

Cultural practices are useful for limiting the establishment, spread and survival of pathogens that cause watermelon diseases.

Many of the fungal, bacterial and nematode pathogens survive in old crop debris and in soil. Fields should be rotated with non-cucurbit crops for at least three years to reduce pathogen levels.

Grass crops are ideal for rotations where nematodes are a problem. Fields with the proper soil characteristics should be selected.

Verticillium wilt (Verticillium dahlia *and* V. alboatrum)

This disease may be a problem. Verticillium wilt causes yellowing of the foliage and wilting. In severe cases entire plants may die off.

Fungicides are generally not economical for control of Verticillium wilt.

The disease may be controlled through the use of resistant cultivars and pathogen-free plants. Among the recommended cultural measures for preventing the disease are: removal of diseased plants or plant debris and the careful use of nitrogen containing fertilisers. Soil solarisation (by covering the soil with transparent polythene sheets during summer) in sunny climates also can be helpful. The method could be applied with low doses of soil fumigants.

Fusarium wilt (Fusarium oxysporum *f. sp.* neveum)

Race 1 is present in many soils. It typically affects runners on one side of the plant, but in advanced stages it may cause the wilting of the entire plant. Watermelon varieties with resistance to Fusarium Race 1 are available but may be ineffective in soils with a high Fusarium Race 1 population. The reduction in canopy coverage that occurs in response to infection by soilborne pathogens exposes fruit to sunburn.

Control measures

- Avoid acid soils or fields with a history of Fusarium wilt or root rots/vine declines. Late plantings should not be situated nearby and downwind of early planted cucurbit fields where foliar or virus diseases already exist. Avoid the movement of contaminated soil or plant debris into clean fields on workers or equipment. Diseases such as anthracnose, bacterial fruit blotch, gummy stem blight, and Fusarium wilt are known to be carried on seed. This can lead to rapid disease development and spread in

greenhouse transplant production and to the introduction of diseases into fields. Purchase seed from reputable sources and apply a fungicide seed treatment prior to planting. Carefully inspect plants to ensure only healthy ones are transplanted into fields. Most foliar diseases are spread by water-splash or are favoured by long periods of leaf wetness.

- Use drip irrigation or avoid frequent sprinkler irrigation with small volumes of water. Finally, use tillage practices that promote the rapid decomposition of old vines and melons soon after harvest.
- The use of disease-resistant varieties is an economical means of controlling diseases. Several varieties have resistance to Fusarium wilt.

Powdery mildew (Podosphaera xanthii)

This disease can rapidly cover leaves, causing reduced crop growth and premature defoliation. Subsequently, losses in fruit yield and quality (owing to sunburn) may occur. Repeated fungicide applications are often necessary to avoid economic damage owing to powdery mildew. Selection and rotation of effective fungicides is critical for controlling powdery mildew epidemics, especially in growing areas where fungicide resistance in the *P. xanthii* population has been reported.

Charcoal rot (Macrophomina phaseolina) *and Monosporascus vine decline* (Monosporascus cannonballus)

These soilborne diseases are most often observed when temperatures are high and plants are stressed. Both diseases frequently occur in the desert.

Death of crown leaves combined with grey stem lesions are symptoms associated with charcoal rot. Monosporascus vine decline may cause complete canopy collapse when fruit are two to three weeks from harvest. Structures diagnostic for *M. cannonballus* can be seen as small, black, round structures protruding from the dead root tissue of affected plants.

Control measures

There are no control measures currently recommended for charcoal rot. Cultural practices such as rotation, deep plowing and maintenance of soil moisture have not been effective. There has been little or no effective disease control by using solarisation or fumigation. Charcoal rot may be found in the same fields at the same time as Monosporascus vine decline, and control measures recommended for this vine decline may also be beneficial in reducing charcoal rot.

Aphid-transmitted viruses

Cucumber mosaic virus (CMV), papaya ringspot virus (PRSV-W), watermelon mosaic virus (WMV) and zucchini yellow mosaic virus (ZYMV) are aphid-transmitted viruses that cause leaf distortions and mosaics. Yield losses are mostly associated with mixed infections (two or more viruses) and virus transmission at early stages of crop development.

In addition to mineral oil sprays to interfere with virus transmissions and insecticides to control aphid populations, resistant cultivars can effectively control WMV.

Cucurbit yellow stunting disorder virus (CYSDV)

This vrus is transmitted by the whitefly. This virus causes severe yellowing of the leaves and is moved in symptomless watermelon transplants.

Cultural control

Destroying infected cucurbit plants and removing overwintering crops early in the spring prior to the emergence of adult whiteflies may prove useful. To be effective, this sort of control measure should be applied over an entire area and preferably where there is no continuous production in glasshouses, as these are often the sites of whitefly activity and active virus spread throughout the year. Weeds in and surrounding glasshouses should also be destroyed as they could act as hosts for *B. tabaci*.

Sudden wilt

This disease is characterised by premature plant die off that frequently occurs after fruit set. The precise cause is not well determined, but a complex of environmental conditions and pathogen species, including Fusarium, *Rhizoctonia*, and *Pythium*. may be implicated. Extreme waterlogging or drought conditions that reduce plant resistance can contribute to watermelon sudden wilt.

The disease is unpredictable. The development of the disease occurs so quickly and without warning that control measures are impossible to implement. Practising long-term rotation (at least 2 to 3 years out of cucurbits) to help prevent the build-up of these pathogens is best recommended. For Pythium control, provide good drainage and avoid excessive soil moisture by extending the intervals between irrigations and avoiding long irrigation periods. Fungicides have not proven effective in controlling sudden wilt.

Foliar diseases

Management of foliar diseases such as anthracnose, downy mildew, Cercospora leaf spot, and gummy stem blight may require fungicide sprays. Fields should be monitored at least weekly for the early detection of disease. Late-planted fields are most vulnerable to foliar diseases. Spray programmes should be initiated shortly after the first appearance of disease or beginning at flowering to prevent disease in late plantings. A 14-day schedule has been effective in most instances, although a 7-day schedule may be required where downy mildew is severe.

Other cultivation practices

Pollination

One to two bee colonies per hectare should be placed in the field when male flowers begin to appear. Poor pollination often causes misshapen fruit. A watermelon plant seldom produces more than two to three harvestable fruit. While it is too expensive to remove all excess fruit, misshapen and split fruit may be selected in the field to allow the plants to channel nutrients into producing marketable fruit. Care must be taken to prevent the bee colonies from being exposed to pesticides.

Windbreaks and plant support

Soil preparation and fertiliser application well in advance of planting promotes improved seedbed moisture and firmness. In addition to plowing and disking, subsoiling beneath the row promotes deeper rooting in soils having a compacted layer. Where winds are a problem, windbreaks of fall-planted wheat or rye or spring-planted hybrid sudan will provide some protection to young plants. The windbreak crop between the rows is cultivated or disked out as the watermelon vines begin to run. A narrow windbreak strip can be left standing between rows for wind protection later in the season, but it should be undercut or killed with chemicals to reduce competition with the watermelon crop.

It is important that the windbreak be early enough, wide and tall enough to provide protection just after the watermelons emergence. Late-planted windbreaks do little good when they are needed most. The greatest wind protection is achieved close to the windbreak row. Little protection is achieved when windbreaks under 1 m tall are farther than 9 m from the watermelon plants.

Field scouting for plant and pest development

Fields should be scouted at least once a week after planting by walking across the entire field in a V-shaped or X-shaped pattern and recording plant development, and weed and insect occurrence and numbers. Results of surveys will be needed to make decisions regarding projection of harvest date, the need to bring in honeybees for pollination and pest control.

If known, scout for diseases in areas of a field where diseases tend to appear first. Otherwise, use the sampling plan outlined for insects. Some foliar diseases will first appear where air circulation is reduced and leaves remain wet, such as in low areas and along borders sheltered by trees. Foliar diseases typically appear first on crown leaves close to the base of the main stem. Shaded crown leaves often die off and can be mistakenly identified as diseased. Root diseases tend to appear where the soil remains wettest, such as in low-lying areas and in heavier soils.

Fruit pruning

Fruit pruning in watermelons should begin as soon as defective melons are noticed. Remove misshapen and blossom-end rot fruit to promote additional fruit set and better size of the remaining melons. If a market demands larger melons, remove all but two or three well-shaped melons from each plant. To avoid disease spread, do not prune melons when vines are wet.

Physiological disorders

Physiological disorders are caused by non-pathogenic agents that affect fruit quality. Usually, aesthetic quality is degraded. The cause can be either one or a combination of environmental, genetic, or nutritional factors.

Fruit disorders

Misshapen melons (gourd-necked or bottlenecked) are frequently produced by varieties with long fruit. Moisture stress is a cause. Occasionally melons of any variety may be misshapen because they lie on uneven ground or were damaged while small in size.

Misshapen or pear-shaped fruit can also be caused by poor pollination that leads to restricted growth at the stem end because of the absence of developing seeds. Poor pollination can be minimised by increasing the

number of beehives in the field. Low temperatures can also cause misshapen fruit.

Blossom-end rot is a deterioration of the blossom end of the fruit. The usual order of development is softening, slight shrivelling, browning, blackening with extensive shrivelling, and sometimes secondary decay. Poor calcium nutrition and moisture stress cause blossom-end rot. Hot, dry winds, nematode damage, excessive fertiliser, low levels of calcium in the soil, pruned roots from late cultivations and other conditions are contributing factors.

Bursting may result from an uneven growth rate, which is particularly associated with heavy rainfall or irrigation when the fruit is maturing. The percentage of bursted fruit is usually low, and types with round fruit are more susceptible.

White heart is white streaks or bands of undesirable flesh in the heart (centre) of the fruit. This is caused by excessive moisture (and probably too much nitrogen) during fruit maturation.

Hollow heart is a disorder that varies among varieties. Hollow heart is marked by cracks in the heart of the watermelon fruit owing to accelerated growth in response to ideal growth conditions facilitated by ample water and warm temperatures.

Sun scald (burn) results from exposure to intense solar radiation that leads to dehydration and overheating damage of the rind tissue. Sun scald can be alleviated by covering the fruit with vines or straw material.

Sunburn occurs most frequently in varieties that have dark-green rinds. Charleston Gray types and other melons with grey-green rinds rarely suffer from sunburn. Good, healthy foliage will minimise sunburn damage as well as favour good yields and quality. Strong winds can blow unprotected vines away from the developing fruit along the edges of the rows and cause full exposure of the fruit to the sun.

Rind necrosis is an internal disorder of the watermelon rind. Symptoms are brown, corky, or mealy textured spots on the rind which may enlarge to form large bands of discoloration that rarely extend into the flesh. Experienced pickers often can detect affected melons by the subtle knobbiness that is visible on the surface of affected melons. The cause of rind necrosis is unknown. Bacterial infection has been reported to be a cause, although similar bacteria are found in healthy melons. Drought stress also is reported to predispose melons to rind necrosis.

Cross stitches are elongated necrotic wounds (2 cm long) that are perpendicular to fruit length. The cause of cross stitches is unknown.

Thinning

Thinning should be done on watermelon seedlings in each hill, namely two seedlings one week after they have germinated.

Harvesting

Determining optimum maturity of a watermelon can be difficult. Watermelons reach harvest maturity five to six weeks after pollination, depending upon variety and season. Varieties may differ in certain characteristics that indicate maturity. An experienced person can identify a ripe melon just by glancing at the glossy rind surface. Other indications of ripeness include a change in the colour of the ground spot from white to light yellow; a change of tendrils nearest the fruit from green to brown and dry; thumping the fruit, a metallic, ringing sound indicates immaturity and a more muffled or dull sound indicates maturity or overmaturity. Thumping is a reliable method to detect overmaturity in round-shaped melons. The best method is to cut a few melons in various parts of the field. Harvesting and marketing green or overripe melons lessens the demand by the consuming public. Sugar content does not increase after harvest; however, a red colour will continue to develop after a slightly immature melon is picked.

Harvesting methods

Watermelons do not slip from the vine or emit an odour when ripening, unlike muskmelons. Indicators for picking watermelons include colour change (the most reliable), blossom-end conditions, rind roughness and drying of the nearest tendril to the fruit (less reliable). A sharp knife should be used to cut melons from the vines; melons pulled from the vine may crack open. Harvested fruit is windrowed to nearby roadways, often located 10 beds apart. A pitching crew follows the cutters and pitches the melons from hand to hand, then loads them in trucks to be transported to a shed. Melons should never be stacked on the blossom end, as excessive breakage may occur.

Loss of foliage covering the melons can increase sunburn. Exposed melons should be covered with vines, straw, or excelsior as they start to mature to prevent sunburn. Each time the field is harvested, the exposed melons must be re-covered. Most fields are picked at least twice. Some

fields may be harvested a third or fourth time, depending upon field condition and market prices.

Harvest recommendations

Melons should be cut from the vine rather than pulled, twisted, or broken off to reduce the chances of stem decay. Leave a long stem on the fruit. To avoid bruising melons, handle carefully at all times. Never stand melons on end to avoid bruising and flesh separation from the rind. Do not place melons with the bottom sides turned up as the ground spot is easily sun scalded. Haul melons from the field in straw or paper-padded vehicles to reduce bruising, punctures and rind abrasion. To help prevent bruising, do not allow field hands to ride on top of the load. After harvest, load melons directly into trucks for shipment to the market or haul them to a central grading station for reloading and shipment. Melons are usually graded and sized during the loading operation. Traditionally, melons have been bulk hauled in trucks. The use of containers has gained popularity because they are more efficient in unloading and damage related to rough handling during loading and unloading is reduced. Bulk bins made of corrugated fibreboard and holding around 450 kg as well as cartons holding three to five melons are used.

Harvest indexes could be used

- Tapping—a dull or hollow sound is an indication of maturity.
- Colour—the fruit part resting on the ground becomes a distinct yellow patch as in sugar baby.
- Tendril right behind each fruit is dried down up to the base.

POST-HARVEST HANDLING

Sorting and grading

Seeded melons are sorted and packed in large, sturdy, “tri-wall” fibreboard containers. The melons are sorted according to grade: number 1, 6,4 to 11,8 kg, and number 2, 3,6 to 6,4 kg. Inferior melons may be sold at nearby markets; rejects (discoloured, misshapen, sugar-cracked, blossom-end rot and insect-damaged fruit) are discarded. Containers that hold 60 to 80 melons and weigh 500 kg to 545 kg are shipped on flatbed trucks to terminal markets or wholesale receivers. The containers are covered to prevent sunburn in transit.

Seedless melons are sorted according to size and packed in cartons containing 3, 4, 5, 6, or 8 fruit. “Fours” and “fives” are preferred sizes; “sixes” and “eights” are common later in the season after the crown-set melons have been removed from the vine. The rough gross weight of a carton is 18 kg to 23 kg. Seedless melons may also be sold in large bulk containers.

Personal seedless watermelons are sorted by size and packed in single-layer boxes containing 6, 8, 9, or 11 fruit. Shipping boxes roughly weigh 15 kg and arranged 50 boxes per pallet.

Packaging

The seeded melons are sorted and packed in large, sturdy, “tri-wall” fibreboard containers. The melons are sorted according to grade and number. Bins hold 60 to 80 melons and will weigh 500 kg to 550 kg. Two-third bins hold about 360 kg of melons. Discoloured, misshapen, sugar cracked, blossom-end rot, and insect damaged fruit is regarded as culls, but still may be sold to nearby markets.

The containers are loaded on flatbed, 18-wheel trucks destined for terminal market resale. The tops of the containers should be covered to prevent sunburn in transit. Watermelon sales usually are based upon a 1% to 2% shrink, because of breakage. The buyer is responsible for supplying bins and lids or the shipper will send a bill for the cost of these items.

Seedless watermelons are sorted according to size and packed in cartons containing 4, 5, 6, or 8 fruit. “Fours” and “fives” are preferred sizes. “Sixes” and “eights” are common later in the season after the crown-set melons are removed from the vine. The rough weight of a carton is 18 kg to 23 kg. Some bins and cartons have high-resolution graphics for logos that may increase overall cost.

Storage

Watermelons are not adapted to long-term storage. Normally the upper limit of suitable storageis about three weeks. However, this will vary from variety to variety. Storage for more than two weeks triggers a loss in flesh crispness.

Storing melons for several weeks at room temperature will result in poor flavour. However, when fruit is held just a few days at warmer temperatures, the flesh colour tends to intensify. Sugar content does not change after harvest. Watermelons’ flesh will tend to lose its red colour if held too long at temperatures below 10 °C.

Watermelons may lose crispness and colour in prolonged storage. They should be held at 10 °C to 15 °C and 90% relative humidity. Sugar content does not change after harvest, but flavour may be improved because of a drop in acidity of slightly immature melons. Chilling damage will occur after several days below 5 °C. The resulting pits in the rind will be invaded by decay-causing organisms.

Market preparation

Watermelons usually are sold by the hundred-weight at harvest time. The bulk of the commercial crop is shipped out. Many are sold from smaller plantings through temporary or permanent roadside stands or at farmers' markets. Some growers sell their fields to shippers or brokers as harvest time approaches. An important consideration in successful marketing is to have adequate facilities for transporting the crop to market outlets. Although earliness usually results in higher prices, quality and maturity should be of prime importance in marketing watermelons.

PRODUCTION SCHEDULE

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

UTILISATION

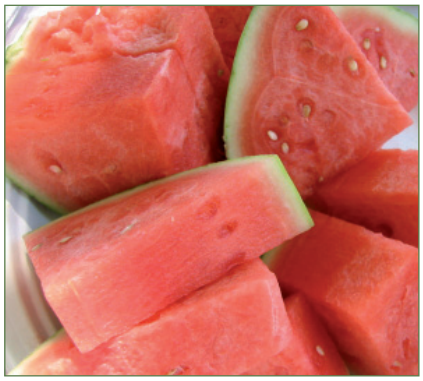
Uses

The entire watermelon is edible, even the rind. In places like China, the watermelon is stir-fried, stewed and often pickled. In this case, the watermelon is being used as a vegetable. Pickled watermelon rind is also widespread in Russia (Wikipedia 2006).

Its fruit, which is also called watermelon, is a special kind referred to by botanists as a pepo, a berry which has a thick rind (exocarp) and fleshy centre (mesocarp and endocarp). Pepos are derived from an inferior ovary and are characteristic of the Cucurbitaceae. The watermelon fruit, loosely considered a type of melon—although not in the genus *Cucumis*—has a smooth exterior rind (green, yellow and sometimes white) and a juicy, sweet interior flesh (usually pink, but sometimes orange, yellow, red and sometimes green if not ripe). It is also frequently used to make a variety of salads, most notably fruit salad.

Nutritional value

Sweet, juicy watermelon is actually packed with some of the most important antioxidants in nature. Watermelon is an excellent source of vitamin C and a very good source of vitamin A, notably through its concentration of beta-carotene. Pink watermelon is also a source of the potent carotenoid antioxidant, lycopene. These powerful antioxidants move through the body neutralising free radicals. Free radicals are substances in the body that can cause a great deal of damage. They are able to oxidise cholesterol,



making it stick to blood-vessel walls, where it can lead to heart attacks or strokes. They can add to the severity of asthma attacks by causing the airways to clamp down and close. They can increase the inflammation that occurs in osteoarthritis and rheumatoid arthritis and cause most of the joint damage that occurs in these conditions, and they can damage cells lining the colon, turning them into cancer cells. Fortunately, vitamin C and beta-carotene are very good at getting rid of these harmful molecules and can prevent the damage they would otherwise cause.

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Further information can be obtained from:

Directorate Plant Production, Division: Vegetables
Private Bag X250
PRETORIA 0001

Tel +27 12 319 6072
Fax +27 12 319 6372
E-mail DPP@daff.gov.za