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Organic processing tomato production

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INTRODUCTION

Processing tomatoes differ from those grown for the fresh market. They tend to be thicker skinned and less acidic and have a lower water content and higher pulp content than fresh market types. They are grown unstaked on beds, often in double rows.

Large-scale monoculture production is a feature of conventional processing tomato operations. Processing tomatoes are mechanically harvested and transported in bulk carriers to processors. Organic production on the same scale is unlikely to be successful. However, careful field layout involving intercropping with other species or staggering plantings could increase the scale of operations and extend the harvest period.

Organic producers sell directly to wholesalers or processors or carry out some form of on-farm value-adding.

A large range of processed organic tomato products is produced. This includes pasta sauces, salsas, juices, ketchup, baby food, tinned whole and pieces, dried tomatoes and pastes.

Most of the organic processed tomato products currently on the Australian market are imported.

ROTATION DESIGN

Tomatoes belong to the botanical family *Solanaceae*. Other members in the family include eggplant, capsicum and potatoes. Rotation design should avoid preceding tomatoes with other solanaceous species, thus reducing the potential for pest, disease and weed carryover. Rotation to non-solanaceous crops for three years is usually recommended to avoid pest problems common to this group of vegetables.

If an intensive market garden regime is practised or where long rotations are impractical, green manuring should be implemented. This practice will help to increase organic matter, biological activity and nutrient reserves prior to cropping and will also favour the suppression of soil-borne diseases. A green manure grown prior to planting should be well incorporated, with minimal crop residue apparent before planting the tomatoes.

Ideally, a green manure should consist of a range of deep and shallow rooted herb, legume and grass species. Sod crops preceding tomatoes — such as grass pasture and small grains crops — may result in heavy cutworm and/or wireworm damage to tomatoes.

Organic whole peeled canned tomatoes – one of the processed tomato product opportunities available to Australian organic producers.

Some producers practice long rotations where the tomato crop is preceded by a 3-year legume-based pasture or lucerne crop. In this instance, nitrogen requirements of the tomato crop should be met by ploughing down the pasture or lucerne well before planting, allowing adequate time for decomposition and ground preparation.

Tomatoes have a relatively shallow root system, extending down to around 30cm. It may be good practice to follow the rotation with a deeper-rooted species able to extract nutrients from deeper in the soil profile.

Paddock layout could include tomatoes interplanted with insectary species. This practice involves interplanting the main crop with species thay are more attractive to pests than the main crop (also known as trap cropping) or that provide a food source (such as nectar) for beneficial species, which migrate into the main crop and predate on pests.

Trials in cotton have shown pest control benefits from interplanting cotton with 20 x 1m rows of lucerne (totalling 4% of the area planted). Research investigating layout of chickpeas as a trap crop for *Heliothis armigera* in cotton has shown that blocks of chickpeas are more effective than strips or patches.

More research needs to be undertaken on suitable species for interplanting in tomatoes and on the ratio of main crop to insectary crop for optimum benefit.

VARIETY SELECTION

Choice of variety will depend on market demand, regional adaptability, disease resistance and the end use of the product. For example, the Roma type is the market preference for drying, while tomato paste processors require a product with high total soluble solids (TSS).

The crux of successful organic production of processing tomatoes can often be resistance or tolerance to disease. Some diseases may be more of a problem than others in your district, so you should ensure that the variety you choose has been bred for tolerance or resistance to these diseases. Seed supply companies will be able to provide this information.

CROP NUTRITION

Nutritional requirements of processing tomatoes are met organically by a range of practices such as green manuring, cover crops, livestock manures and composts, lime, mineral rock dusts, commercial organic fertilisers and foliar sprays.

Many organic sources of nutrients may take a number of seasons to become fully available, so soils should be assessed for their nutrient status a few seasons before planting the tomatoes. This is particularly the case with rock phosphate and mineral dusts. These can be added to composts.

When selecting crops to include in a green manure it is important to use a range of root systems that can explore, work and enrich the soil. Shown here, from left, are oats, faba beans and fodder rape.

Tomatoes prefer a soil with a pH of 6.0 – 6.8. Soil pH below this can be adjusted by adding natural lime to green manures or pastures before they are incorporated. If magnesium is found to be lacking, dolomitic lime should be applied.

Tomatoes require moderate to high levels of phosphorus and potassium. Advanced applications of rock phosphate should be made based on soil test results. The availability of rock phosphate in less acidic soils (>5.5 pH) in low rainfall areas can be improved by applying the colloidal form. The addition of elemental sulfur has also been shown to improve solubility; although this will also cause a moderate increase in soil acidity.

The crop's potassium and sulfur requirements can be met with applications of mined sulfate potash. Compost and seaweed fertilisers are other organic sources of potassium.

GROUND PREPARATION AND PLANTING

Primary cultivation should aim to turn under green manures or cover crops well before planting to allow for adequate decomposition.

Initially, soils should be worked deeply to ensure adequate soil depth for bed forming. Deep-ripping is advised if beds are being formed for the first time. If soils are poorly drained, adding naturally mined gypsum prior to ripping may be beneficial.

Follow-up cultivations should be slow and shallow, and should avoid bringing subsoil to the surface. This will minimise the germination of weeds.

The aim should be to produce straight, evenly spaced beds to facilitate cultural (particularly weed management) and harvest operations. Bed width will most likely be determined by machinery wheel spacing.

Once formed, beds should be irrigated if rainfall is insufficient prior to sowing to stimulate weed emergence. A final slow and shallow cultivation to remove weed seedlings usually then precedes planting.

Transplants are the most common method of planting. Transplants are preferred over seeds as they have a competitive advantage over weeds.

Transplants should be raised organically. This is a requirement of the National Standard for Organic and Bio-Dynamic Produce. If organic seedlings are not available you must provide evidence to your certifier that you have made every effort to source organic material. These should be pre-ordered (if not growing your own) at least 6 months prior to planting to ensure that suppliers can supply the variety and quantities you require.

Check transplants upon arrival to ensure they are pest and disease free. If pests or disease are present, treat with an organically acceptable pesticide prior to planting. Transplants should be hardened-off after delivery and pre-watered prior to planting.

Transplants are generally planted by machine, although hand planting may be considered for smaller areas. To avoid stimulating weed germination, aim for minimum soil disturbance during planting.

Plants should be placed 40cm apart in straight, evenly spaced double rows. Tomatoes should be watered-in as soon as possible after planting.

Planting in double rows makes efficient use of soil nutrients and encourages rapid coverage of the bed surface thus providing competition (shade, moisture and nutrients) against potential weed invasion. However, weed control can be more difficult between the two rows.

Alternatively, the tomatoes could be planted in single rows and undersown with a leguminous green manure crop. Suitable species could include dwarf red and white clover.

Undersowing is best done 4 weeks after planting tomatoes to ensure they are well established. You will need to flame or cultivate any weeds that emerge in this intervening period. The clover should be sown in a weed-free seedbed.

Careful water and nutrient management will be needed to ensure competition between the cover crop and tomatoes does not occur.

Compost is an important addition to an organic soil management program. This compost was produced at the Yanco organic demonstration site.

WEED MANAGEMENT

Weed management begins well before planting. If planting in a previously uncropped field, you should select one that is relatively weed-free. This is particularly important with difficult to manage weeds such as nightshade or weeds with persistent seed banks such as Bathurst burr.

If the tomatoes are part of an ongoing rotation, weed ‘cleaning’ crops such as short season vegetables or green manures should precede the tomato crop.

Weeds in areas bordering the field should be controlled, particularly if they are hosts for thrips or aphids as these may transmit diseases to the crop.

Irrigation as a weed control method

Beds should be pre-irrigated or have received rainfall prior to planting to stimulate weed germination. Germinating weeds are then controlled by shallow cultivation or flaming prior to planting.

Sub-surface drip irrigation can minimise weed competition. The drip line should be buried at, or just below, rooting depth. You may need to compromise slightly with the depth as the drip line will remain in

The Weedfix® cultivator is an effective implement for controlling post-emergent weeds in row crops.

the soil for a number of seasons and crops following tomatoes in the rotation may have a different root depth.

Soil type will also dictate the depth at which the drip line should be laid. Crop type and soil type will also dictate the distance between in-line emitters in the drip line. If unsure, you should seek advice from the drip line supplier or a NSW Agriculture Irrigation Officer. NOTE: Some drip line is impregnated with herbicide, so be sure to specify when purchasing that this is **not** required.

Post-planting weed control

The critical period for weed management occurs during crop establishment and until the tomato crop canopy closes over the bed. Following planting, emerging weeds can be flamed or interrow cultivated. Weeds emerging within the plant row may require hand removal (chipping) at least until the crop canopy closes.

Once the crop canopy closes over the bed, little — if any — weed management is usually required. Weeds in the furrows between beds may be mechanically cultivated or flamed.

The application of surface mulch may also be considered to suppress weeds and to conserve

Mulching can help inhibit weed emergence and retain moisture. This oat crop has been slashed to form a mulch over beds prior to sowing.

moisture. Non-synthetic woven or processed materials or organic mulches such as straw, hay, sawdust and rice hulls are suitable. Equipment is available to mechanically lay some commercial mulch. These should be laid prior to transplanting.

Organic mulches should be maintained in a layer 10cm or deeper, and are generally applied after planting so not to interfere with equipment. If surface mulch is applied, drip irrigation can be placed under the mulch on the bed surface.

INSECT PEST MANAGEMENT

Effective pest management can only be achieved through monitoring and correct identification of the pest and predatory species. An understanding of the pest's (and predator's) lifecycle will help you to plan and design an integrated pest management strategy.

Monitoring for the presence of pests and predators should start before planting — in surrounding fields, on weeds and in the soil. The presence of pests that live in the soil (such as wireworms) can be determined by soil sampling. Sticky traps, baits and light traps located around the field will help to monitor the presence of flying insects. Crop monitoring should be done at least weekly.

Beneficial insects are very susceptible to insecticides, so care must be taken to reduce drift from neighbouring properties. Some organic farmers plant windbreaks or arrange with their neighbours to sow crop buffers such as sorghum along the boundary. *Casuarina spp*. is very effective at reducing spray drift by trapping spray droplets.

Windbreaks also add to the biodiversity of the farm by providing shelter for smaller birds and other potential pest predators.

Major insect pests of tomatoes

Caterpillars

*Helicoverpa spp (*Heliothis). *Heliothis punctigera*, and *H. armigera* are the two most common species that damage tomatoes. While *Heliothis* larva will feed on buds and flowers of tomato plants and may also bore into the stems, it prefers fruit. Fruits that are damaged when young are most likely to rot before harvest.

Monitoring for Heliothis

All processing tomato producers monitor crops on a twice-weekly basis from planting until about two weeks before harvest. Regular monitoring for pest presence will let you know if the beneficial insects are present and if they are keeping *Heliothis* at a satisfactory level of control. Pheromone and light traps are used to monitor moth numbers, species and flight patterns.

Monitoring pest/predator build-up involves collecting random leaf samples to determine the level of *Heliothis* eggs present. The eggs are then collected and inspected

Effective biological control requires an effective system design. A Heliothis caterpillar is parasitised by a predatory shield bug in a pigeon pea trap crop.

4–6 days later to determine the level of parasitism from wasps such as *Trichogramma* or *Telenomis*. If the eggs turn black, they have been parasitised by the wasp. This enables you to determine if an organically acceptable spray is required to further reduce pest numbers. The threshold for spraying *Heliothis* in tomatoes is five viable eggs on 30 leaves or 2 larvae on 30 leaves. See Table 1 for beneficial insect and spider ratings as reported by the Department of Primary Industries, Queensland.[1]

Biological control

Mass-reared beneficial insects including *Trichogramma* wasps are available for biological control of *Heliothis*. These wasps are egg parasites of *Heliothis*. Commercially reared *Heliothis* eggs parasitised by *Trichogramma pretiosum* may be released to control *Heliothis* and loopers, although this is an expensive operation, costing around $100 per ha.

Eggs can be released in a water solution through a backpack at a rate of 8 ha / hour or over larger areas with a specially built machine, or on egg cards that are placed throughout the field. The most important consideration with *Trichogramma* release is timing. Farmers have found it is normally necessary to make two releases approximately 5–7 days apart. Monitoring is essential to determine the best time for release.

Cultural controls

It is possible to reduce the risk of *Heliothis* damage through a number of cultural practices.

Plant early. Early season crops (harvest late January / early March) are generally less prone to damage from *Heliothis*. Avoid planting late season crops in NSW.

Cultivar selection. Different tomato varieties may

[1] Deuter, P, et. al. (2000), *Heliothis in Sweet Corn*, Queensland Horticulture Institute, Gatton Research Station.

be able to tolerate different levels of insect damage. More research is required in this area.

Crop sanitation. Thoroughly cultivating the field after harvest will destroy pupation chambers (this known as 'pupae busting'). This will reduce the population of the next generation of *Heliothis*.

Insectaries and strip cropping

Strip or trap cropping is 'growing two or more crops simultaneously in different strips, wide enough to permit independent cultivation, but narrow enough for the crops to interact agronomically' (Francis, C.A., *Multiple cropping systems*, 1986, MacMillan). Strip crops, or insectaries, can be the breeding grounds for beneficial insects that migrate, are forced (for example, by cutting) or transferred (by D-Vac™ suction collection) to nearby commercial crops.

In trials conducted at NSW Agriculture's Yanco Agricultural Institute's organic demonstration site, pigeon pea has been shown to be a very effective trap crop for *Heliothis* when planted in soybeans.

Sweet corn has also shown some effectiveness as a trap crop. The egg-laying moths prefer corn to beans, tomatoes and other crops, so borders or strips of corn planted around or within the crop may reduce *Heliothis armigera* densities on the less-preferred crops. This approach is likely to only be effective if the corn is silking at the same time as the tomatoes, or other crops are setting pods or fruit. Staggered plantings would be required to ensure silking is continuous.

Organically acceptable pesticides

These include naturally occurring bacterial and viral insecticides. They can provide significant control of *Heliothis* in tomatoes if applications are well timed and frequent. Note: All products must be registered for their designated use. Minor use 'off-label' permits may be obtained by contacting the Australian Pesticide and Veterinary Medicine Authority.

The sap-suckers

Aphids, leafhoppers and thrips are sap-suckers that reduce crop vigour, fruit quality and yield. Some may act as vectors, or carriers, of viral diseases in tomatoes and other plants.

Thrips

Thrips are very tiny, slender insects that feed primarily in flowers and developing fruit. Thrips transmit the tomato spotted wilt virus (TSWV), causing tomato spotted wilt. Not all species of thrips are capable of transmitting the virus. The onion thrips (*Thrips tabaci*) is the most common vector of TSWV in Australia.

The Green Vegetable Bug (Nezara viridula) is one of the more difficult pests to organically control.

The thrips acquire the virus as they feed on tomatoes and other host plants, including weeds. Thrips are most likely to migrate to tomatoes when plants they have been feeding on have matured or dried out.

A large number of weeds and ornamentals (particularly perennials) are known to host thrips, and while removal of host weeds or those known to be susceptible to spotted wilt will reduce the risk of disease transmission, this may not be a practical solution. Anecdotal evidence suggests basil interplanted in tomatoes may help to repel thrips.

When monitoring for thrips, sampling should be done at the same time as *Heliothis* sampling. Select one tomato flower from each of the plants sampled (5 plants per location in the field). The flowers are then placed in jar with alcohol and after a few minutes the thrips will sink to bottom of the jar where they can be counted. Tapping flowers into the palm of the hand is another quicker method.

An organic spray is recommended if an average of one thrips per flower is found (5 thrips in a jar with 5 flowers). Soap, natural pyrethrum and horticultural mineral oils can be used successfully.

The common brown leafhopper (*Orosius arentatus*)

This is a brown speckled insect about 3mm long that is responsible for the spread of the mycoplasmic disease Big Bud.

Host weeds in and around the crop should be destroyed. High tomato plant populations can reduce losses due to the disease within the crop.

Aphids

These feed on the underside of leaves, causing curling and reduced growth potential. The feeding of large numbers of aphids results in excretion of honeydew that supports the growth of secondary fungal diseases. Aphids may also act as vectors of certain virus diseases of tomato. Virus transmission has been observed when lucerne is interplanted to attract beneficials.

Research has shown that reflective polyethylene mulch placed on beds before transplanting significantly reduces the rate of colonisation by winged aphids and whiteflies, and can delay the build-up of damaging numbers of aphids by 4 to 6 weeks.

Control of aphids

Common natural predators of aphids are lady beetles and their larvae, lacewing larvae, and syrphid fly larvae. Aphid parasitoids, *Aphidius* spp, can occur naturally in the field, but often only when aphids are in large numbers. *Aphidius* spp are commercially reared in New Zealand, while green lacewings *Mallada signata* are commercially available in Australia.

Organically acceptable pesticides to control aphids are sprays of insecticidal soap or natural pyrethrum. Pyrethrum is harmful to beneficials so treatment should aim to avoid their peak activity, but still contact aphids.

Organic farmers have reported good control of aphids with spray applications of garlic oil, when it is combined with mineral oil and pure soap.

Green vegetable bug (Nezara viridula)

The green vegetable bug (*Nezara viridula*), or GVB, also damages fruit through the sucking and piercing

Table 1. Beneficial insect and spider ratings (sweet corn)

Common name	Scientific name	Beneficial rating*
Wasps and ants:	**Hymenoptera:**	**+++++**
Trichogramma	*Trichogrammatidae*	+++++
Black ants	*Iridomyrmex sp.*	++++
Microplitis	*Microplitus demolitor*	+++
Telinomus	*Telinominae*	+++
Bugs:	**Hemiptera:**	**++++**
Black mirid	*Tytthus chinenis*	+++++
Pirate bug	*Orius sp.*	+++++
Apple dimpling bug	*Campylomma liebknechti*	++
Brown smudge bug	*Deraeocoris signatus*	++
Bigeyed bug	*Geocoris lubra*	+
Damsel bug	*Nabis kinbergii*	+
Spiders:	**Araneae:**	**+++**
Foliage dwellers (e.g., jumping spider)	*Salticidae*	++++
Soil dwellers(e.g., wolf spider)	*Lycosidae*	+++
Web builders (e.g., orb weaver)	*Araneidae*	++
Beetles:	**Coleoptera:**	**+++**
Ladybirds	*Coccinellidae*	+++
Carab beetle	*Carabidae*	++
Red and blue beetle	*Dicranolaius bellilus*	++
Green soldier beetle	*Chauliognathus pulchellus*	+
Lacewings:	**Neuroptera:**	**++**
Green Lacewing	*Mallada sp.*	++
Brown Lacewing	*Micromus tasmaniae*	++
Flies:	***Diptera:***	**++**
Tachinid flies	*Tachinidae*	++
Hover flies	*Syrphidae*	+

* Level of pest management in sweet corn = Low (+); Moderate (+++); High (+++++).

feeding action, although there are no reports of disease transmission through this activity. Tomato fruit that is attacked develops mottled areas.

Organic control of GVB is difficult. Release of predatory wasps and natural predation are the common control methods relied upon by organic producers. A parasitoid wasp *(Trissolcus* spp.) and parasitic fly (*Trichopoda* spp.) are two predators of GVB.

The CSIRO has conducted trials aimed at establishing the South American parasitoid, *Trichopoda giacomellii*, at sites in south-eastern QLD and northern NSW. Results indicate that *T. giacomellii* has successfully established in these regions and is now impacting on the abundance of GVB at sites in northern NSW. Ants are also known to be effective predators of GVB.

Crop nutrition. Some organic farmers apply foliar sprays when the plant is under insect attack, believing this improves plant health and renders the crop less attractive to pests. Two of the most common foliar sprays are kelp and fish emulsion.

Organically acceptable insecticides. Natural pyrethrum is a pesticide used by organic farmers to limit GVB damage. However, in trials conducted at Yanco organic demonstration site, pyrethrum did **not** give a satisfactory level of control against GVB.

Trap cropping. It may be possible to plant species that are more attractive than tomatoes to GVB. This attracts the GVB away from the crop, where they can be destroyed eg by cultivation, rolling or mulching. Suitable crops include sunflowers, soybeans and *Amaranthus*.

Cultural control. Some of the crops that are effective trap crops can also host GVB, for example, Amaranthus. You will need to weigh up whether your aim is to use these plants in a trap situation or try to control them in the area instead.

If you do not wish to use trap cropping, then plants and weeds in areas immediately surrounding the tomato crop that are known to host GVB should be controlled. Weeds known to support development of GVB include castor oil, yellow-vine (caltrop), privet and A*maranthus*. GVB has also been observed on silver leaf nightshade.

Mite pests

Two-spotted mite (*Tetranychus urticae*) and tomato russet mite (*Aculops lycopersici*) feed on the underside of leaves. Tomato russet mite also feed on the stems and on fruit. Damage is usually greater in hot, dry weather. Both mites are extremely small, best seen with a hand lens or magnifying glass.

Biological control. The predatory mites, *Phytoseiulus persimilis* and *Typhlodromus occidentalis*, and the fungus gnat, *Hypoaspis* spp are commercially available to control two-spotted mite. A small, shiny black ladybird (*Stethorus* spp.), often occurs naturally in the field and is also an effective predator.

Predators that are commercially reared and released in the crop will require a non-crop plant on which to overwinter once the commercial crop is harvested. Otherwise, annual releases will be required. Windbreaks containing a variety of species and weedy borders (that don't host pests or diseases) act as suitable overwintering sites.

Monitoring of pest and predator populations is essential to track their movement into the crop, their numbers and hence effectiveness.

Chemical control. Wettable sulfur and sulfur dusts are organically acceptable compounds are available that will control mite pests. Horticultural mineral oils can also be used successfully at rates between 0.5 – 1.0% volume of oil / vol water. Sprays should not be applied when temperatures are above 35 °C and caution should be taken to avoid spraying when predators are most active.

(Note that Japanese organic standards have recently been amended to disallow use of these, so producers need to be aware of this when considering this type of control).

DISEASES AND NUTRITIONAL DISORDERS

Organic producers should aim to select tomato varieties that are bred for resistance to disease.

Long rotations with non-related crops and improving soil biological activity through incorporation of green manures and compost will have a positive impact on reducing the incidence of soil borne diseases. Crop sanitation, by removal and composting or ploughing under of crop residues, will help to prevent disease carryover.

Compost teas could prove beneficial in control of certain bacterial and fungal diseases.

Viral and mycoplasmic diseases

Big bud

Big bud is a mycoplasmic disease that may not develop until six weeks after infection by the brown leaf-hopper (Orosius argentatus). It is more common in dry inland regions from October, particularly after hot weather forces leafhoppers from weeds and on to crops.

Symptoms appear as a thickening of stems, and a proliferation of small stiff shoots with short internodes. Roots may develop high on the stem and splitting may occur. Flower buds are greatly enlarged and do not develop properly.

Control. Weeds in and around the crop that host the brown leaf-hopper should be destroyed. Increasing tomato plant populations can help to reduce losses.

Spotted wilt

Spotted wilt is a viral disease that can cause heavy losses in spring and early summer crops. The disease is spread by the onion thrips (*Thrips tabaci*), a small yellowish brown / grey flying insect about 1mm long, and by Western Flower Thrips (*Frankliniella occidentalis).* It breeds on weeds and migrates on to tomatoes as weeds dry out. Dandelion, lamb's tongue, nightshade and thornapple are favoured weed hosts. Many ornamental plants also host spotted wilt.

Symptoms first appear 7 to 20 days after infection. Small areas of bronzing appear on the upper side of young leaves in top growth, and on older leaves as bronze spots or rings between the veins. As the disease develops the spots blacken and shrivel. Affected fruit show irregular or circular blotches as they ripen, often shrivelling and falling off.

Control. Weeds and ornamentals that may host thrips near the crop should be destroyed. Tomatoes should not be planted near flower crops.

Increasing tomato plant populations can help to reduce losses. Soap, natural pyrethrum and horticultural mineral oils can be used successfully to control thrips.

Bacterial diseases

Bacterial diseases commonly affecting processing tomatoes include bacterial canker (*Corynebacterium michiganense)*, bacterial speck *(Pseudomonas syringae* pv. *tomato)* and bacterial spot (*Xanthomonas campestris* pv. *vesicatoria*).

Sources of infection include seeds, contaminated soil (can survive in soil for up to 3 years and, in the case of bacterial speck, on plant debris for 30 weeks), and weeds (particularly blackberry nightshade, *Solanum nigrum* and thornapples, *Datura* spp.).

Control. A 4–5 year rotation between tomato crops is desirable. Seeds saved from healthy plants should be planted. If the disease status of seed is unknown it should be treated in hot water.

Host weeds in and around the crop should be destroyed. Sanitation should involve removing and burning diseased plants as they appear. Hands and tools should be washed in warm soapy water after touching diseased plants. Overhead irrigation should be avoided. Crop refuse should be deeply buried or removed for composting.

At the time of writing, use of copper hydroxide is an organically acceptable chemical control method. However, the use of copper as an allowed organic treatment for disease is currently under review. The National Standard for Organic and Biodynamic Produce (2003) states that the annual application of copper should not exceed 8 kg/ha/annum and that producers should have a staged reduction strategy in place.

Producers should check for any changes to the National Standard by looking on the web site www.aqis.gov.au/organic.

Fungal diseases

Fungal diseases commonly affecting processing tomatoes include anthracnose (*Colletotrichum* spp.), and *Phytophthora* spp. Spread of anthracnose is favoured by warm, humid conditions with temperatures above 26°C and relative humidity above 93%. *Phytophthora* commonly occurs where extremes in soil moisture occur and where drainage is poor.

Control. Anthracnose is controlled by hot water treatment of seeds, crop rotation and sanitation measures. Anthracnose is principally a disease of ripening fruit, so harvesting mature green fruit can reduce incidence. Copper hydroxide sprays may (at the time of writing) be used when fruit begins to ripen. However, producers should check before use to ensure this is still permitted.

Phytophthora incidence can be minimised by good irrigation management and adequate drainage. Maintaining high organic matter and biological activity in the soil will also assist in control of *Phytopthera*.

Nutritional Disorders

Blossom End Rot

Blossom-end rot appears as brown to black spots on the underside (blossom-end) of the fruit of tomatoes. As the fruit grows, half or more of the fruit may be affected — the fruits ripen earlier and may be prone to secondary infections.

Causes. This is primarily a nutritional disorder is caused by a deficiency in calcium, a water-soluble element. Any factors affecting water and calcium availability, or movement, into the plant will therefore contribute to the problem.

Environmental and cultural factors that contribute to the occurrence of blossom end rot include:

- poorly drained soil
- improper soil preparation and planting
- inadequate or excessive watering
- soil pH levels below 5.5
- inadequate calcium in the soil
- applying too much nitrogen
- excessive root disturbance
- use of plastic mulch instead of an organic mulch, high soil and air temperatures and low humidity.

Control. Contrary to past belief the direct application of calcium as a spray is ineffective.

A soil test should be conducted to help determine nutrient levels. Excess levels of ammonium, magnesium, potassium and sodium have been reported to reduce the availability of calcium.

The addition of limestone, gypsum or dolomite to the soil well before transplanting is recommended to overcome the soil calcium deficiency. Liming is recommended in areas with low pH (below 5.5) soils.

Maintaining the proper balance of potassium, phosphorus and other soil nutrients and avoiding excessive growth due to over-fertilisation with nitrogen is recommended.

Having a uniform and adequate soil moisture content is critical to preventing blossom-end rot. Irrigation scheduling with the aid of soil moisture probes and mulching can help to maintain optimum soil moisture for plant growth.

HARVESTING AND MARKETING

Conventional processing tomatoes are harvested mechanically to supply large processors. Vines are lifted from the field, the fruit removed mechanically and then conveyed along a sorting platform, where it is graded by field workers.

Fruit is graded according to whether it is rotten or badly blemished (rejects), mature green and red ripe. The degree of acceptable blemish will depend on your end market. For example, a higher degree of blemish will be acceptable for fruit that is to be pulped than for whole peel or dried tomato products. Some tomato growers invite hand picking for the local market prior to machine harvesting.

Markets

A large range of processed organic tomato products is currently produced. These include pasta sauces, salsa, juices, ketchup, baby food, tinned whole and pieces, dried and pastes. Most of these lines are currently imported into Australia.

Contracts for processing tomatoes are difficult to obtain unless you are an established producer. Contracts are issued before the season begins.

Organic processed tomatoes are a niche product, not yet being sourced in Australia by the larger tomato processors. However, there does appear to be potential for import replacement of processed tomato products.

Heinz Watties currently contracts New Zealand organic producers to produce processing tomatoes for their organic baby food lines. Cedenco Foods Ltd, New Zealand, is developing a number of processed organic vegetable lines. Australia has a climate more suitable for processing tomato production, so potential exists for Australian organic producers to become the preferred supplier should reliable supplies become available. Growers should investigate these opportunities.

Smaller producers could consider on-farm value-adding or supplying unprocessed product to farmers' markets, health food and restaurant outlets. Consumers often prefer the egg or Roma type processing variety. The Sydney based wholesaler and exporter, Eco Farms, has indicated interest in receiving processing tomatoes to supply smaller clients.

If processing is carried out on-farm you will need to have these operations inspected by your certifier. Your processing operation must also comply with State and Territory health regulations. The development and implementation of a Hazard Analysis Critical Control Point (HACCP) plan will help you to achieve compliance with organic standards and health regulations.

Economics

The economics of organic processing tomato production will largely depend on the market you are targeting. On-farm value-added products will return more than unprocessed tomatoes sold to a processor. However, the labour and infrastructure requirements for on-farm value-adding will be significantly greater. So, returns will largely depend on how much effort, time and initial resources you are prepared to outlay.

Returns will also depend on costs of inputs (labour, fertiliser), yield, quality, the type of market you target (fresh or processed) and supply and demand for your product.

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FURTHER READING

Organic Industry Export Consultative Committee (OIECC) 2003, The National Standard for Organic and Bio-Dynamic Produce, c/o AQIS. See the web site www.aqis.gov.au/organic.

A useful information source on pest management for processing tomato growers is the 'UC pest management guidelines — tomato', published on the web by the University of California.

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ALWAYS READ THE LABEL

Users of agricultural or veterinary chemical products *must always* read the label and any permit, before using the product, and strictly comply with the directions on the label and the conditions of any permit. Users are not absolved from compliance with the directions on the label or the conditions of the permit by reason of any statement made or not made in this publication.

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