PIP

CROP PRODUCTION PROTOCOL

CHERRY TOMATO (*LYCOPERSICON ESCULENTUM*)

COLEACP is an international network promoting sustainable horticultural trade.

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In accordance with the Millennium Development Goals, the global objective is to: "Maintain and, if possible, increase the contribution made by export horticulture to the reduction of poverty in ACP countries".

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PIP

FOR SUSTAINABLE DEVELOPMENT OF THE ACP HORTICULTURAL INDUSTRY

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Disclaimer

The document « Crop Production Protocol » (fruit or vegetable) describes all the agricultural practices linked with the (fruit or vegetable) and suggests a pests and diseases control based mainly on active substances supported by the pesticides manufacturers in the European Regulation 1107/2009 and due to comply with pesticides residues limits. Most of these active substances have been tested through a field trials programme and the residue level of each active substance has been measured. The pests and diseases control suggested is dynamic and will be adapted continuously integrating all informations gathered by the PIP. Nevertheless, each grower has the possibility to select among the products listed a set of active substances of no concern regarding residues.
It is obvious, that are allowed for usage only those formulations which have been legally registered in the country of application. It is each grower obligation to check with the local registration authorities whether the product he wishes to use is mentioned on the list of registered products

The PIP's crop protocols and guides to good phytosanitary practices are regularly updated. For further information, see the PIP website www.coleacp.org/pip

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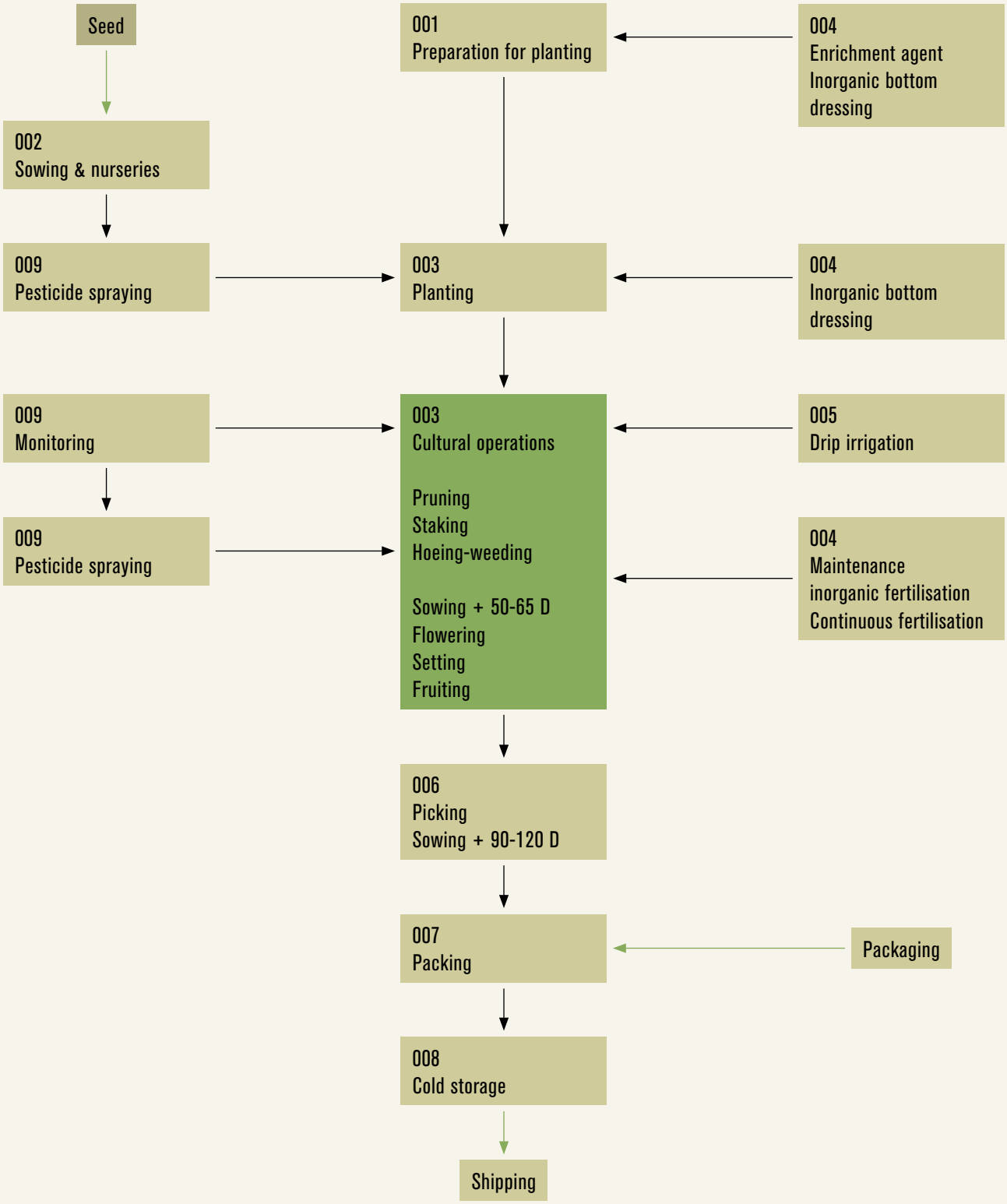
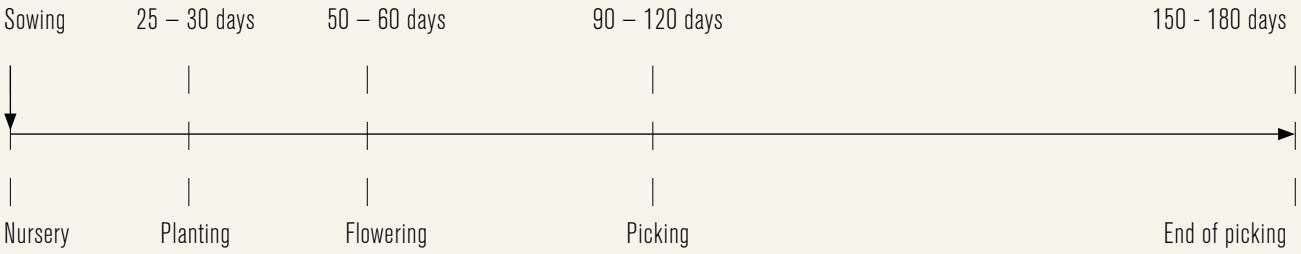


000 - Crop cycle in Senegal



Month	1	2	3	4	5	6	7	8	9	10	11	12
Senegal	■	■	■	■						■	■	■

001 - Preparation for planting

1. Soil characteristics

Tomatoes are not difficult with regard to soil type and commercial results can be good on soils of very varied textures (sandy-clayey, loamy-sandy, etc.) as long as the soil is not too compact or likely to cause asphyxiation as the plant must root deeply for good resistance to drought. Light soils (sandy loam) are easier to till than heavy clayey or clayey loam soils. In contrast, heavy soils that are richer in organic matter fix nitrogen better together with the other major elements and trace elements (they give the fruits better taste quality). They then release them more steadily over a longer period. Soils that are richer in organic matter are therefore more suitable and generally give larger harvests overall.

Tomato plants are affected by a denitrification phenomenon, a loss of nitrogen that can be taken up by the roots in heavy clayey soils that are compacted and subject to waterlogging during heavy rain or a long wet period. Soils of this type also limit plant growth. Ridge cultivation is preferable when tomatoes are grown in insufficiently drained soils with mediocre structure. The risk of denitrification arises most often in dips in the ground or in fields subject to waterlogging as a result of plough pan or where impermeable subsoil is at a depth of 25-60 cm. It is thus seen that soil structure plays a very important role in plant growth and the economic performance of the crop. Careful fertilisation will not entirely make up for the effects of mediocre soil structure.

Certain soil-related conditions (edaphic factors) must be respected to achieve good yields:

- → soil depth must be sufficient (the root system goes to depths of more than 60 cm unless the soil is too compact or liable to cause root asphyxia). Loose, well-drained soil is suitable for the crop. Soil that retains little water, that drains too freely-sandy soil for example-often results in irregular water supply to the plants; this causes in particular a physiological disease called blossom-end rot and the bursting of fruits (see below).
- → rapid drying (excess water causes risks of root and collar rot and asphyxia during germination);
- → optimum pH (H_2O) from 5,5 and 7,0;
- → relatively stable structure;
- → salinity : the plant becomes sensitive from 2.5 mS/cm, which causes decreased yield. Avoid saline soils and water. Split fertiliser application for soils with a low cation exchange capacity (CEC) to avoid excess salts and the leaching of non-fixed elements and especially nitrogen;
- → a minimum of organic matter. Apply decomposed organic matter before planting (for example along the planting rows if it is difficult to obtain large quantities).

2. Recommended/not recommended preceding crop

The position of the crop in the rotation should be taken into account (ideally, 3 years should be left between two solanaceous crops). Certain preceding crops should be avoided (see table below). Rotation is strongly recommended or at least long fallow or soil treatment for pest reasons and especially to prevent the many diseases that remain in the soil (bacterial wilt, fusarial wilt, damping-off disease, *Phytophthora*, disease caused by *Cladosporium*, grey leaf spot, etc.) and/or the proliferation of root knot nematodes (*Meloidogyne* spp.).

PRECEDING CROPS NOT RECOMMENDED	RECOMMENDED PRECEDING CROPS
tomato, eggplant, jaxatu potato, chilli peppers and bell peppers, melon, cucumber, squash, water melon, okra tobacco, onion, garlic, shallot (not favourable)	green beans, strawberry, cabbage, turnip red sorrel, cassava groundnut, grains (maize, sorghum, millet)

3. Tillage - Field preparation

→ Tomato requires the soil to be thoroughly loosened and aerated to adepth of at least 40 cm and to have homogeneous structure. Excessive disturbance of the existing soil layers should be avoided during tillage to prevent the bringing to the surface of the poorer layers more likely to cause asphyxia and colonised by different microorganisms. Soil preparation should enable the root system to spread to a depth of 40 to 60 centimetres to ensure good water and mineral supply to the plant (loose, fine soil). Any ploughing should be performed once a year and be completed before cropping by levelling and finer loosening, for example by two runs of an offset plough set at a depth of 15-25 cm.

→ Organic, lime or lime-magnesium enrichment agent are applied before ploughing so that they are turned in evenly.

→ Good soil levelling prevents the accumulation of water that could asphyxiate the plants or cause the spread of diseases. The field should be perfectly level and not too stony. Choose well-orientated flat land, preferably next to a watercourse to make watering easier. Avoid depressions that can be flooded and that can cause asphyxiation during the rainy season.

→ Ridging (performed by machine at 1.2 m intervals) or shaping (by hand) is performed in case of furrow irrigation. The ridges should be regular, 30 - 35 cm high and 25 - 30 cm wide at the top, which will be levelled off.

→ The fields must be fenced to prevent livestock from entering. It is not advised that livestock should be allowed to graze the crop residues: they can bring weed seeds or spread nematodes.

→ The false sowing technique can be used to reduce the number of weed seeds in the soil before planting. This consists of full preparation of the soil as for sowing and then watering to cause weed seeds to germinate. These are then eliminated by hoeing or chemical weedkiller.

002 - Sowing and seedling production operations

Seed requirements

Target planting density ranges from 20,000 to 35,000 plants/ha.

Given the cost of seed of F1 hybrid export cherry tomato varieties, the usual rule of planning double the quantity of seed for the number of seedlings to be planted out is not applied.

Tomato seeds are small, with 300 to 450 seeds per g.

The principle is to have a large enough number of healthy, short stocky and vigorous seedlings at planting (e.g. cv *Brillatino*, cv *Cherilino*, cv *Caramelina*).

For the planting densities mentioned (as long as the germination percentage is 90% at minimum, the sowing substrate is satisfactory and the season allows easy germination), 30,000 to 45,000 seeds will be sown per ha planted, that is to say an average of 125 g seed per ha planted, with sufficient reserve to cover all risk of loss of plants in the nursery.
The use of selected, treated seed is an excellent prophylactic method.

Choose cultivars that possess high genetic resistance or tolerance to fusarial wilt, *Verticillium* wilt and root knot nematodes in particular.

Sowing facility

The nursery should be installed in a place protected from direct sunlight, the prevailing winds and livestock. The soil should ideally be healthy, rich and flat with appropriate structure for sowing.

Sowing on prepared substrate

In soil blocks, in pots (individual or cell packs) at 1 seed per block or container.
Either soil for blocks or a clean mix of compost and sand will be used; this must be permeable and such that the block will remain in good condition.

This technique has many advantages:

- it avoids sowing in infested or exhausted soil;
- the seedlings are healthy and vigorous, less susceptible to subsequent stress and ready for planting out in a short time,
- practically 100% regrowth is assured if the conditions of planting out are good (the root hairs remain intact);
- it saves expensive F1 hybrid seed;
- any application of products (pesticide or other) is performed either directly in the substrate when the blocks are prepared or subsequently in local applications of very small amounts.

The substrates used must have:

- good porosity;
- rich organic content;
- low salinity;
- good moisture retention capacity;
- sterility with regard to pathogens and no weed seeds;
- balanced mineral content.

They must not contain heavy metals (lead, mercury, cadmium, etc.) or substances that are toxic for the seedlings (chlorine, arsenic, etc.). Avoid too high a density (this might result in small, weak seedlings and the rapid development of whitefly).

Sowing in the soil

The seedlings produced using this method are planted with bare roots and regrowth is less successful than after sowing in prepared substrate, especially when the weather conditions are unfavourable for establishment: for example when sowing is in September (rainy season in Senegal) for harvesting from December onwards.

Horizontal beds 1 m wide are prepared. They can be raised by 15 cm during rainy periods to improve drainage. They will be a maximum of 10 m long to make access and moving around in the nursery easier.

Bottom dressing is applied in sandy soil: 50 U (units or kg / ha) nitrogen – 50 U P_2O_5 – 100 U K_2O.

The application of a minimum of 30 T/ha, ideally 50 T/ha, or organic matter is desirable.

Prior disinfection may be necessary in case of infested or exhausted soil or during a period of unfavourable weather.

The soil must be prepared, loosened and pre-watered before sowing is performed.

All watering will be done with watering cans with roses with small holes. It is essential to sow in soil that is moist but not too wet and to maintain the moisture content throughout the duration of the nursery. Watering doses and frequency must be adapted according to this criterion.
Sow in rows at 20 cm intervals at right angles to the axis of the bed. Mark out and make straight furrows. Sow 50 to 100 seeds per linear metre:
- 100 seeds per linear metre during the favourable season;
- 50 seeds per linear metre during the rainy season, in very wet weather

In the light of these figures, prepare 200 to 400 m^2 seedbed per ha planted (at 125 g / ha planted).
Carefully refill the furrows with fine, loose soil and tamp lightly.

Water after sowing mulch can be placed and then removed in the evening in settled, dry weather when the cotyledons have lifted the surface of the soil.

Sowing depth

The seeds are sown at a depth of 0.5 - 1 cm in heavy soil and 1 - 1.5 cm in light soil.

Sowing must be regular to obtain homogeneous, regular emergence and as many seedlings as possible should be planted at the same time. Germination (epigeal) is 6 to 9 days after sowing (with soil temperatures of between 25 and 30°C.). Anything that carries a risk of asphyxia (heavy soil, excess water, compacted soil, sowing too deep, etc.) will compromise emergence. The latter will be irregular and the seedlings will be subject to collar and root diseases.

Sowing dates

A tomato seed sown in soil at 25-30°C germinates faster and emergence is more homogeneous. The gain is maintained until harvesting with better grouped ripening.

The scheduling of sowing dates must take many other important data into account such as shipping capacity or the duration of the crop cycle (22 to 25 weeks for cherry tomato). In Senegal, sowing must be performed in September, a hot, damp and often rainy period, for harvesting and shipping to start at the beginning of December. Sowing in September and October is particularly delicate as careful attention must be paid to the quality of the soil or substrate, the quality of the sowing operation, monitoring and crop protection.

Protection of the nursery

Particular attention must be paid to protecting the nursery against pests soil diseases and nematodes (disinfected/sterilised substrate), whitefly and other vectors of viruses (aphids and thrips). For example, insect-proof unwoven synthetic textile protection (of the Agryl P 17 + type) can be used but only when the weather is not too damp. Normal duration of the nursery: maximum 25-30 days.

003 - Crop management

1. Planting

The seedlings are ready for planting out when they have reached the 5-6 *real* leaf stage. The seedlings should be sorted at planting. Prefer short, stocky plants with large collars and that are vigorous and turgescent. They are placed in the ground in such a way that the first real leaf is about 5-10 cm above the surface on condition that the soil is loose and not liable to waterlogging. The soil is firmed around the seedling, with moderate pressure applied around the stem but without wounding or crushing it. Moderate watering is required after planting. It is preferable to avoidexcess water in the first days after transplantation to avoid the development of soil diseases (especially bacterial wilt) and to enhance root growth. It is preferable to plant out the seedlings at the end of the afternoon or when the sky is overcast in order to reduce stress. Before planting, ensure the full turgescence of the seedlings by watering the nursery sufficiently.

The ideal planting density depends on numerous factors such as the type of growth, development of the variety, the pruning method planned, the yields sought, temperature, light, etc.

Some examples of planting layouts for cherry tomato:

→ *single rows 1.20 to 1.40 m apart with the seedlings at 0.40 m intervals along the row (21,000 plants/ha) for single-truss management;*

→ *double rows 0.80 m apart (2 m from centre to centre) with the seedlings at 0.50m intervals along the row (20,000 plants/ha) for single-truss management;*

→ *double rows 0.80 m apart (2 m from centre to centre) with the seedlings at 0.80m intervals along the row (12,500 plants/ha) for double-truss management.*

Plant out either on levelled land (*mechanised cultivation, trickle irrigation*), or on ridges (*manual cultivation, furrow irrigation*), on the upper third of the side of the ridge or on the top of the flattened ridge.

2. Staking

The use of hybrid varieties with indeterminate growth, the need to harvest high-quality, regular, healthy, red fruits and a search for high planting densities and yields require the staking of export cherry tomato plants. Staking enables better aeration of the crop-foliage and fruits. It increases the cost of cropping but is compensated by higher yields, improved fruit quality and easy picking.

Staking methods can be:

- **individual**: bamboo or more frequently synthetic string around which the plant is trained as it grows. The string runs beneath the plant and attached to a horizontal line at a height of about 2 m;
- **collective**: bamboo or poles set up in 'tent' fashion and connected by bamboo set horizontally at three or four different heights. The plants are attached to the horizontal bamboos as they grow.

3. Pruning tomatoes

- Pruning tomatoes is not usually recommended as it carries the risk of the spread of certain diseases (e.g. virus diseases, bacteriosis caused by *Ralstonia solanacearum*). If it is done, tools must be disinfected regularly during the work. However, the use of hybrid varieties with indeterminate growth, with high production potential, planted at high densities and, in addition, staked, requires a minimum of sucker removal. Pruning will be necessary if the plants are grown with several stems.

- Sucker removal consists of removing any lateral growth (suckers) that grow in the axils of each leaf as soon as possible after this appears. A sucker is removed by pinching it between thumb and index finger and making a simple lateral or backward movement. This is done in the morning when the plants are turgescent and the suckers are easy to detach.

- Pruning is only performed when it is decided to manage an indeterminate growth variety with more than one stem (or truss). This makes it possible to achieve the same production while reducing the numb er of plants per ha, but the risk of the spread of certain diseases by pruning should never be ignored. Double-truss management is the most common method in this case. After planting (the plants are more widely spaced at 80 cm), the main stem is pruned at 3-4 leaves, lateral stems develop and the two most vigorous are kept to become producing stems. They are staked or trained like the main stem but spaced at 30-40 cm. These two stems should not be pruned again but the suckers are removed.

4. Deleafing

As the trusses are harvested, the leaves beneath these trusses can be removed and taken away. The technique improves the aeration of the crop and helps to maintain the sanitary condition of the crop, but the fruits must not be directly exposed to the sun; this can cause sun scorch that becomes necrotic and makes the fruits unsaleable. More damage can also be caused by birds if deleafing is exaggerated.

5. Hoeing or hoeing/weeding

Two soil maintenance operations are performed in a single run:
- hoeing: this is essential for breaking the soil crust, aerating the soil, reducing the evaporation of the water present and improving the effectiveness of watering and fertilisation;

- weeding: digging up or cutting weeds, according to their age.

These operations must be performed as soon as possible after planting (when the seedlings are established) and very regularly thereafter, especially if a crust forms at the surface of the soil. Hoeing and weeding must also be done before each application of fertiliser. They are sometimes followed by light earthing-up to initiate the growth of adventitious roots.

6. Weeding

- Manual or mechanical: hoeing/weeding operations.

- Use plant or plastic mulch, but beware in the latter case of considerable increases in soil temperature that are sometimes lethal in hot climates. Furthermore, the use of plastic mulch makes drip irrigation necessary.

7. Grubbing up / Burying after the crop

- For many reasons related to pest control, it is better not to delay the grubbing up (with roots) and removal of the plants from the field. They are then either buried, burned or composted.

- Likewise, all crop plant debris must be carefully and methodically removed immediately after the plants have been taken away.

- Do not allow livestock to graze in the fields after the end of the crop.

004 - Fertilisation

General

When the nutrient requirements of tomatoes are to be determined, most of the problems concern nitrogen. The potassium and phosphorus requirements are easier to handle. Tomato plants have extensive root systems and explore a large volume of soil to find nutrients, on condition, however, that the physical and chemical characteristics of the soil allow root penetration.

Fertilisation must be rationalised in such a way that the total dose of each nutrient perfectly matches the conditions in each field **(a full soil analysis is required** every 2-3 years). The crop requirements will be established as accurately as possible to avoid any excess application.

Total exports of the main nutrients are as follows in kg per ton of fresh fruits picked: **N: 2.5; P_2O_5: 0.9; K_2O: 5; CaO: 3 to 5; MgO: 0.7**

As the crop has a short cycle, tomatoes grown in conventional non-organic agriculture should receive inorganic fertiliser in which the nutrients can easily be taken up by the plants.
It is always necessary to balance fertilisation to prevent the occurrence of deficiencies caused by the preferential uptake of certain nutrients at the expense of others; in particular, antagonisms exist between K and Mg, Ca and K and Ca and Mg.
Fertiliser application must be split during the cropping to avoid excessive soil salinity just after fertilisation. It also reduces loss of nutrients by leaching.

Surface dressing must be performed without touching the foliage to avoid burn. It is followed by surface forking to dig in the fertiliser, followed by watering.

Organic ameliorator

The digging in of completely decomposed manure generally improves production better than solely inorganic fertiliser.
The application of fresh or not sufficiently rotted manure should be avoided as it can cause root necrosis and cause pest problems in the root system.

Whatever the crop rotation may be the aim is for the soil to be amply provided with organic matter. The presence of rotted material in sufficiently large quantities increases crop yield and improves fruit quality. Furthermore, organic matter plays a key role in maintaining soil moisture through better retention of irrigation water.

Tomato responds well to large applications of well-rotted organic matter before planting. If organic matter is rare and expensive, it is better to limit bottom dressing and turning in to the planting rows (strips 30 to 50 cm wide).
Dose : minimum 30 t/ha well-rotted manure, but 50 to 100 t/ha should be sought for soils with low organic contents.

Nitrogen (N)

Nitrogen applications are needed at the start of vegetation but never in excess, especially before flowering, to ensure a good start to vegetation. When tomato follows crops to which large amounts of nitrogen have been applied (such as cabbage) or, on the contrary, that produce large amounts of nitrogen (such as legumes), tomato plantations are more vigorous but mature later if too much nitrogen is applied. Attention must be paid to the crop rotation and to possible turning in of rotted organic matter (composted manure for example) before nitrogen is applied.
Nitrogen fertilisation should be increased in fields that have been treated with a soil fumigant so that the yield benefits fully from the treatment. In addition, fumigation may have temporarily decimated the population of soil organisms involved in the transformation of nitrogenous substances into nitrates.

Nitrogen (N) is the main nutrient involved in the quantitative growth of plants. Tomato nitrogen requirements increase gradually and become very large during the fruit production period, but excess should always be avoided.

Deficiency is shown by foliar chlorosis (pale green or even yellow colour) and a decrease in growth. **Excesses** cause in particular excessive growth, late production, failure to set fruit and increased susceptibility of the plants to various stresses (heat, water and pests).
Nitrogen is mainly taken up in nitric form (nitrates, NO_3-).
Nitrogen fertilisers can provide nitrogen in nitric (NO_3-), ammonium (NH_4+) or urea form.

The main nitrogen fertilisers are:
- urea: 46% N;
- potassium nitrate: 13% N (and 46% K_2O);
- calcium nitrate: 15% N (and 28% CaO);
- magnesium nitrate: 11% N (and 15% MgO);
- monoammonium phosphate: 12% N (and 52% P_2O_5);
- diammonium phosphate: 18% N (and 46% P_2O_5).

With total exports of 2.5 kg N per t of fruits harvested and on the basis of a target yield of 60 t/ha, **N requirements are estimated at 150 kg/ha or 150 U (units) of N**.

These data should be recalculated in the light of the richness of the soil and the availability of nitrogen by mineralisation of organic matter.
Splitting nitrogen application is the rule: one bottom dressing beforeplanting and maintenance applications during the season.
The more the soil is free-draining, the more N application should be split. In trickle fertigation (fertilisation via irrigation), splitting goes to the extreme and fertiliser can be applied at each watering.

For sandy soils and with conventional application, 1 bottom dressing and 4 maintenance applications can be proposed as follows:
- 20% as bottom dressing;
- 20% 20 days after planting;
- 25% 50 days after planting;
- 25% 80 days after planting;
- 10% 100 days after planting.

In urea form : as bottom dressing.
In ammonium form : as bottom dressing, possibly as top dressing but to be avoided after flowering (risk of flower drop).
In nitric form : only as top dressing (or sometimes to stimulate slow vegetation).

Phosphorus (P_2O_5)

Phosphorus enhances firm rooting (an important point in sandy soils). It must also be applied in a form that can be taken up from emergence onwards. It is also a factor in earliness. Phosphorus (P) contents higher than 50-60 ppm, measured by soil analysis, are sufficient for tomato and no application is necessary. Levels of 60-80 ppm P are too high for tomato. Too much phosphorus can cause zinc deficiency in the plants, in particular in sandy soil or those with low organic matter contents.

The optimum pH for P_2O_5 availability in mineral soils is 6.5. Availability decreases at 6.1 and between 6.5 and 7.4, and this requires a larger amount as bottom dressing and top dressing may be required. P deficiency is shown by weak development of the root system, dark green and sometimes violet leaf laminae, an erect habit and the browning and then fall of old leaves.

The main fertilisers providing phosphorus are as follows:
- monoammonium phosphate: 52% P_2O_5 (and 12% N);
- diammonium phosphate: 46% P_2O_5 (and 18% N);
- triple superphosphate: 45% P_2O_5 (and 20% CaO).

With total exports of 0.9 kg P_2O_5 per t of fruits harvested and on the basis of a target yield of 60 t/ha, **P_2O_5 requirements are estimated at 54 to 60 kg/ha or 54 to 60 U (units) of P_2O_5**. These data must be adjusted according to the soil phosphorus content and the application of organic matter.

The splitting proposed is based on three applications: one bottom

dressing and two maintenance applications as follows:
- 50% as bottom dressing;
- 30% 20 days after planting;
- 20% 80 days after planting.

As phosphorus has little mobility in the soil, it is applied locally and turned in close to the roots but without damaging them.

Potassium (K_2O)

Potassium (K_2O) has an effect on the production quality (taste and colour) and enhances plant resistance to diseases. Deficiency causes discoloration of the foliage, chlorosis between leaf veins, the down rolling of old leaves and defects in fruit colour.
Application of potassium is not required when soil analysis shows the content to be 250 ppm. Tomatoes may display problems of colour at levels lower than 150 ppm. A level of 250 ppm K is too high.

This can cause magnesium deficiency in the tomatoes (antagonism).
The main fertilisers that provide potassium are as follows:
- potassium sulphate: 50% K_2O (and 45 % SO_3);
- potassium nitrate: 46% K_2O(and 13 % N);
- monopotasssium phosphate: 34% K_2O (51% P_2O_5);
- patentkali: 30% K_2O (and 9 % MgO, 45% SO_2);
- potassium chloride should be avoided for its chloride content.

With total exports of 5 kg K_2O per t of fruits harvested and on the basis of a target yield of 60 t/ha, **K_2O requirements are estimated at 300 kg/ha or 300 U (units) of K_2O**. These data must be adjusted according to the soil potassium content and the application of organic matter.

The splitting proposed is based on one bottom dressing and four maintenance applications as follows :
- 30% as bottom dressing;
- 20% 20 days after planting;
- 20% 50 days after planting;
- 20% 80 days after planting;
- 10% 100 days after planting.

Patentkali, monopotassium phosphate : bottom dressing.
Potassium sulphate : bottom dressing and possibly maintenance.
Potassium nitrate : maintenance.

Magnesium (MgO)

Magnesium is thought to prevent insufficient fruit firmness. MgO deficiency may occur in acid, leached, sandy soils. The symptoms are thickening and inter-vein chlorosis of leaves. There are many causes: true deficiency in the soil, excess K_2O, root waterlogging, drought (shortage of water).
The main fertilisers providing magnesium are as follows:

- magnesium sulphate: 16% MgO (and 34% SO_3);
- patentkali: 9% MgO (and 45% SO_3, 30% K_2O);
- magnesium nitrate: 15% MgO (and 11% N).

It should be noted that magnesian lime is a very useful source of MgO and is used as a lime-magnesium soil ameliorator.
With total exports of 0.7 kg MgO per t of fruits harvested and on the basis of a target yield of 60 t/ha, **MgO requirements are estimated at 40 to 50 kg/ha or 40 to 50 U (units) MgO**.

These data must be adjusted according to the soil magnesium content and the application of organic matter.
The splitting proposed for magnesium fertilisation consists of one bottom dressing and two maintenance applications as follows:

- 30% as bottom dressing;
- 40% 50 days after planting;
- 30% 80 days after planting.

In case of real deficiency, it is also possible to perform foliar spraying of magnesium sulphate or a complete foliar fertiliser.

Calcium (CaO)

Calcium plays an important role in tomato production. For various reasons, poor calcium uptake causes blossom end rot. Some varieties and varietal groups are more susceptible to this.

The main fertilisers providing calcium are as follows:

- calcium nitrate: 28% CaO (and 15% N);
- phosphal: 11% CaO (and 34% P_2O_5);
- dicalcium phosphate: 32% CaO (and 38% P_2O_5);
- basic slag: 45% CaO (and 16% P_2O_5);
- triple superphosphate: 20% CaO (and 45% P_2O_5).

It should be noted that lime and magnesian lime are also important sources of CaO to be applied as liming.

With total exports of 3 to 5 kg **CaO per t of fruits harvested and on the basis of a target yield of 60 t/ha, CaO requirements can be estimated at 180 to 300 kg/ha or 180 to 300 U (units) of CaO**. Splitting will be revised according to whether or not liming has been carried out before planting.

With no liming, the following applications can be proposed:

- 40% as bottom dressing;
- 30% 50 days after planting;
- 30% 100 days after planting.

In case of blossom end rot or of temporary calcium deficiency, foliar spraying of calcium chloride (400 g anhydrous calcium chloride per hl), calcium nitrate (750 to 1000 g calcium nitrate per hl), a foliar fertiliser specifically rich in calcium or a complete foliar fertiliser can be applied.
Unsuitable Ca supply also tends to cause fruit splitting.

Trace elements

These are essential for a healthy, productive crop that is little susceptible to the various kinds of stress. Applications of organic matter partly make up for possible shortages of trace elements in the soil. However, it is always possible to apply them during the cropping sequence in the form of complete leaf fertiliser containing all the essential trace elements (Fe, B, Cu, Zn, Mo, Mn, Ni, Co, etc.) in a form that can be taken up immediately. Application is possible via trickle irrigation systems.

Toxic elements

Tomato is susceptible to excess salts.
Chlorine, although essential in very small quantities, is phytotoxic in larger amounts.

This is why it is advised:
- to use irrigation water with a very low chlorine content;
- not to use fertiliser containing chlorides.

005 - Irrigation

Although irrigation is often essential for attaining maximum production, tomato is **very susceptible to root waterlogging**, even when this is sporadic and little marked. This phenomenon caused by excess water can cause magnesium, phosphorus and nitrogen deficiencies. Water supply to tomato must be regular; the plant cannot stand alternate phases of over-watering and under-watering or drought.Such practices cause serious wilting and sometimes the death of plants, poor production (flowers failing to set, fruits bursting) with poor quality (blossom end rot and internal blemishes).

Watering must above all be regular, especially during critical periods (flowering, setting and growth of the fruits; watering can be reduced at the end of the crop).

Regular water supply throughout the growing season is beneficial in several respects, (a) it reduces the incidence of blossom end rot, (b) it enhances uniform fruit development and prevents splitting, (c) it enhances fruit growth, reduce the risk of sun scorch, and (d) increases the size and number of fruits.

Planting is performed in soil that has attained field capacity, that is to say whose particles retain a maximum of non-gravity water.
Drought during the fruiting period is the most harmful for the final yield.

Watering must be performed regularly according to requirements from the 'flowering' stage until the end of the harvest. In very hot weather, it is preferable to perform sprinkler irrigation early in the morning to avoid heat shock, burned leaves, non-setting flowers and the setting up of a microclimate favourable for diseases.

Irrigation can also be performed at the end of the day on condition that the plants have dried by nightfall.

IRRIGATION GUIDELINES

Water requirements

Water requirements are related to movements of the PE (potential evapotranspiration) of the crop.
In practical terms, it can be considered that the average water requirements of tomato in Senegal are as follows :

- 3 - 4 mm per day at planting;
- 6 mm per day after the first flowering;
- then 6 - 10 mm per day according to the development of the foliage in particular.

However, these figures must be adjusted according to the period of the year, the climate and the production area!
Irrigation can be decreased towards the end of the harvest.

Water quality

Avoid brackish water. This causes an immediate decrease in yield.

Irrigation method

Trickle or sprinkler irrigation.

Watering frequency

From transplanting onwards, it is essential never to subject the plants to water stress conditions (no excess and no shortage).
The 'flowering' and 'setting' stages are particularly sensitive.

Watering frequency depends on the moisture retention capacity of the soil and PE. Watering will be carried out daily on sandy soils and less frequently on heavier soils that retain water better.

Amount of water

Irrigation dose = easily usable soil water reserve.
The soil must reach field capacity after watering.
Use of tensiometers: driven into the soil along the rows, these devices measure the soil water content directly. It is advised that several tensiometers should be installed in different places to allow for variations in the nature of the soil.

Water balance method: this uses climatic data to estimate the amount of water taken up by plants from the root zone and lost by evapotranspiration.
PE (potential evapotranspiration) varies according to the growth stage and weather conditions:

- cool, cloudy day, PE < 6 mm;

- sunny day with harmattan, PE > 6 mm.

006 - Harvesting

Method

Manual: Pre-sorting in the field (discard fruits that are damaged, blemished, perforated, wounded, not ripe enough, burst, etc.).
Precautions: Harvest and handle the fruits very delicately. Place them in a rigid harvesting container and do not form layers more than 20 cm deep. Place picked fruits in the shade at regular intervals (ideally every 10 minutes). Take the picked fruits to the packing station as quickly as possible (every 30-45 minutes).

Maintain produce traceability throughout all operations from picking to storage and shipping.

Frequency

Pick every other day (for shipping by sea) and one day in three (for shipping by air). Approximately 20 to 30 picking operations per crop (average 60 days of harvesting from mid-December until the end of March or April in Senegal).

Moment

Start of picking: plantation + 60 days on average.
Start as early as possible in the morning when the produce is clearly turgescent and stop at the end of the morning at the latest.
Red tomatoes will be picked for shipping by air.

Labour force

The pickers must be trained and aware of the importance of the harvest in order to respect the conditions above. They must be supervised.

007 - Packing

As soon as they arrive at the packing station (light, cool, well ventilated and clean premises) from the field, the tomatoes must be kept in a cool place (<25°C.) and not be exposed to direct sunlight. The handling of warm fruits should be avoided.

Cherry tomatoes will then be:

- sorted:
  - discard all fruits with perforations, that are wounded, rotten, etc.;
  - remove fragments of leaves, stems, flowers, sepals and plant or other debris;
  - do not mix varieties or grades.

- graded by size:
  - size is determined by the maximum width of the fruit;
  - European size grading standards (size = fruit diameter measured in the centre) exist for ordinary tomatoes but not for cherry tomatoes ;
  - packaging and size standards are specifically commercial and may be required by the importer.

Examples of commercial packaging :

→ *5 kg extra grade cluster tomatoes (3 or 4 fruits) ;*
→ *cocktail tomatoes in clusters of 6 to 8 fruits, sizee 30/35 mm in 3-kg boxes;*
→ *round cocktail tomatoes in 500-g punnets;*
→ *cherry tomatoes in clusters of 10 fruits or more, size 20/35 mm in 3-kg boxes;*
→ *round cherry tomatoes in 250-g and 500-g punnets;*
→ *Tentation' tomato, size 35/45, in clusters of 6 to 8 fruits, 4-kg boxes;*
→ *Olivine' tomato in elongated clusters of 5 or 6 oblong fruits.*

- packed: placed in boxes to reach the net weight indicated at the site of consumption. Plan an extra 5 to 10% at packing to allow for loss of water before the produce reaches the consumer.

- stack boxes on standard palettes for shipment by air.

- quality standards exist for tomatoes in European legislation. They must be respected to the letter:
  - minimum characteristics taken from the standards for each category;
  - classification ("Extra", "Category I", "Category II");
  - quality and size tolerances (see **Annex**).

008 - Storage

The storage time of the fruits depends on their ripeness. Under normal maturation conditions (18-21°C and RH 90-95%), tomatoes will generally keep for 8 to 10 days, but green fruits will keep for several weeks at 13 to 16°C. Red fruits can only be kept for a few days at 7 to 10°C.

Fruits for export must necessarily be placed in cold storage under optimum conditions:

- the temperature must not fall below 5°C for storage for 6 to 8 days or below 10°C for storage for more than 2 weeks. Excessive or prolonged cold has the following effects: no ripening, no development of fruit colour and aroma, the appearance of irregular colouring, softening, browning of the seeds, irregular surface, etc.;

- **high relative humidity** (90-95%) is essential for maintaining the postharvest quality of fruits; ventilation should remain moderate so as not to dry the fruits but the prolonging of a saturated atmosphere or condensation on the fruits causes surface rots;

- the harvest-refrigeration period should be as short as possible to conserve all the quality potential during keeping. A precooling temperature of 12.5°C is recommended;

- avoid any interruption in the cold chain until the retail sale stage.

Post-harvest diseases are a serious cause of production losses (development of *Alternaria, Botrytis, Geotrichum and Rhizopus* fungi).

Treatment with hot air or immersion in hot water at 55°C for 30 seconds to 1 minute can be effective in limiting the development of fungi during storage. Tomatoes sold in clusters are particularly susceptible to *Botrytis*.

009 - Pest control

1. Monitoring

Operations during cultivation consist essentially of preventive treatments and threshold level treatments :

→ for pests for which there is no **threshold level**, spraying is performed when the risks are medium or high for the region concerned (see Pest and Disease sheets);
→ for pests and diseases for which a **threshold level** exists, treatment is performed when this is reached or exceeded. Monitoring is performed on the day preceding the date planned for the treatment when the risk is medium or high;
→ for cluster tomatoes grown in greenhouses, **the treatments planned must respect the bumblebee colonies** introduced for pollination (8 hives per greenhouse - lifetime of about 8 weeks).

2. General framework

Pest control falls within the general framework of Good Agricultural Practices (GAP) with respect of the general instructions as taken up, for example in EUREPGAP reference documents. The final objective remains that of supplying sound, high-quality produce (that is to say which is in conformity with Quality Standards - Regulation 778/83 amended by Regulations 1657/92 & 888/79 -Annex 5) and financially affordable. It is essential to combine the specific control methods recommended below and all the cultural techniques available (choice of varieties, rotation, staggering of sowing, tillage, rationalised fertilisation, etc.) to provide optimum protection (Integrated Production and Protection), with emphasis of the role and impact of agronomic and ecological factors.

Tomato cultivars have different degrees of resistance to diseases and nematodes. They may be resistant in particular to *Verticillium* wilt and *Fusarium* wilt. Up to now, commercial tomato cultivars have not shown proof of good resistance to leaf scorch and bacterial diseases.
Furthermore, the cultivars differ with regard to vulnerability to blossom end rot, a physiological disorder whose incidence is generally higher in cultivars with dense foliage.

Limiting pressure by several pests requires:
→ the best possible use of phytotechnical pest control resources;
→ avoiding cultivation near a crop infested by pests that can attack tomato;
→ avoiding cultivation in a field recently used for tomato (a 3-year rotation is considered to be a minimum).

All aspects of the effect/s of the method/s chosen should then be appraised so that a cost-benefit balance of the method/s can be drawn up:
→ efficacy and profitability for the farmer;
→ selectiveness for the crop and the non-target organisms;
→ respect of MRLs (safety for the consumer);
→ secondary effects on the operator and domestic and wild animals;
→ environmental effects (soil, water, plants and air);
→ effects on cultural techniques;
→ possibly the social consequences induced (e.g. the freeing of working time if herbicide is used).

3. Pesticides

The pesticides recommended for tomato should take the following factors into account:

- the marketing authorisations, with respect of authorised uses and registered doses;
- obligatory precautions for use (application period, waiting period before harvest, maximum dose authorised, the existence or not of non-treated zones, protective equipment) and any restrictions on use;
- the existence of a maximum residue limit (MRL) of the compound on the produce. If the produce is exported, the MRL on the destination market must be taken into account (national MRL, MRL harmonised at the European level or even an MRL set in the Codex Alimentarius).

4. Traceability

As for the other crop operations, it is important to organise full traceability of pest control actions, with at least the following data recorded for each treatment :

- date of application (and day in relation to the sowing date);
- product used (full name, supplier, formulation, batch number, etc.);
- dose actually used;
- mix volume;
- type of application (sprayer, nozzle, volume per ha, run width, speed, wind, etc.).

5. Pests of economic importance

NAME	TYPE	IMPORTANCE /SUSCEPTIBLE STAGE
		SENEGAL
Bemisia tabaci (whitefly)	I	Nursery - Start of planting
Myzus persicae (green aphid)	I	Nursery - Start of planting
Aculops lycopersici (tomato russet mite)	M	Setting until picking
Meloidogyne spp. (root knot nematodes)	N	Nursery - transplanting
Tetranychus spp. (spider mites)	A	Setting until picking
Lyriomyza trifolii (leafminer)	I	Nursery - start of picking
Helicoverpa armigera (noctuid - caterpillars)	I	Setting until picking
Trichoplusia ni (cabbage looper)	I	Setting until picking
Birds (damage by birds)	I	Harvest period

Not very important Very important

	Useful spraying periods and threshold levels (% of leaves attacked, for *Helicoverpa* % fruits attacked)									
Days after planting	7	14	21	28	35	42	49	56	63	70
Bemisia	2	2	2	4	4	6	8	10	12	
Aculops	2	2	2	4	4	6	8	4	8	
Liriomysa	50	55	60	65	70	75	80	85	90	
Helicoverpa					3	3	3	3	3	6

6. Harvest and physiological diseases

NAME	TYPE	IMPORTANCE /SUSCEPTIBLE STAGE
		SENEGAL
Fruit rots	F	Harvest period
Sun scorch	Ph	Harvest period
Blossom end rot	Ph	Harvest period

7. Diseases of economic importance

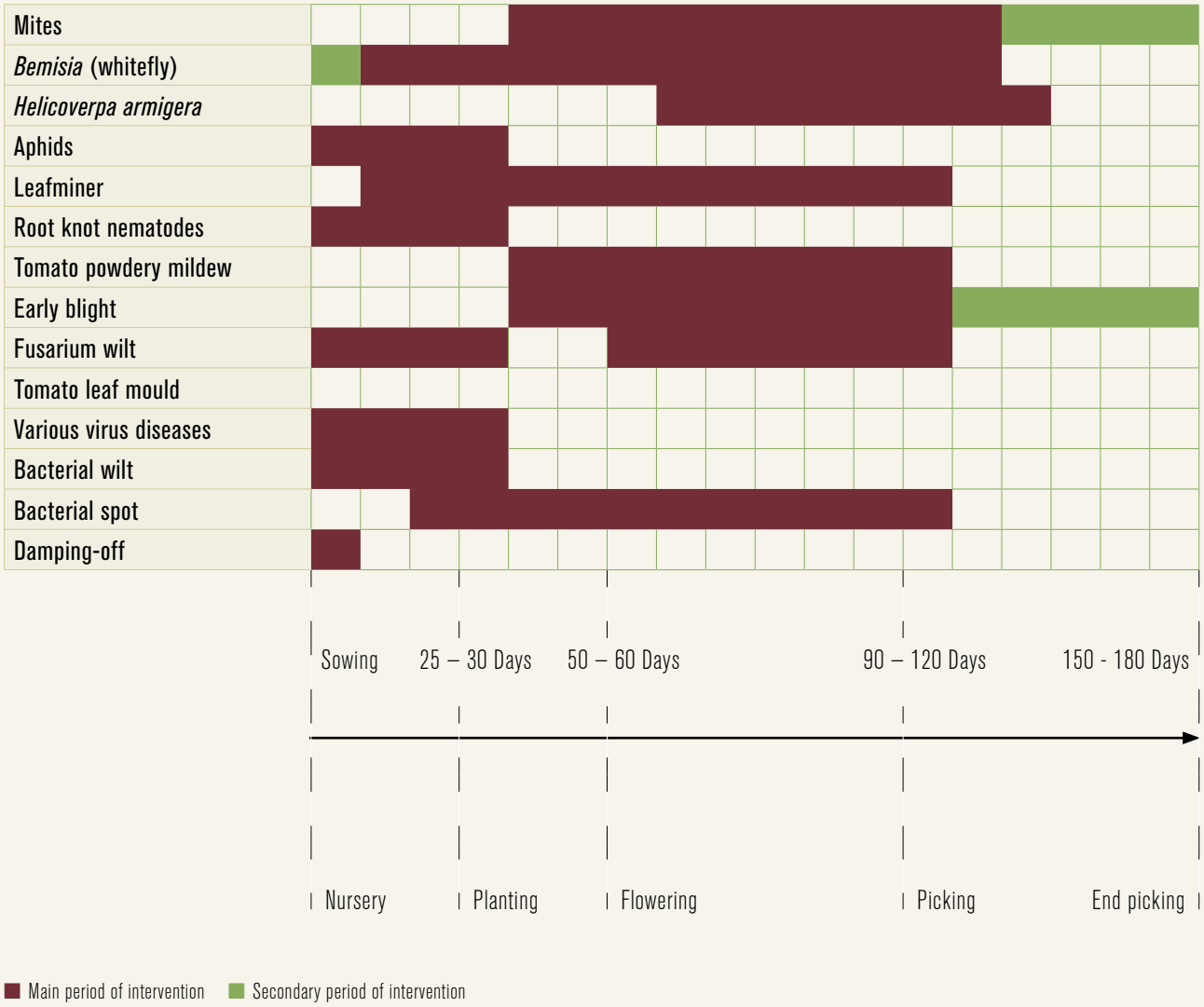
NAME	TYPE	IMPORTANCE /SUSCEPTIBLE STAGE
		SENEGAL
Pythium aphanidermatum (Pythium)	F	Nursery
Sclerotium rolfsii (southern blight)	F	Fruiting to harvest
Rhizoctonia solani (fruit rot)	F	Harvest period
Ralstonia solanacearum (bacterial wilt)	B	All stages
Xanthomonas vesicatoria (bacterial spot)	B	All stages
Fusarium oxysporum (Fusarium wilt)	F	All stages
Alternaria solani (early blight)	F	Nursery and flowering-harvest
Colletotrichum phomoides (anthracnose)	F	Fruiting - harvest
Leveillula taurica (tomato powdery mildew)	F	Transplanting - harvest
Phytophthora infestans (tomato late blight)	F	Transplanting - harvest
Fulvia fulva (tomato leaf mould)	F	Maturation - harvest
Stemphylium solani (grey leaf spot)	F	Flowering
Verticilium sp. (Verticillium wilt)	F	All stages
Phytophthora, Rhizoctonia (damping-off)	F	Nursery
TYLCV (Yellow Leaf Curl Virus)	V	All stages

Not very important Medium importance Very important

	Useful spraying periods and threshold levels (% leaves attacked)									
Days after planting	7	14	21	28	35	42	49	56	63	70
Early blight	2	4	6	8	10	12	14	16	18	25
Tomato leaf mould						12	14	16	18	25
Tomato powdery mildew	2	4	6	8	10	12	14	16	18	25
Bacterial spot	2	2	2	2	2	2	2	2	2	10
Virus diseases	Continuous control of virus vectors									

From 70 days after planting, spray every 7 days if more than 25% of leaves are infected; stop spraying when the number of infected leaves falls below 25%.

Useful intervention periods



Annex 1: Efficacy of active substances or biocontrol agents on main pests of tomato

Active substance or biocontrol agent	Aculops	*Spider mites*	*Meloidogyne*	*Bemisia*	*Liriomyza*	*Trichoplusia ni*	Aphids	*Helicoverpa*
Azadirachtin				X	X	X	X	X
Abamectin	X	X			X			
Bacillus thuringiensis						X		X
Buprofezine				X				
Carbofuran			X					
Cadusafos			X					
Cyromazine					X			
Delatmethrin						X	X	X
Dicofol	X	X						
Fenbutatin	X	X						
Hexythiazox	X	X						
Imidacloprid				X			X	
Indoxacarbe						X		X
Lambda-cyalothrin						X	X	X
Methomyl				X		X	X	X
Oxamyl			X					
Spinosad					X			X
Sulfur	X	X						
Thiamethoxam				X			X	

Annex 2: Efficacy of active substances and biocontrol agents on main diseases of tomato

Active substance or biocontrol agent	Fusarial wilt	Alternaria	Powdery mildew	Bacterial wilts	Tom. leaf mould	Anthracnose	Grey leaf spot	Verticillium wilt	Tom. late blight
Azoxystrobin		X	X						X
Chlorothalonil		X			X	X	X		X
Difenoconazole		X			X	X			
Iprodione		X			X				
Maneb		X			X	X			X
Mancozeb		X			X	X			X
Myclobutanil			X						
Sulphur			X						

Annex 3: Status of the active substances and biocontrol agents in Regulation 1107/2009; European and Codex MRLs in October 2011and GAP tested for insecticides, miticides and nematicides

Caution: The information contained in this table is subject to change by future directives of the Commission of the European Communities and Codex.

Active substance or biocontrol agent	EU regulation		Codex MRL	GAP*****					
	Regulation 1107/2009	MRL		Dosage g/ha	Number of appli-cation	Interval between application in dayss	PHI in days		
							EU MRL	Codex MRL	LOQ***
Azadirachtin	approved	1	/	12	5	7	7	7	7
Abamectin	approved	0.02	0.02	23	35	7	7	7	7
Bacillus thur-ingiensis	approved	n.a.	/	Not relavant since no residues concern					
Buprofezine	approved	1	1	132	3	14	28	28	28
Carbofuran	not approved	0.02**	/	400****	1	n.a.	At planting		
Cadusafos	not approved	0.01*	/	****	1	n.a.	At planting		
Cyromazine	approved	1	1	187,5	2	35	7	7	7
Deltamethrin	approved	fruiting vegetables	0,3	12,5	2	14	2	2	2
Dicofol	not approved	0.3	0.3	720	2	14	7	7	7
Fenbutatin	approved	1	/	500	2	14	//	//	//
Hexythiazox	approved	2	1	50	2	14	//	//	//
Imidacloprid	approved	0.5	0.1	150	3	14	28	28	28
Indoxacarbe	approved	0.5	0.5	37,5	2	14	2	2	2
Lambda-cyalothrin	approved	0.1	0.3	25	2	14	2	2	2
Methomyl	approved	fruiting vegetables	1	450	5	7	7	7	7
OXamyl	approved	0.02**	1	****	1	/	At planting		
Spinosad	approved	0.02	2	160	2	14	2	2	2
Sulfur	approved	1	0.3	6000	3	7	7	//	7
Thiamethoxam	approved	n.a.	/	40	2	14	28	//	28

Approved : active ingredient approved for use in EU countries
Not approved : active ingredient not authorized in EU countries but usable in countries out of EU if the EU LMR are respected for the imported products in EU.
* default value
** LOQ value
*** PHI obtained from EU LOQ
**** application only on sowing or at planting
***** data highlighted in yellow was tested in PIP residues trials conducted in Senegal
n.a. = not applicable
/ = for this active substance Codex doesn't give the MRL or LOQ value
// = not known

Sources of GAP validated by PIP trials: insecticides

Active substance	trade name	Manufacturer	Trials	
			Year	Country
Abamectin	vertimec 18 EC	Syngenta	2006	Senegal
Azadirachtin	not specified	Senchim	2006	Senegal
Buprofezine	applaud 250 SC	Arysta LifeScience	2006	Senegal
Cyromazine	trigard 75 WP	Syngenta	2006	Senegal
Deltamethrin	decis 0,25 EC	Bayer CropScience	2006	Senegal
Dicofol	kelthane MF	Dow AgroSciences	2006	Senegal
Imidacloprid	confidor 350 SC	Bayer CropScience	2006	Senegal
Indoxacarbe	avaunt 150 SC	Dupont	2006	Senegal
Lambda-cyalothrin	karaté Zeon 2,5 CS	Syngenta	2006	Senegal
Methomyl	lannate 90	Dupont	2006	Senegal
Spinosad	spinosad 480 SC	Dow AgroSciences	2006	Senegal
Sulfur	thiovit 80 WG	Syngenta	2006	Senegal
Thiamethoxam	actara 25 WG	Syngenta	2006	Senegal

Note : GAPs indicated in previous pages are those corresponding to the trade names listed above. User of this information should check if the product used is equivalent (same concentration and same type of formulation) to the reference product. If it is not the case, the indicated GAP could not be adequate.

Annex 4: Status of the active substances or biocontrol agents in Regulation 1107/2009; European and Codex MRLs in October 2011 and GAP tested for fungicides

Caution: The information contained in this table is subject to change by future directives of the Commission of the European Communities and Codex.

Active substance or biocontrol agent	EU regulation		Codex MRL	GAP*****					
	Regulation 1107/2009	MRL		Dosage g/ha	Number of appli-cation	Interval between application in dayss	PHI in days		
							EU MRL	Codex MRL	LOQ***
Azoxystrobine	approved	3 fruiting vegetables	3	250	3	7	2	2	2
Chlorothalonil	approved	2	5	1000	3	7	2	2	2
Difenoconazole	approved	2	0.5	125	2	7	7	7	7
Iprodione	approved	5	5	1100	2	7	2	2	2
Maneb	approved	3	2	2000	3	7	7	7	7
Mancozeb	approved	3	2	2000	3	7	7	14	7
Myclobutanil	approved	0.3	0.3	60	3	7	2	2	2
Sulfur	approved	n.a.	/	6000	3	7	Not relavant since no residues concern		

Approved : active ingredient approved for use in EU countries
Not approved : active ingredient not authorized in EU countries but usable in countries out of EU if the EU LMR are respected for the imported products in EU.
* default value
** LOQ value
*** PHI obtained from EU LOQ
**** application only on sowing or at planting
***** data highlighted in yellow was tested in PIP residues trials conducted in Senegal
n.a. = not applicable
/ = for this active substance Codex doesn't give the MRL or LOQ value
// = not known

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Sources of GAP validated by PIP trials: fungicides

Active substance	Trade name	Manufacturer	Trials	
			Year	Country
Azoxystrobine	azoxystrobine 250 SC	Syngenta	2006	Senegal
Chlorothalonil	bravo 720	Syngenta	2006	Senegal
Difenoconazole	score 250 SC	Syngenta	2006	Senegal
Iprodione	rovral 50%	BASF	2006	Senegal
Mancozeb	dithane M45	Dow AgroSciences	2006	Senegal
Maneb	triamangol 80 WP	CERAGRI	2006	Senegal
Myclobutanil	systhane 24 E	Dow AgroSciences	2006	Senegal

Note : GAPs indicated in previous pages are those corresponding to the trade names listed above. User of this information should check if the product used is equivalent (same concentration and same type of formulation) to the reference product. If it is not the case, the indicated GAP could not be adequate.

Annex 5: Registered insecticides/miticides/nematicides in ACP countries for use on tomato

Active substance or biocontrol agent	Registrations in some ACP countries				
	CILSS	Ghana	Côte d'Ivoire	Kenya	Tanzania
Abamectin	-	-	X	X	X
Azadirachtin	-	-	-	X	X
Bacillus thuringiensis	-	-	Vegetable in general	Vegetable in general	Horticultural crop
Bifenthrin	-	-	Vegetable in general	Vegetable in general	Vegetable in general
Buprofezine	-	-	-	X	Horticultural crop
Carbofuran	-	Vegetable in general	Vegetable in general	Vegetable in general	Vegetable in general
Cadusafos	-	-	-	-	-
Cyromazine	-	-	-	-	X
Deltamethrin	X	Vegetable in general	Vegetable in general	X	X
Dicofol	-	-	-	Vegetable in general	-
Fenbutatin	-	-	-	-	Horticultural crop
Hexythiazox	-	-	-	-	Horticultural crop
Imidacloprid	-	Vegetable in general	-	X	X
Indoxacarbe	-	-	-	X	Horticultural crop
L-cyalothrin	Vegetable in general	Vegetable in general	Vegetable in general	X	X
Methomyl	-	-	-	Vegetable in general	Vegetable in general
Oxamyl	-	-	Vegetable in general	-	-
Spinosad	X	-	-	Vegetable in general	-
Sulfur	-	-	-	X	-
Thiamethoxam	X	-	-	Vegetable in general	Horticultural crop

Note : for Tanzania horticultural crop include vegetable and fruit trees

Annex 6: Registered fungicides in ACP countries for use on tomato

Active Substance or biocontrol agent	Registrations in some ACP countries				
	CILSS	Ghana	Côte d'Ivoire	Kenya	Tanzania
Azoxystrobine	-	-	-	-	Vegetable in general
Chlorothalonil	-	-	Vegetable in general	X	X
Difenoconazole	-	-	-	-	Horticultural crop
Iprodione	X	-	Vegetable in general	Vegetable in general	Horticultural crop
Maneb	-	-	Vegetable in general	-	-
Mancozeb	X	Vegetable in general	X	X	X
Myclobutanil	-	-	-	-	-

Note: for Tanzania, horticultural crop include vegetables and fruit trees

Annex 7: Climatic requirements and development of tomato (*Lycopersicon esculentum L.*)

Climatic requirements

Tomatoes grow best during the months in which the average temperature is between 21 and 24°C, but they still grow when the average temperature is only 18°C or attains 27°C. In contrast, temperatures lower than 10°C compromise the development of tomatoes and temperatures of around 5°C halt development definitively. If the temperature falls below 13°C or exceed 35°C for several hours when the flowers are pollinated, there is no, or very limited fruiting. Flower buds exposed to a temperature of 10°C for short periods can bear tomatoes blemished by cracks.

Growth and development

Tomato cultivars differ in growth, which can de determinate or indeterminate. Cultivars with determinate growth generally have a more compact habit, more grouped ripening and are more suitable for growth without staking. Indeterminate cultivars are usually taller and more suitable for staking because they grow continuously, stopping only when topped.
In indeterminate tomatoes for staking, a genetically determined flower cluster develops every three nodes, whereas in determinate growth varieties the first two flower clusters generally grow at the sixth and eighth nodes. The abortion of flower clusters is caused more by bad weather than by any other factor.

In open field cropping, a period of some six weeks elapses between the opening of the flower and full ripeness of the fruit. Ripening can be delayed by low temperatures, cloudy weather and excessive shading of the fruit.
Conversely, ripening is faster when the developing fruit is exposed to the sun and is warmed as a result.
Staking tomato plants and the accompanying pruning contribute to exposing the fruits to the sun and speeding up ripening. However, excessive heating can harm the fruits and sometimes cause sun scorch on some varieties.

Annex 8: Common standards of quality for tomatoes

REGULATION 778/83 amended by REGULATIONS 1657/92 & 888/97

I. DEFINITION OF PRODUCE

This standard applies to tomatoes of the varieties (cultivars) grown from *Lycopersicon esculentum* Mill., to be supplied fresh to the consumer, tomatoes for industrial processing being excluded.

Tomatoes may be classified into three commercial types, according to shape:
- 'round' (i.e. of spherical type, including 'cherry' tomatoes);
- 'ribbed';
- 'oblong' (or 'elongated').

II. PROVISIONS CONCERNING QUALITY

The purpose of the standard is to define the quality requirements for tomatoes after preparation and packaging.

A. Minimum requirements

In all classes, subject to the special provisions for each class and the tolerances allowed, the tomatoes must be:

- intact;
- fresh-looking;
- sound, produce affected by rotting or deterioration such as to make it unfit for consumption is excluded;
- clean, practically free of any visible foreign matter;
- free of abnormal external moisture;
- free of any foreign smell and/or taste.

The development and condition of the tomatoes must be such as to enable them :

- to withstand transport and handling, and;
- to arrive in satisfactory condition at the place of destination.

B. Classification

The tomatoes are classified into the three classes defined below:

(I) 'EXTRA' CLASS

Tomatoes in this class must be of superior quality. They must have firm flesh and have the characteristics typical of the variety as regards shape, appearance and development.
Their colouring, depending on their state of ripeness, must satisfy the requirements set out in the last sub-paragraph of paragraph A above.
The tomatoes must be free from 'green backs' and other defects, except for very slight superficial defects, provided this affects neither the quality nor the general appearance of the produce, nor the general presentation in the package.

(II) CLASS I

Tomatoes in this class must be of good quality, reasonably firm and have the characteristics typical of the variety.
They must be free of unhealed cracks and visible 'green backs'.
The tomatoes may show the following slight defects provided they do not affect the general appearance, quality, conservation or presentation of the product:

- slight defect in shape and development;
- slight defect in colouring;
- slight skin defects;
- very slight bruises.

Furthermore 'ribbed' tomatoes may show:
- healed cracks not more than 1 cm long;
- no excessive deformations;
- small umbilicus, but no suberisation;
- suberisation of the stigma up to 1 cm2;
- fine blossom scar in elongated form (like a seam), but not longer than two-thirds of the greatest diameter of the fruit.

(III) CLASS II

This class includes tomatoes which do not qualify for inclusion in the higher classes, but satisfy the minimum requirements specified above.
The tomatoes must be reasonably firm and must not show unhealed cracks.
The tomatoes may show the following slight defects provided they retain their basic characteristics as regards quality and presentation:
- defects in shape, development and colouring;
- skin defects or bruises, provided the fruit is not seriously affected;
- healed cracks not more than 3 cm in length.

Furthermore 'ribbed' tomatoes may show:
- more marked deformations than allowed under Class I, but without being mis-shapen;
- umbilicus;
- suberisation of the stigma up to 2 cm2;
- fine blossom scar in elongated form (like a seam).

III. PROVISIONS CONCERNING SIZING

Sizing is determined by the maximum diameter of the equatorial section.
The following provisions shall not apply to 'cherry' tomatoes.

A. Minimum size

For tomatoes classified in the 'Extra' Class and Classes I and II, the minimum size is set at :
- for 'round' and 'ribbed' tomatoes: 35 mm;
- for 'oblong' tomatoes: 30 mm.

B. Sizing scale

The following sizing scale has been adopted:
- 30 mm and above but under 35 mm(3);
- 35 mm and above but under 40 mm;
- 40 mm and above but under 47 mm;
- 47 mm and above but under 57 mm;
- 57 mm and above but under 67 mm;
- 67 mm and above but under 82 mm;
- 82 mm and above but under 102 mm;
- 102 mm and above.

Observance of sizing scale is compulsory for 'Extra' Class and Class I tomatoes.

(3) Only for 'oblong' tomatoes.

IV. PROVISIONS CONCERNING TOLERANCES

The following tolerances in respect of quality and size are allowed for produce not satisfying the requirements of the class indicated in each package.

A. Quality tolerances

(I) 'EXTRA' CLASS

5% by number or weight of tomatoes not satisfying the requirements for the class, but meeting those for Class I or, exceptionally, coming within the tolerances for that class.

(II) CLASS I

10% by number or weight of tomatoes not satisfying the requirements for the class, but meeting those for Class II or, exceptionally, coming within the tolerances for that class.

(III) CLASS II

10% by number or weight of tomatoes satisfying neither the requirements for the class nor the minimum requirements, with the exception of produce affected by rotting, pronounced bruising or any other deterioration rendering it unfit for consumption.

B. Size tolerances

For all classes, 10% by number or weight of tomatoes conforming to the size immediately below and/or above that specified, with a minimum of 33 mm for 'round' and 'ribbed' tomatoes, and 28 mm for 'oblong' tomatoes in the 'Extra' Class and Classes I and II.

V. PROVISIONS CONCERNING PRESENTATION

A. Uniformity

The contents of each package must be uniform and contain only tomatoes of the same origin, variety or commercial type, quality and size (if the produce has to be sized). The ripeness and colouring of tomatoes in the 'Extra' Class and Class I must be practically uniform. In addition, the length of 'oblong' tomatoes must be sufficiently uniform.

The visible part of the contents of each package must be representative of the entire contents.

B. Packaging

The tomatoes must be packed in such a way as to protect the produce properly.

The materials used inside the package must be new, clean and of a quality such as to avoid causing any external or internal damage to the produce.

The use of materials and particularly of paper or stamps bearing trade specifications is allowed provided that the printing or labelling has been done with a non-toxic ink or glue.

Paragraph deleted by 1657/92.

The packages must be free from all foreign matter.

VI. PROVISIONS CONCERNING MARKING

Each package must bear the following particulars in letters grouped on the same side, legibly and indelibly marked and visible from the outside.

A. Identification

Packer and/or Dispatcher: Name and address or officially issued or accepted code mark. However, in the case where a code mark is used, the reference “packer and/or dispatcher (or equivalent abbreviations)” has to be indicated in close connection with the code mark.

B. Nature of produce

'Tomatoes' and the commercial type, if the contents are not visible from the outside. These details must always be provided for 'cherry' tomatoes and for Class III tomatoes:

- grown under protection (glass or plastic) and of a size between 20 and 35 mm;
- 'oblong', and of a size between 20 and 30 mm;
- name of variety (optional).

C. Origin of produce

Country of origin and, optionally, district where grown or national, regional or local place name.

D. Commercial specifications

CLASS.

- When sized, size expressed as minimum and maximum diameters or, alternatively, the word 'unsized'.

E. Official control mark (optional)

Annex 9 : Identification of main pests and diseases

Pictures credits: Gilles DELHOVE

Lepidoptera: Noctuidae

Agrotis spp.

Damage of the *Agrotis* larvae on fruit

Larvae of *Agrotis* sp.

Helicoverpa (Heliothis) armigera

Larva of *Helicoverpa armigera* penetrating a fruit

Fruit after penetration of *H. armigera* larvae

Pupa of *H. armigera*

Larva of *Helicoverpa armigera*

Lepidoptera: Noctuidae	Homoptera: Aleyrodidae
Spodoptera spp.	*Bemisia tabaci* (White Fly)
	
Larva of *Spodoptera littoralis*	Adults of *Bemisia tabaci* on the underside of tomato leaf

Thysanoptera (Thrips)	
	
Thrips larvae on the underside of leaf	Damaged fruit after thrips attack
	
Underside leaf with damages	Upper side leaf with damages

Hemiptera: Aphididae (Pucerons)

Mycus persicae (Green Peach Aphid)

Adults and nymphs of on the underside of leaf

Deformed leaf

Diptera: Agromyzidae

Liriomyza spp.

Mine on a leaf

Acarina (mites): Eriophyidae

Aculops lycopersici (tomato russet mite)

Silvering of the underside of a leaf

Acarina (mites): Tetranychidae (Spider Mites)

Tetranychus spp.

On the underside of a tomato leaf

Damaged leaves after *Tetranychus* attacks

Fungi

Alternaria solani

Necrotic leaf

Damage on stem

Phytophtora infestans (Mildew)

Damage on leaf

Damage on leaf

Fruit heavily attacked

Symptoms on the whole plant

Fungi	
Cladosporium fulvum (Tomato Leaf Mould)	*Stemphylium*
	
Brown moulds on leaves are visible	Spots on a leaf

Leveillula taurica	
	
	
	
Leaf damage on underside	Symptoms on the whole plant

Bacteria	
Ralstonia solanacearum (Bacteria wilt)	
	
Wilt as a symptom	Browning of vascular tissue
	
Adventitious roots may developing on the main stem	A cross section of the stem of a plant with bacterial wilt produces a white, milky ooze of bacterial cells in clear water

Bacteria

Xanthomonas campestris pv. *vesicatoria* (Bacterial spot)

Evolution of symptoms on a leaf

Virus

TMV (Tabac Mosaic Virus)

Symptom on the whole plant

TYLCV (Tomato Yellow Leaf Curl Virus)

Curling leaf as a typical symptom of TYLCV

CROP PRODUCTION PROTOCOLS

Avocado (*Persea americana*)
French bean (*Phaseolus vulgaris*)
Okra (*Abelmoschus esculentus*)
Passion fruit (*Passiflora edulis*)
Pineapple Cayenne (*Ananas comosus*)
Pineapple MD2 (*Ananas comosus*)
Mango (*Mangifera indica*)
Papaya (*Carica papaya*)
Pea (*Pisum sativum*)
Cherry tomato (*Lycopersicon esculentum*)

GUIDES TO GOOD PLANT PROTECTION PRACTICES

Amaranth (*Amaranthus* spp.)
Baby carrot (*Daucus carota*)
Baby and sweet corn (*Zea mayis*)
Baby Leek (*Allium porrum*)
Baby pak choy (*Brassica campestris* var. *chinensis*), baby cauliflower (*Brassica oleracea* var. *botrytis*), baby broccoli and sprouting broccoli (*Brassica oleracea* var. *italica*) *and head cabbages* (*Brassica oleracea var. capitata* and *var. sabauda*)
Banana (*Musa* spp. – plantain (*matoke*), apple banana, red banana, baby banana and other ethnics bananas)
Cassava (*Manihot esculenta*)
Chillies (*Capsicum frutescens, Capsicum annuum, Capsicum chinense*) and sweet peppers (*Capsicum annuum*)
Citrus (*Citrus* sp.)
Coconut (*Cocus nucifera*)
Cucumber (*Cucumis sativus*), zucchini and pattypan (*Cucurbita pepo*) and other cucurbitaceae with edible peel of the genus *Momordica, Benincasa, Luffa, Lagenaria, Trichosanthes, Sechium* and *Coccinia*
Dasheen (*Colocasia esculenta*) and macabo (*Xanthosoma sagittifolium*)
Eggplants (*Solanum melongena*, *Solanum aethiopicum*, *Solanum macrocarpon)*
Garlic, onions, shallots (*Allium sativum, Allium cepa, Allium ascalonicum*)
Ginger (*Zingiber officinale*)
Guava (*Psidium catteyanum*)
Lettuce *(Lactuca sativa*), spinach (*Spinacia oleracea* and *Basella alba*), leafy brassica (*Brassica* spp.)
Lychee (*Litchi chinensis*)
Melon (*Cucumis melo*)
Organic Avocado (*Persea americana*)
Organic Mango (*Mangifera indica*)
Organic Papaya (*Carica papaya*)
Organic Pineapple (*Ananas comosus*)
Potato (*Solanum tuberosum*)
Sweet potato (*Ipomea batatas*)
Tamarillo (*Solanum betaceum*)
Water melon (*Citrullus lanatus*) and butternut (*Cucurbita moschata*)
Yam (*Dioscorea* spp.)

PIP
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THE ACP HORTICULTURAL INDUSTRY

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