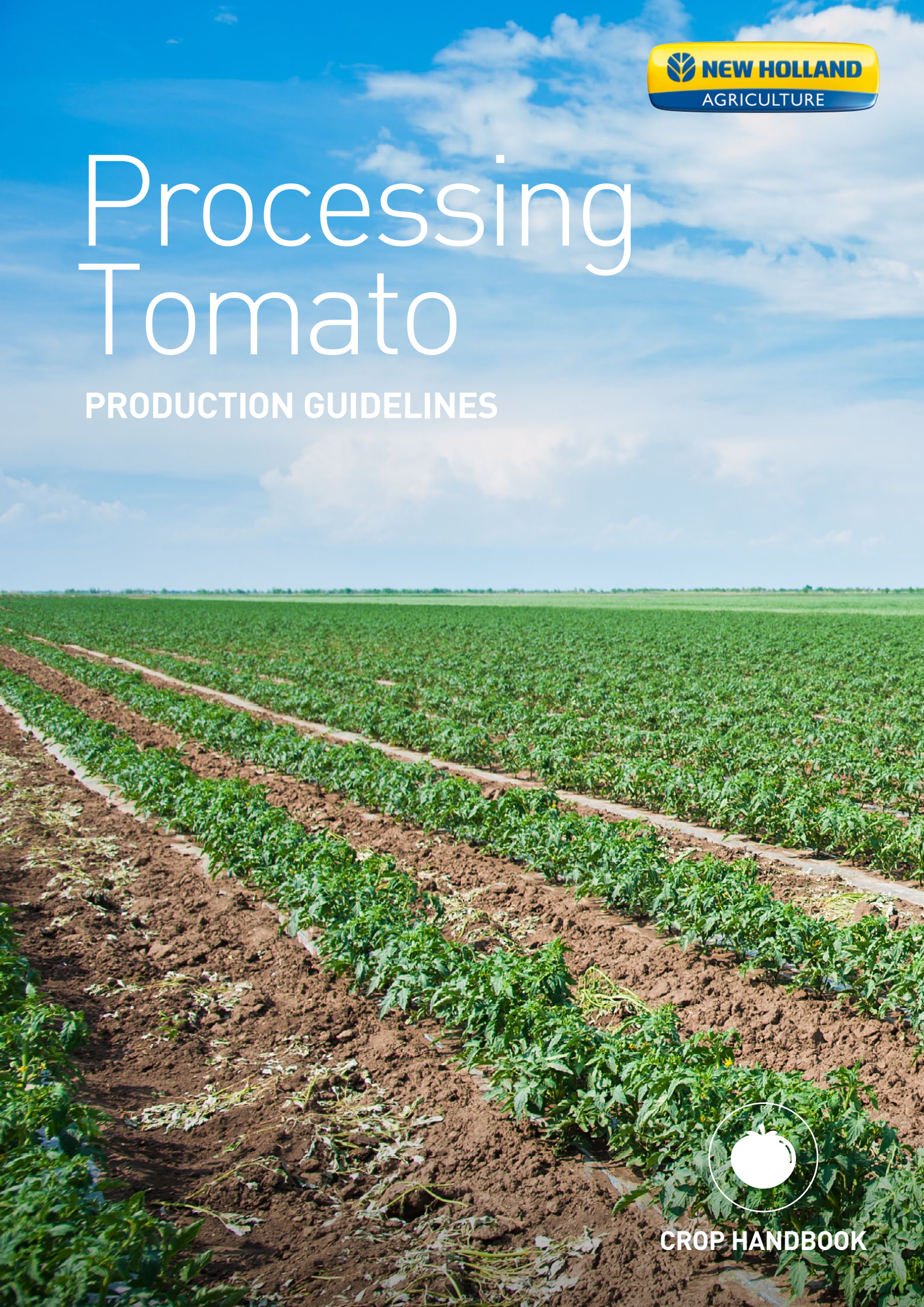
NEW HOLLAND AGRICULTURE

Processing Tomato

PRODUCTION GUIDELINES



CROP HANDBOOK

Processing Tomato

CROP HANDBOOK

Production Guidelines

PROCESSING TOMATO	
OPERATIONS	AGRONOMICS AND TIMING
Crop rotation	Better plant (transplant) after winter wheat or other winter cereals. Soybeans also is a good choice, as well as corn silage. Avoid planting (transplanting) after pepper, potatoes and other plants of family nightshade (Solanaceous)
Primary tillage	Deep primary tillage (35-40 centimeters). Plough first choice, disk ripper an alternative
Secondary tillage	Tine harrows, power harrows, rotor harrows. Packing
Planting or Transplanting (Northern Hemisphere)	
Timeliness transplanting	from March to June
Timeliness planting	April to May
Distance between rows or double rows	150 centimeters is more usual
Distance between seeds	5-6 centimeters, when planting
Distance between transplants	About 20 centimeters, when transplanting
Depth	1.5-3 centimeters when planting; when transplanting, cover the root ball
Soil insecticide	Highly recommended at planting or transplanting
Fertilizing (guidelines, to be adjusted on soil analysis base)	
Nitrogen (N kg/ha)	120-250, depending on realistic production target
Phosphorus (P_2O_5 kg/ha)	120-220, depending on soil content in phosphate
Potash (K_2O kg/ha)	0-220, depending on soil content
Weed control	Both pre transplanting and post emergence recommended
Pest control	Applications of fungicides and insecticides by spraying
Harvesting	Manual or mechanized

DROPLET SIZES FOR DIFFERENT CHEMICALS

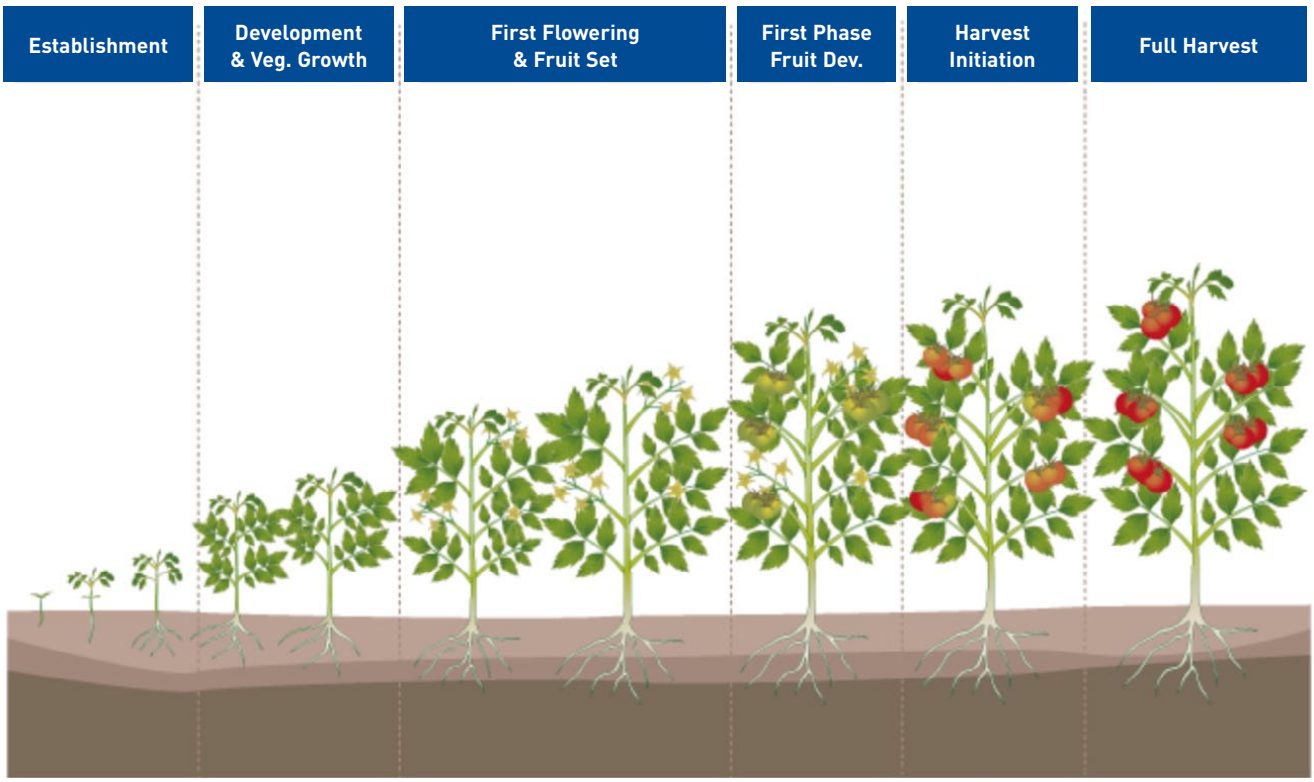
ASABE STANDARD S-572.1 DROPLET SPECTRUM CATEGORIES[1,2]	CONTACT INSECTICIDE AND FUNGICIDE	SYSTEMIC INSECTICIDE AND FUNGICIDE	CONTACT FOLIAR HERBICIDE	SYSTEMIC FOLIAR HERBICIDE	SOIL-APPLIED HERBICIDE	INCORPORATED SOIL-APPLIED HERBICIDE	RELATIVE SIZE	COMPARATIVE SIZE	ATOMIZATION
VERY FINE (VF) RED								Point of Needle (25 microns)	Fog
FINE (F) ORANGE	✓							Human Hair (100 microns)	Fine mist
MEDIUM (M) YELLOW	✓	✓	✓	✓				Sewing Thread (150 microns)	Fine Drizzle
COARSE (C) BLUE		✓		✓	✓	✓		Stample (420 microns)	Light Rain
VERY COARSE (VC) GREEN				✓	✓	✓		Stample (420 microns)	Light Rain
EXTREMLY COARSE (XC) WHITE						✓		#2 Pencil Lead (2,000 microns)	Thunderstorm

Droplet sizes are suggestions for each pesticide. [1] Based on VD0.5, the Volume Master Diameter (VMD) designation. Source: Kansas City University.
[2] Revision of Stantard S-572.1 also includes extra-fine and ultra-coarse categories for non agricultual users.
This droplet guide summarizes suggested droplet sizes for a variety of chemicals, based on the ASABE standard droplet spectrum categories.

Crop Rotation

- **Crop rotation, as a rule, can improve the performances of all crops**. Tomato belongs to nightshade (Solanaceous) family, like pepper, potatoes, tobacco, and other plants: so, turning with such crops should be "long" because some diseases are common among these plants (Phytophtora for example). Tomato should not be grown on the same field within the period of 4 or, better, 5 years in order to avoid the building up of pathogens
- **Crop Rotations** allow the farmer to spread labor intensive operations out throughout the whole season, reducing labor and equipment requirements peaks.
- **Exploitation of soil fertility** is improved, because different crops roots explore different horizons of soil and utilize nutrients at different rates. For example, Soybean enriches the content of N in soil for following crops and Alfalfa moves nutrients from deep horizons of soil to shallower layers.
- **Structure of soils improves** because residues from crop roots stay and decay at different depths and crop residues have different nutritional contents.
- **Management of pests and diseases gets easier** because different crops have different pests: crop rotation is a powerful mean to avoid or reduce damages.
- **Management of weeds also get easier** for the same reason: for example, control of monocot weeds (grasses) is much more easy in tomato than in monocot crop as cereals or corn.

TOMATO DEVELOPMENT STAGES



SOME DATA ABOUT PROCESSING TOMATO: ITALY AND USA

In Italy total production in year 2009 has been about 5 millions tons from acreage of about 70.000 hectares. Average yield is 70 tons per Hectare. Tomato is cropped everywhere, but two Regions, Puglia in the South and Emilia in the North produce 85% of crop.

In USA, more than 170.000 hectares of tomatoes are cropped, 95% of which in California.
The yearly production exceeds 12.7 million tons, average yield is very like Italy, about 70 tons per hectare.

During the last 20 years, yield increase is the result of a number of factors, most notably (not in order of importance)

- the breeding of more productive hybrids, resistant to bruising and thus suitable for mechanical harvesting
- the use of mineral fertilizers based on soil tests and crop requirements
- the use of effective pesticides in integrated pest management programs
- irrigation
- improved management practices.

More recent developments include the use of transplants and drip irrigation. Since 1990, direct seeding has been largely replaced by transplanting. Advantages of transplanting are relatively simplified seedbed preparation, better stand establishment, reduced weed competition in early stages of growth.

The adoption of drip irrigation during the last decade has been impressive. While only 2% of the acreage was under drip irrigation in 2001, this percentage was 19% in 2003, 33% in 2007 and 78% in 2012. With drip irrigation, yields of 150tons/Ha are not uncommon these days. Of course, also other production factors as fertilizing, seeds, crop protection, mechanization and management must be at a very high level.

Rank	Country	Production year 2012 (metric tons)
1	China	50,000,000
2	India	17,500,000
3	United States	13,207,000
4	Turkey	11,350,000
5	Egypt	8,625,000
6	Iran	6,000,000
7	Italy	5,132,000
8	Spain	4,000,000
9	Brazil	3,874,000
10	Mexico	3,433,500
	World	**161,800,000**

CLIMATIC (ENVIRONMENTAL) AND SOIL REQUIREMENTS

TEMPERATURE

Optimum soil temperature for processing tomato's growth is 23°C during the day and 15°C at night: flowering is scarce with air temperature above 33°C and vegetative activity stops above 35°C.

The optimum air temperature for fruit ripening is about 26°C during the day and 18°C at night. Lycopene (the red pigment of which fruits are rich) production stops above 30°C.

SOIL

Tomatoes can be produced on a variety of soil types. Obviously, they grow optimally in deep, medium textured sandy loam or loamy, fertile, well-drained soils. Avoid sites that tend to stay wet and are subject to ponding. Leveling of fields is highly recommended, not only for planting but also for easy harvesting. In field production, plants depend on the soil for physical support and anchorage, nutrients and water. The degree to which the soil adequately provides these three factors depends upon topography, soil type, soil structure and soil management. Optimum pH is 6.8, the growth is scarce with pH above 8. Compaction pans are present in many soils. They are formed mainly, but not only, by machinery and implements traffic and are normally located at or just below plow depths. Although compaction pans may be only a few inches thick, their inhibitory effects on root growth can significantly reduce tomato yields.
A good seed bed is important because plant roots require water and oxygen from the soil pore space. A good seed bed is defined as:

- smooth and level seed bed, without large clods and weeds
- good soil tilth, soft structure of seedbed and more firm deeper

The right soil-air-water balance helps limit plant stress during drought periods and enables the plant to fully explore the soil profile for nutrients.
Plants are able to use water efficiently and grow strong roots for good anchorage. At the end tomato, both planted and transplanted needs a very smooth seedbed.

Tillage

PRIMARY AND SECONDARY

For tomato production, proper tillage is crucial for quick and uniform establishment of the crop in initial stages of growth, proper crop stand and thus optimal yields. Land preparation should involve enough tillage operations to get fine soil particles and make the soil suitable for seedlings or transplants establishment, providing the best soil structure for root growth and development.
In areas where winter is cold, **primary tillage must be carried out at fall**. Tilled soil winters in cold conditions and clods are sized by frost in an optimal way. Tillage and preparation can take substantial time and wintering of the fields helps to get proper soil tilth, specially in heavy soils, thus decreasing the tillage passages in spring.

Moldboard plows are currently the main tool for primary tillage. Tillage systems using the moldboard plow prepare the greatest soft soil volume for vigorous root growth. Fine particles and aggregates of soil allow the development of more extensive root systems, which can more efficiently access nutrients and water in the soil. Disking after moldboard plowing tends to re compact the soil and should be avoided.

Disk rippers can be used as an alternative, for primary tillage especially where hard pan exists or ponding is a problem. Development of root system is influenced by the soil profile. Root growth will be restricted if there is a hard pan, compacted layer or heavy clay zone. Tomatoes is a deep rooted plant and, under favorable conditions, some roots will grow to a depth of as much as 10 feet.
The majority of roots, however, will be in the upper 12 to 24 inches of soil.
Since root development is severely limited by compacted soil, proper land preparation should eliminate or significantly reduce soil compaction and hard pans.

Secondary tillage is carried out before planting in spring. The goal is to achieve a proper seedbed, which means soil particles of right size for good contact between transplants roots or seeds.
Large clods can cause a bad soil to roots contact, so that transplanting machinery does not perform in a proper way.

PRIMARY TILLAGE

A **Disk Ripper** is an alternative to plough, destroying compaction and hard pans. If a compaction pan exists just below or near mold-board plow depth, this hard pan can be disrupted by sub soiling to a depth of 16 to 18 inches to allow the development of a more extensive root system.
Sub soiling also helps increase water infiltration.

Summer or fall ploughing is still the most viable option for tomato cropping. In heavy soils, working depth can reach 40 centimeters.

Also Chisel Plows can be applied as an alternative to moulboard ploughs and disk rippers.

WATER MANAGEMENT THROUGH TILLAGE

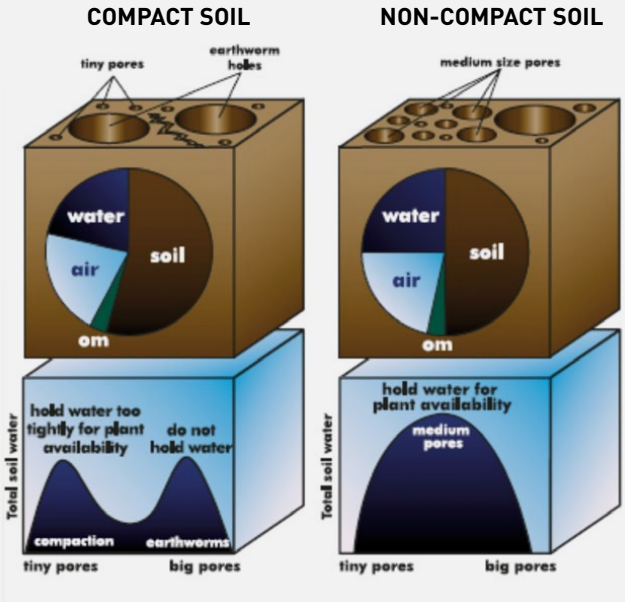
WE CAN NOT MANAGE WEATHER OR SOIL TEXTURE. BUT WE CAN MANAGE LEVEL AND TILLAGE OF FIELDS

Levelling fields is recommended on tomato fields, for easier transplanting, irrigation and harvesting.

PONDING

MISCONCEPTION: PONDING IS A RESULT OF TOO MUCH RAINFALL

Not necessarily. Usually ponding is a result of poorly managed soil. When soil is compacted, it cannot absorb water. Compacted soil is like a sponge that is squeezed tight: there is no space for air and water. To make matters worse, compacted soil forms an impenetrable layer that prevents excess water from draining through. The result is ponding.



Transplanting and Transplants

The vast majority of processing tomato fields are transplanted. Assuming transplanting and not seeding is carried out, tomato will require from 25,000 (USA) to 33,000-35,000 transplants per Ha (Italy). Typically, 5 to 6 week old tomato seedlings are transplanted into the field.
As with most similar vegetable crops, container-grown transplants are preferred over bare root plants. Container grown transplants retain transplant growing substrate (soil-substitute) attached to their roots after removal from the container (flat, tray). Many growers prefer this type transplant because

- they are less subject to transplant shock
- they usually require little if any replanting
- they resume growth more quickly after transplanting
- they grow and produce more uniformly.

Seeding tomatoes directly into the field is not recommended due to the high cost of hybrid seed and the specific conditions required for adequate germination, which are rather difficult to obtain. Most tomatoes are transplanted to the field from greenhouse-grown plants. Direct seeding has other disadvantages:

1. because of the shallow planting depth required for tomato seed, the field must be nearly level to prevent seeds from being washed away or covered too deeply with water-transported soil
2. harvest dates will be at least 2 to 3 weeks later for direct seeded tomatoes
3. a thinning is required.

For maximum production, transplants should never have fruits, flowers or flower buds before transplanting. An ideal transplant is young (6 weeks, 12-14 centimeters tall), does not exhibit an elongated form growth, and is slightly hardened at transplanting time. Rapid growth following transplanting helps in assuring a well established plant before fruit development.

In most cases, it is more economically feasible to have transplants produced by a commercial transplant grower than to grow them on the farm. When purchasing transplants, be sure the plants have the variety name, have been inspected and approved by a plant inspection service, and they are of the size and quality specified in the order.

Set transplants as soon as possible after removing from containers or after pulling. If it is necessary to hold tomato plants for several days before transplanting them, keep them cool (around 13°C if possible) and do not allow the roots to dry out prior to transplanting. When setting plants, place them upright and place the roots 3 to 4 inches deep. Setting plants at least as deep as the cotyledons has been shown to enhance plant growth and early fruit production and maturity. Completely cover the root ball with soil to prevent wicking moisture from the soil. Tomatoes grow best if nighttime soil temperatures average higher than 15°C.

After transplanting (especially within the first 2 weeks) it is very important that soil moisture be maintained so that plant roots can become well established.

TRANSPLANTING AND LAYING OUT OF DRIP IRRIGATION LINES

Modern transplanting machinery allows for transplanting and at the same time for laying drip irrigation lines.

Precision Planting

- Planting, as said above, is a second choice operation for tomato crops. If such a pattern has to be implemented, here are some suggestions.
- **Uniformity in tomato** is an important factor for high yield crops. Producing a high yield crop starts with the right balance between healthy, productive plants and the plant's ability to utilize available resources.
- **Uniformity begins** with a well-prepared seed bed and the use of precision vacuum planters.
- **Plants that emerge uniformly or transplants that start uniformly after transplanting**, progress at the same rate of development throughout the growing season and deliver improved yield potential.
- Precision planter is set with inter row spacing of 150 centimeters, spacing between seeds 5.8 centimeter to obtain a seed rate of 115,000 seeds per hectare. This is the double than the final target, but decreasing the seeds rate would be very risky. Granulators for insecticide distribution are a must on the planter.
- Seeds are usually pelleted. Seeding depth is 2 to 3 centimeters, working speed 4-5km per hour. The final target is 30,000-40,000 plants per hectare, and to get this target a manual thinning is required. Emergence of seedlings requires from 15 to 30 days, depending on soil temperatures.

Crop Protection

Crop protection is of paramount importance, because processing tomato is used to produce human food and the quality of fruit is crucial to get good price for the product. Diseases, insects, and weeds are serious competitors for crop, and spraying is needed on a regular basis. Weeds and/or pest can damage the yield up to the 100%, if not controlled or controlled too late.

Weed control is carried out both with pre-planting (or transplanting), pre-emergence and post emergence (on-top spraying). In pre-emergence, herbicide of total action can be used (glyphosate and similar). In post emergence, residual herbicides are used against broadleaves weeds and graminicides are used against grasses.
Weeds also make difficult mechanical harvesting. Tomato is not a strong competitor against weeds and many weeds can grow taller than the crop. Because weeds can become taller than the crop, tomato is more susceptible to yield losses due to weed competition compared to other high-canopy crops. Weeds losses from direct competition are only part of the problems that may be caused by weeds. Weeds as a rule also:

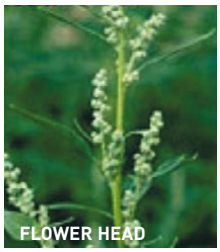
1. produce seed that increases future weed problems
2. act as co-hosts for insects and diseases
3. increase tillage needed for weed control.

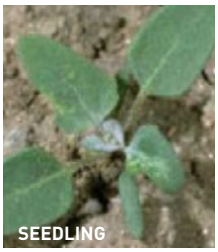
Insect and diseases control also is carried out by spraying the fields with proper chemicals. For fungi diseases, a spraying is scheduled each 10-15 days. Eradication (systemic) and contact fungicides are alternatively applied.
Higher working pressures are required in order to penetrate the crop canopy.

In certain areas, ripening chemicals are applied in order to speed up and make uniform the ripening process.

WEEDS

PIGWEED





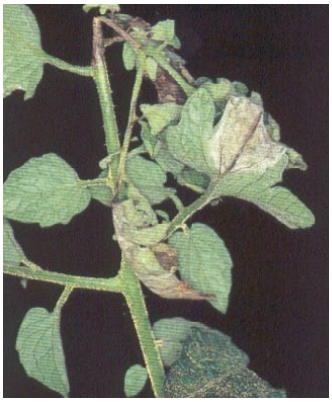
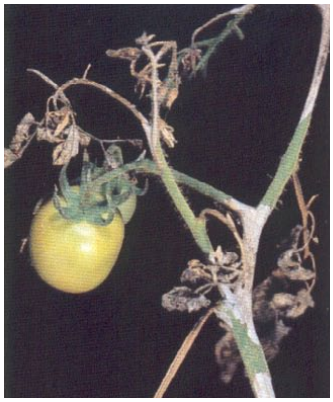
LAMBSQUARTER

VELVET LEAF

SOLANUM NIGRUM LEAFS FLOWERS FRUITS

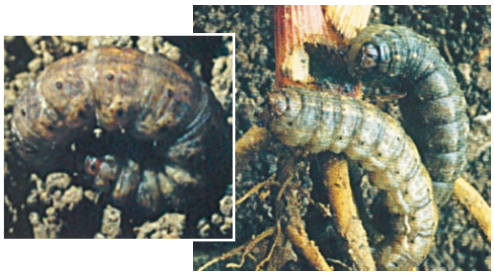
by Harald Hubich - photo taken by Harald Hubich.

INSECTS AND DISEASES

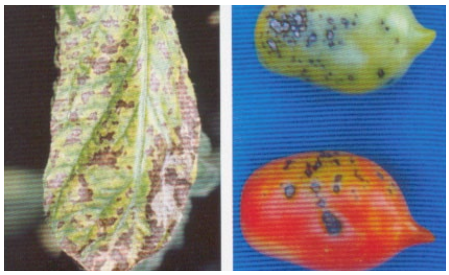




DOWNY MILDEW

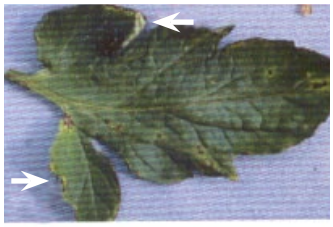
APHIDS



CUTWORMS

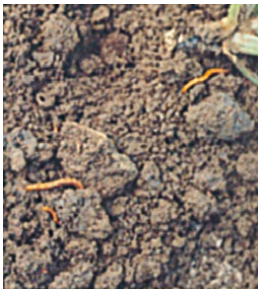


ALTERNARIA


BACTERIAL SPECKS





WIRE WORMS

Spraying

TOOLS

Guardian™ Front Boom Sprayers have clearance and balance which are crucial facts from agronomic point of view.

Delivering consistent droplet size is a critical part of sprayer operation. This function can be more important depending on which chemical is used and on what canopy type.

Hoeing

Hoeing is an essential operation, and helps with weed control, improving the texture of soil and managing limited water in dry soil conditions.
Hoeing is carried out when the plants have 3-5 leaves. At hoeing is also possible to carry out a top fertilization, if needed. A working depth about 5-8cm helps to kill weed that have survived herbicides applications (for example nightshade) and interrupts the porosity in the upper layer of soil. Interrupting porosity and closing surface cracking can help to reduces moistures losses. Sweeps or spikes can be used as ground engaging tools.

Fertilization

Fertilization of processing tomato, as for all crops,
should be based on soil tests results.
Requirements of crop are as follows:

	Production tons /hectare					
	40	50	60	70	80	90
Nutrients, kg /hectare						
N	100	125	150	175	200	225
P_2O_5	40	50	60	70	80	90
K_2O	160	200	240	280	320	360

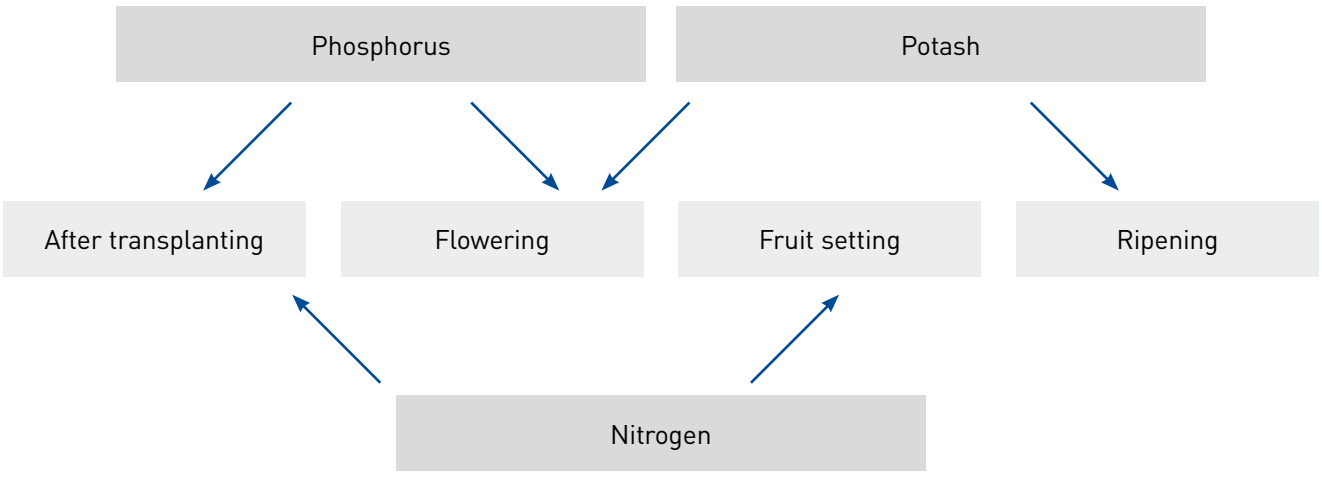
So, for example, in condition where soil is rich in potash but poor in Phosphorus and production target is 50 ton per hectare, fertilization plan could be:

1. N 120 total rate divided in two applications
2. P_2O_5 120 pre transplanting
3. K_2O 0 ----------

For maximum production in soils not particularly rich in P_2O_5 and K_2O:

1. N 200 pre transplanting and top dressing
2. P_2O_5 150 pre transplanting
3. K_2O 220 pre transplanting

NUTRIENT ABSORPTION TIMING



Irrigation

- Processing tomato is a typical irrigated crop. Different system are possible
- Surface irrigation
- Drip irrigation
- Sprinkler irrigation (hose reel irrigators, pivots)

With drip irrigation, starting investments per hectare are higher than with other systems.
Anyway, there are some agronomical advantages as

- fertirrigation, which is the possibility for applying fertilizer with irrigation water
- high efficiency of water used in irrigation (losses of water are very low when compared with other irrigation systems)
- high uniformity concerning water height and fertilizers' rates
- leaves are not wetted and therefore diseases spreading is hindered

Sprinkler irrigation is carried out both with hose reel systems (on the left) or pivot systems (below), depending on acreage. A large choice of sizes is available both for drums and pivot.

Mechanical Harvesting

Processing tomato is harvested both manually and mechanically, but without doubt a modern agriculture must be equipped with self propelled or pulled harvesters. Mechanical harvesting is possible because a complex work has been carried out to obtain:

1. proper varieties or hybrids, resistant to mechanical damage (bruising)
2. a proper shape and size of fruits
3. a relatively uniformity in ripening time.

Mechanical harvesting is carried out on 100% of acreage in California and on 70% of acreage in North Italy. New hybrids and increased fertilizing, irrigation and crop protection have also increased the yields: mechanical harvesters can be equipped with sorters, both electro mechanical and electronic. The result is that the labor requirements for harvest has dropped to 0.4 hour per ton.
The productivity of a modern self propelled harvester can be estimated in 300-400Ha per season (season lasts from 50 to 60 days).

Harvesting.
Self propelled harvester, 2 tractors with trailers, productivity is about 5 hectares in 9 hours.

Self propelled tomato harvester.
Note the catwalk for personnel engaged in sorting out the product when harvesters are not equipped with sorting devices.

Processing tomatoes ready for harvesting.
Fruit are very regular in shape, size and ripening stage.

Modern tomato harvester are equipped with electronic sorters, in order to sort out the green fruit from the ripe ones. Also clods are eliminated, thus obtaining a clean sample of tomato.
Productivity can reach 50tons per hour.

Machinery

IMPLEMENTING YOUR GROWTH PROJECTS

Crop producers know that their soil is the most precious natural resource, and better soil conditions mean higher crop yields. New Holland knows that every individual plant counts towards your bottom line and that's why we design our equipment specifically to help you maximize yield potential.

NEW HOLLAND TD 5 SERIES

These tractors can be used for light operations, as fertilizing, packing or sprayers pulling.

NEW HOLLAND 6000 SERIES

Cash crop tractors find application in primary, secondary tillage and planting.

NEW HOLLAND T7 SERIES

Cash crop tractors are typically used in primary tillage and soil preparation.

NEW HOLLAND T8 SERIES, SMARTRACK

For all fields and operations, these tractors combine power, outstanding floating and manoeuvrability.

NEW HOLLAND T8 SERIES, WHEELED

Tomato hauling is a demanding task. T8 tractors are the right answer concerning power and road speed.

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