

TOMATO

TOMATO CULTIVATION IN
OPEN FIELDS AND GREENHOUSES

INTRODUCTION

Tomato is one of the most popular vegetables in the world. With the help of modern irrigation technology, this crop can grow all year round.

Top tomato-producing countries in 2008 (million tons) were:
China 33.8; USA 12.5; Turkey 11.0; India 10.3; Italy 6.0

Tomato production is sensitive to temperature—the optimal temperature is 23-27° C. Temperatures lower than 15° C or higher than 35° (and night temperatures above 21°) are detrimental to fruit setting.

Tomatoes grow best in warm temperatures with a lot of light. Low levels of light (less than 15% of summer light levels) will greatly reduce fruit yield in fall or winter crops in greenhouses.

Tomato crops can be classified as either determinate or indeterminate: Determinate tomato crops will ripen and harvest at one time, whereas indeterminate tomato crops will grow as a vine that never tops off and can produce fruit throughout the season.

PROCESSING TOMATO AND FRESH TOMATO

There are two main groups:

1. Processing tomato—cultivated in open fields
2. Table tomato—cultivated in open fields or in greenhouses

Open field cultivation can produce 100-120 ton/ha. Table tomato cultivation in greenhouses can yield up to 500 ton/ha.

Different qualities are demanded by the market from each tomato type:

- Processing tomato—the brix (measure of the carbohydrate level in the fruit juices) is counted
- Table tomato—the consumer test and shelf life are dominant

Besides the tomato variety, other factors affect the quality of the tomato fruit. Irrigation and fertigation are the most influential of these factors.

Crop cycle

Processing tomato in open fields: 120-135 days, according to variety

Table tomato in greenhouses: 6-10 months

PROCESSING TOMATO

For tomato farmers, the main criteria for crop management is deciding whether to grow for quantity or quality (with maximum tonnage). Highly soluble solids (brix) are accompanied by lower yield.

The limited wetted volume under the drip system gives maximum flexibility of control, providing the right amount of moisture for each growing stage up until the harvest.

Soil and Water

Most soils are suitable for growing tomato, as long as there is good drainage. Optimal soil pH is 6-7.5.

The tomato plant is capable of developing a deep and well-spread root system. It's important to allow the roots to utilize the soil profile—up to 1.2 m in heavy soil, and 40-60 cm in light sandy soil. It's important to fill up the soil profile accordingly, before planting.

The tomato plant is relatively more tolerant to salinity. However, above 3.0 mS/cm you can expect a reduction in yield, but an increase in quality. The fruit is smaller and sweeter.

As tomato is sensitive to soil diseases, disinfecting treatment should be applied every year.

Temperature Requirements (Celsius) vs. Growing Stage (Processing Tomato in Israel)

Growth stages	Minimum	Optimum	Maximum
Gemination	11	16-29	34
Growth development	18	21-24	32
Fruit set—night	10	14-17	20
Fruit set—day	18	23-26	30
Turning red	10	20-24	30
Turning yellow	10	21-23	40

IRRIGATION (Processing Tomato)

Watering Guideline and Crop Factors—Drip Irrigation

Growth stage	Pre-planting Irrigation to 120 cm depth with sprinklers/rain	Germination and Establishment Seeds or seedlings 45-60 days	Flowering & Fruit Set Till the oldest fruit change color 20-30 days	Ripening 20-30 days
Crop factor and tips	100-250 mm	First dose: 30-50 mm Second dose: (after 7 days) 20-30 mm	0.4-0.6 Intensive irrigation starts 2 weeks after flowering starts. Filling up with technical irrigation of 50 mm. Intervals of 1-3 days	0.7-0.9 Last irrigation 10-20 days before harvest (50-80% red fruits). Plant utilizes the deep water storage.
Moderate stress management for higher brix				0.4-0.6
Tensiometer reading (in cbar) at 30-60 cm depth			10-30 cb, depending on soil type	40-60 cb for high brix, depending on soil type



Irrigation Guide Lines for Table Tomato in Open Fields

From planting to establishment, apply light irrigation of 5-10 m³/day/ha
For sandy soil, irrigate daily.

For medium to heavy soil, irrigate every 2-3 days.

After establishment, apply irrigation in wider intervals of 3-5 days, depending on the soil type.

In winter, irrigate every 5-7 days.

Irrigation quantity will be calculated according to ET and tensiometers (tensiometer station of 30 & 60 cm depth).

Total amount of water per crop cycle: 630-750 mm

Planting

Open fields

Double row on 1.5-2.0 m bed, with 30-50 cm between rows

25,000-30,000 plants/ha (5-6 plants /meter/ bed)

Irrigation Management

Using a tensiometer is recommended in order to better gauge the moisture availability at each profile depth and according to the plant's needs. This helps in deciding when to irrigate and how much (quantity) to irrigate.

Each station includes 2 units at a depth of 30 and 60 cm, or 20 and 40 cm, in light soil.

Water Stress and Soluble Solids Control (brix)

Deficit irrigation should be applied to put the tomato plant in a state of moderate controlled stress. This technique enables the grower to get higher soluble solids at minimal yield reduction.

The ideal time to apply deficit irrigation is when the first fruits show color.

Fertilization

In general, the fertilizer program should be based on a soil test, conducted before planting.

Minimum levels for Phosphorus and Potash in the soil:

Phosphorus (P): 25-30 mg/kg (for each 1.0 mg/kg missing, broadcast 20 kg/ha P₂O₅ or 12-14 kg/ha P₂O₅ via the drip system)

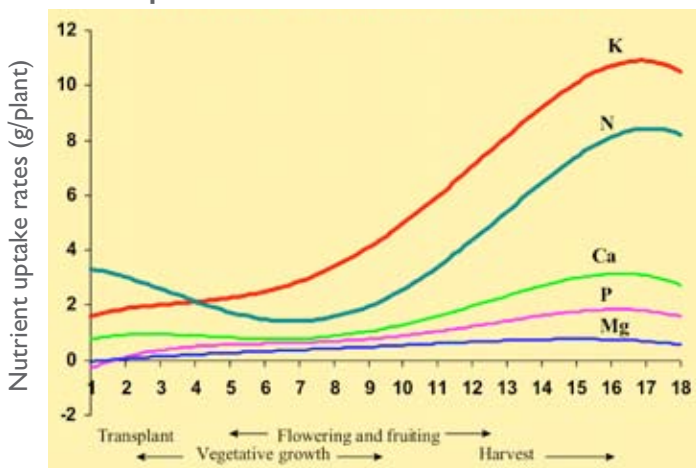
Add the required Phosphorus till the end of establishment stage (about 25-30 days after planting).

Potash (K): 14 mg/liter (CaCl₂ extraction method), or ΔF - (-)3,300 cal/mol.

For 10-12 mg/l, add 200 kg/ha K₂O. If less than 9 mg/l, add 400 kg/ha



Nutrient Uptake Rates for Tomatoes



* source-Huett 1985

Fertilizers Quantity Guide for Expected Crop of 100-120 t/ha, Absorbed by Plant

N	P	K
350	60 (138 kg P ₂ O ₅)	500 (600 kg K ₂ O)

The phosphorus and potash can be applied as a base or partly through the irrigation water.

NPK Ratio—Table Tomato

Crop Stages	N	P ₂ O ₅	K ₂ O
Germination and establishment	1	1	1
Flowering and fruit set	1	0.3	1.5
Till end of harvesting	1	0.2	1.5

Additional Micro- & Macro- Elements for Table Tomato

From picking time, the addition of Iron (Fe) and Manganese (Mn) is recommended. Magnesium (Mg) is also recommended for light soil.

SDI

The SDI (Sub-surface Drip System) is a recommended solution for processing tomato crops.

The heavy machinery used during harvesting can damage the drip line. This problem can be overcome with shallow installation, around 10 cm, which protects the drip lateral. After harvesting, the drip laterals are extracted and can be reused. The selection of suitable wall thickness should be considered for this operation.

Deep installation (30-40 cm) is practical for permanent installation and cultivation methods follow the same track.

The application of fertilizer directly to the root system at 30-40 cm contributes to improved efficiency and higher yields.

During the germination stage, wetting the seeds or young plants sufficiently can prove challenging when the dripline installation is deep. An efficient solution to this problem is using a portable sprinkler system.

AmnonDrip AS (Anti-Siphon) and TopDrip AS are most suitable for SDI application. Anti-siphon is a built-in characteristic of the dripper. It prevents sand from being sucked into the dripper during drainage.



GREENHOUSE (GH) CULTIVATION

Tomato crops in greenhouses are grown on local soil or on substrate (soilless culture).

In GH, tomato can be grown 10 months a year, producing 300-500 ton /ha (or even more, depending on the variety). This protected high-yield crop requires a professional drip system and fertigation system. A heating system is necessary in cold countries, and a cooling system or ventilated GH is required in hot places (tropical and sub-tropical climates).

Tomato in Soilless Culture

Growing tomato on substrate allows better control of moisture and oxygen levels, pH and nutrient availability; factors which all contribute to earlier production and high-quality yields.

The growing substrate is shallow—15-20 cm in height. At this shallow depth and high drainage rate, the water spread is limited.

Dense dripper spacing at low flow rate (1.0-1.6 l/hr) is required to achieve uniform, complete coverage of the growing substrate, avoid salinity buildup and facilitate maximal growing volume for the roots

Drainage System

In soilless culture, the surplus irrigation and the nature of the substrate create substantial drainage.

The design of an irrigation system and the growing beds or gutters must include the solution for the drainage recycle. (NDJ) design office can advise and design a complete system to suit your needs.)

Irrigation and Fertigation

The characteristics of the substrate and limited growing volume require intensive irrigation and fertilizer application:

1. Small water doses a few times a day, combined with continuous fertigation (4-8, with more pulses in some cases)
2. Increase of water quantity by 30-50% (depending on water quality) to allow leaching of salt buildup and fertilizer residue. CNL (Compensated Non-Leakage) drip system is recommended for pulse irrigation.



Laterals & Dripper Spacing

The density of the plants depends on light conditions and variety.

Growing conditions	Bed width/Lateral spacing (m)	Dripper spacing (cm)
Processing tomato	1.8-2.0: 1.0 lateral for two rows	50-75
Table tomato open field	1.6, 1.8: 1.0 lateral per row	40-50 (sandy soil 20/25)
Green house/ net house on soil (21,000-24,000 plants/ha)h	1.2: 1.0 lateral 1.6-2.0: 2 rows /beds, 50-60 cm between the rows, 2 laterals	40-50
Greenhouse soilless culture - Continuous bed - Rockwool block/bag system (average 23,000 plants/ha)	2 laterals per bed One dripper per plant	20-30 5-6 plants /meter

DRIP SYSTEM SOLUTIONS

Open fields

Tal drip—17 mm, 22 mm thin-walled dripline, 6-25 mil, 1.0, 1.7 l/h
TifDrip—16 mm traditional round strong pipe, 1.0, 1.6 l/hr
TopDrip—16 mm, 22 mm thin-walled PC dripline, 1.0, 1.6 l/h

Greenhouses

Amnon Drip PC—or CNL, 16 mm, 20 mm, 1.1, 1.6 l/h, 0.63-1.2 mm wall thickness
Click Tif HD—PC button dripper 1.3, 2.0, 3.0, 4.0 l/h, for growing in bags, sleeves, rock wall blocks or buckets

Dripline LPD

The Leak Prevention Device (LPD) is a special check-valve that prevents drainage from high places to the end of the row (a 1-2% slope is common in greenhouses). In pulse irrigation drainage of the submain and laterals can contribute to 30% variation along the GH, unless CNL drippers are used.

AmnonDrip



TalDrip



ClickTif HD



LPD



GREENHOUSE CLIMATE CONTROL

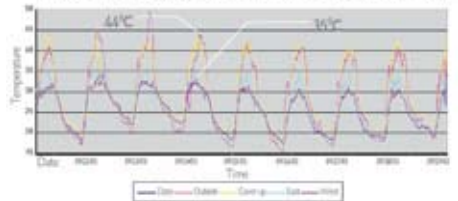
The GH structure and conditions cause an increase of temperature that affects the tomato plant development (flower pollination and fruit sets).

The NDJ Fogger system is very effective in helping to cool the greenhouse, while increasing humidity. Humidity helps the plant to better withstand high temperatures.

Bee pollination is very successful in tomato greenhouses. The bees become less productive in high temperatures, and the cooling system with the fogger will increase pollination percentage success.

TEST RESULTS OF TOMATO GREENHOUSE, BEIT-SHEAN ISRAEL

The graph line show the temperature differences, in/out of the greenhouse with -10°C



SPRAY SYSTEM WITH NDJ FOGGER SYSTEM

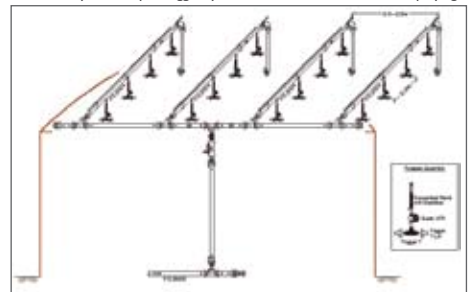
Pesticide and insecticide practice in GH with the same cooling system is highly effective and has numerous advantages:

- On-time operation with no delay
- One man operation
- Environmentally safe

It is most useful as a preventative treatment method, with minimal dose of 500 liters/ha.

The system can work with a wide range of pesticides

Schematic Layout of Super Fogger System for Climate Control and/or Spraying



IRRIGATION & FERTIGATION CONTROL UNITS

A compact head control unit, which controls irrigation and fertigation (climate control is optional), is available for greenhouse tomato crops.

The system monitors water requirements and scheduling, allowing pH and EC control of both the irrigated water and the drainage water (for soilless culture GH).





NaanDanJain is committed to finding the ideal solution for your tomato crop, tailored to your local climatic conditions, soil, water properties, and budget. Contact our office or your local dealer for further information.

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All information should be used only as a guideline.
For specific recommendations contact your local agronomist.



NaanDanJain Irrigation Ltd.
Post Naan 76829, Israel.
T: +972-8-9442180, F: +972-8-9442190
E: mkt@naandanjain.com www.naandanjain.com