Tomato nutrition management

Nutrient demands

Modern tomato cultivars are heavy mineral feeders. They consume high amounts of mineral nutrients and reward the grower with bountiful yields. As tomato fruits are rich in sugars and organic acids, their production requires rich potassium nutrition, because this element is very instrumental in the synthesis of these fruit ingredients.

Nutrient removal by fresh tomato fruits

Nutrient	Removal (kg/MT)		Nutrient	Removal (kg/MT)
Nitrogen (N)	2.2		Nitrogen (N)	**2.2**
Phosphorus (P)	0.5		Phosphorus (P_2O_5)	1.2
Potassium (K)	3.9		Potassium (K_2O)	**4.7**
Calcium (Ca)	1.6		Calcium (CaO)	2.2
Magnesium (Mg)	0.4		Magnesium (MgO)	0.6
Sulphur (S)	0.6		Sulphur (SO_3)	1.5
Zinc (Zn)	0.005		Zinc (Zn)	0.005
Manganese (Mn)	0.004		Manganese (Mn)	0.004
Iron (Fe)	0.008		Iron (Fe)	0.008
Boron (B)	0.003		Boron (B)	0.003
Copper (Cu)	0.002		Copper (Cu)	0.002
Molybdenum (Mo)	0.00002		Molybdenum (Mo)	0.00002

Total **K_2O** removal by tomatoes is **more than two-fold** higher than that of **N**

The specific effects of the nutrients on tomato yield and quality

	N	P	K	Ca	Mg	S	B	Fe	Mn	Cu	Zn
Fruit size	+	+	+	+	+	+	+			+	+
Number of fruits	+	+	+	+			+		+	+	
Sugars	+	+	+		+		+	+			+
Organic acids	+	+	+		+		+	+			+
Fruit external quality			+	+							+
Fruit firmness			+	+			+				
Lycopene (red pigment)			+								+
Resistance to biotic and a-biotic stresses			+	+		+					
Post-harvest duration			+	+		+	+				

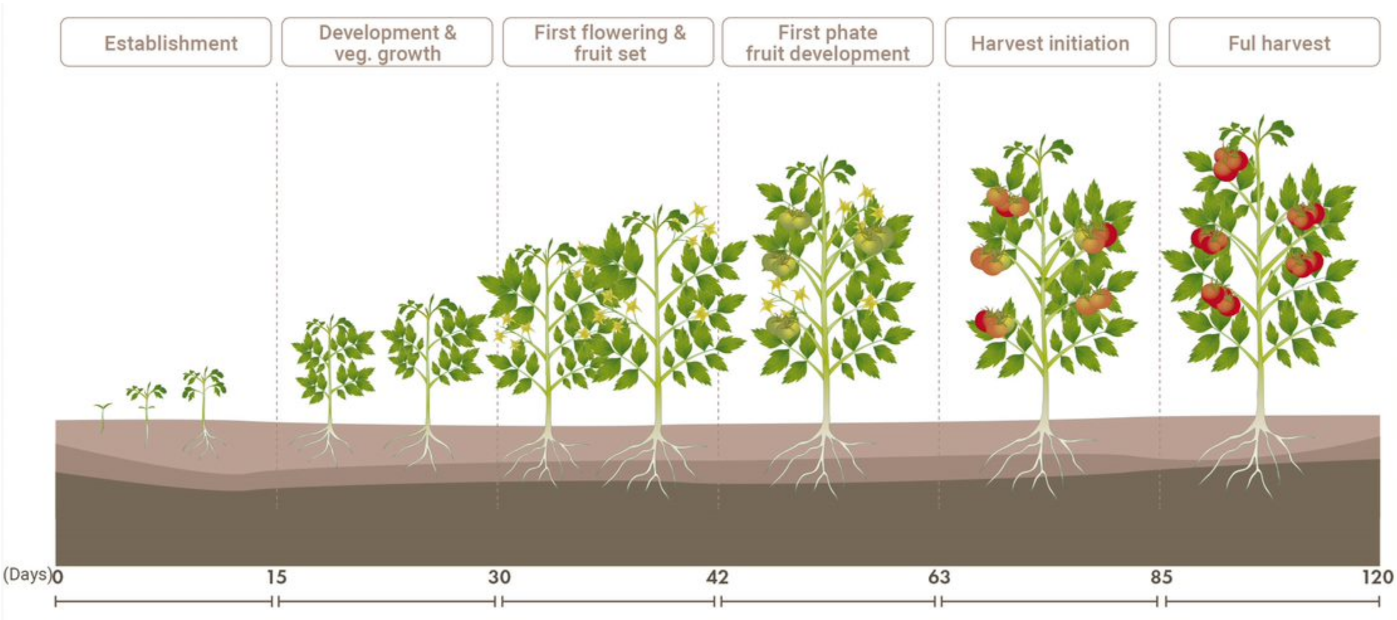
Summary of main nutrient functions

Each element has specific functions within the tomato plant morphology and functioning, and in most cases several elements participate in various stages of the same process. So, it can be schematically summarized as follows.

Nutrient	Main functions in the tomato plant
Nitrogen	Synthesis of structural and functional proteins (enzymes). Nitrate parti formation of cytokinins.
Phosphorus	Development of the root system, especially on seeds and transplants. En processes (ATP). Cell division.
Potassium	Source-to-sink carbohydrate transportation. Important osmoticum fa control. Photosynthesis enhancement. Enhancement of resistance to diseas
Calcium	Plant structural firmness. Improved post-harvest storage, and reduced s diseases.
Magnesium	The central atom of the chlorophyll molecule.
Sulphur	Synthesis of the essential amino acids, cysteine and methionine. En resistance to diseases and pests.
Iron	Chlorophyll synthesis process and a constituent of many enzymes e. catalase in the nutritional metabolism of the tomato plant.
Manganese	Photosynthesis process.
Boron	Cell walls and membranes formation (pectin and lignin). Metabolism an carbohydrates. Flowering, fruit-set and seed development.
Zinc	Auxins synthesis. Also, a constituent of the enzyme carbonic anhydrase metabolism of nutrients in tomato.

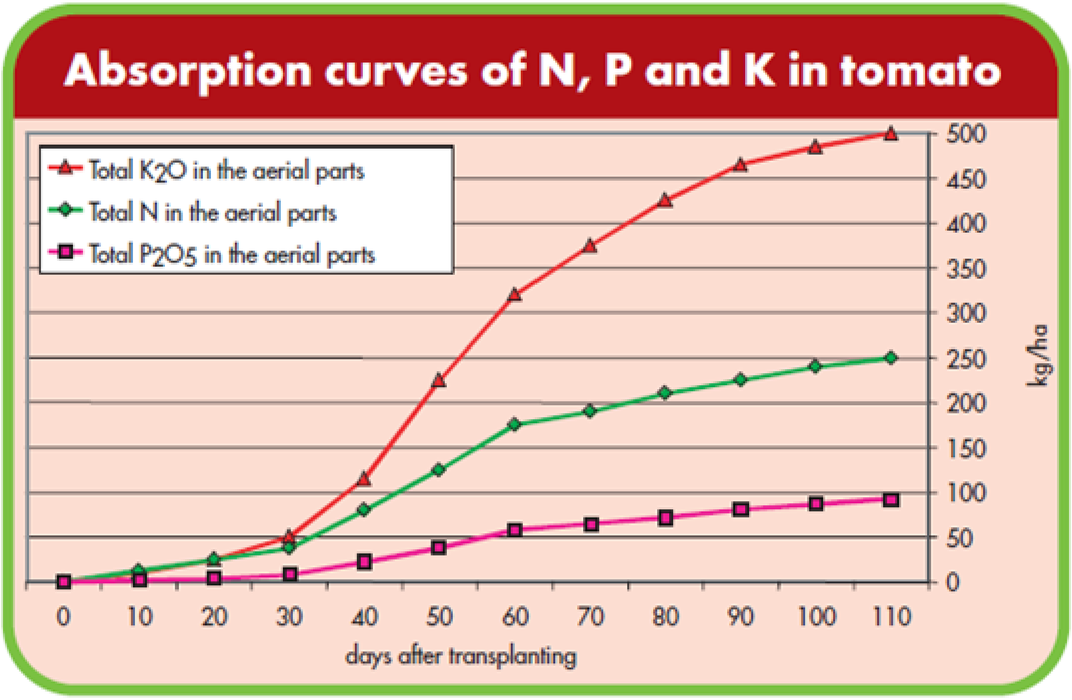
Copper	Metabolism of nitrogen and carbohydrates.
Molybdenum	N metabolism in the tomato plant, a central part of the nitrate-reductase en

Phenological growth stages



Nutrients uptake dynamics

The following figure represents the uptake dynamics of Nitrogen (N), Phosphorus (P) and potassium (K), of a determinate field tomato cultivar, with an expected yield of 90 MT/ha, throughout its entire life cycle.



In the first growing stage, the transplant or the seed must develop a substantial root system, which will support the development of the stems and foliage, which are the precondition for carrying the plant's yield. All three macro nutrients, i.e. N, P and K, should be available at sufficient amounts to enable the development of this root system. It should also be stressed in this regard, that the ideal form of nitrogen, to be supplied throughout the growth cycle of the tomato crop, is nitrate (NO_3^+).

The maximum share of ammoniacal nitrogen that the plant can take without reduced performance is 20% under field conditions, and merely 5-7% under hydroponic nutrition, (Voogt, 2002). Once the plant has developed sufficient root system, and above-ground biomass, it starts producing flowers, which rapidly develop into the first fruitlets, and they, in turn, start a long process of development and accumulation of sugars, organic acids, vitamins, pigments and anti-oxidants that enrich this fruit with their specific health values.

Now, as can be seen in the above scheme of the uptake curves in the following tables, the requirement for potassium keeps growing throughout the growth cycle of the tomato plant. The clear solution for these two requirements is the application of potassium nitrate, which is the only straight binary fertilizer that combines both these nutrients. Naturally, other nitrate carrying fertilizers should supply the additional nitrate- nitrogen required. These are calcium nitrate, magnesium nitrate and ammonium nitrate. Also, during this period of rapid fruit growth, fully soluble fertilizers are crucial for ensuring that a nutritional supply is available during the bulking up of the fruits.

The following plan is suggested for realizing the said requirements, for a determinate cultivar of field tomatoes with a life span of 140 days, and an expected yield of 100 MT/ha, by fertigation via drip irrigation.

The **relative shares** of nutrients to be applied according to the indicated phenological growth stages of the tomato crop, for an intended yield of 100 MT/ha, by fertigation via drip irrigation.

Fertilizer application phases	DAT (*)	N %	P_2O_5 %	K_2O %	CaO %	MgO %	S %
Transplant establishment	0-14	5	17	5	5	5	5
Plant development	15-28	12	17	7	15	20	20
From flower initiation to begin fruitset	29-42	20	17	17	20	20	20
From begin fruitset to fruit formation	43-63	20	16	20	20	20	20
From fruit formation to first harvest	64-84	17	17	18	20	20	20
From first harvest to full harvest	85-112	17	16	18	15	15	15
From full harvest to end of harvest	113-140	9	0	15	5	0	0
	TOTAL	100	100	100	100	100	100

*DAT= Days after transplanting

The **actual rates** of nutrients to be applied at the different phenological growth stages of the tomato crop, for an intended yield of 100 MT/ha, by fertigation via drip irrigation.

Step 5	Fertilizer application phases (grouped)	DAT (*)	N kg/ha	P_2O_5 kg/ha	K_2O kg/ha	CaO kg/ha	MgO kg/ha	S kg/ha
I	Transplant establishment to plant development	0-28	47	34	60	30	25	19
II	From flower initiation to fruit formation	29-63	110	33	185	60	40	30
III	From fruit formation to full harvest	64-112	94	33	180	53	35	26
IV	From full harvest to end of harvest	113-140	25	0	75	8	0	0
		TOTAL	275	100	500	150	100	75

Growth stage (DAT)	Explanation of the changes in the demand dynamics
0-28	Relatively balanced rates of N, P, K and Ca, for establishing root system building shoot biomass.
29-63	Much higher N demand for producing the flowers, the fruit-set and fruit e development stages. P requirement remains stable at this time for early s formation; Very high K demand for fruit formation and its bulking up. Increa demand for Ca, Mg and S, for continued vegetative development.
64-110	A slight reduction in the vegetative development dictates somewhat low requirement. Stable P demand. All other nutrients (K, Ca, Mg and S) show same pattern as the nitrogen, i.e. stable and slightly lower demand for lower pace of vegetative and regenerative organs.
111-140	Markedly reduced requirement for all nutrients, due to markedly lo production of shoots and fruits. The highest demand is for K (K:N = 3:1), w is required for the continued bulking up of the developing fruits.