Strawberry analysis chart – optimum ranges

Horticulture Development Company

Water mineral analysis

Suitability of water sources for use in irrigation of strawberries

Parameter	Maximum	Notes
Electrical Conductivity (EC) (uS, 20°C)	900	• When the EC of the source water is high it is difficult to add sufficient fertiliser to produce a satisfactory feed without an excessively high EC
Bicarbonate Hardness, mg/L	240	• High levels are often associated with high pHs which can in turn lead to low availability of Fe and P and formation of insoluble precipitates which block drippers • Higher levels can be allowed but the amount of acid required to reduce the level to the recommended 50 mg/L can lead to nutrient imbalances
Nitrate (NO_3) N, mg/L	50	• High levels can cause excessive growth particularly where further N has to be added for acidification
Ammonium (NH_4) N, mg/L	21	• Higher levels can occur in feed solutions for substrate crops particularly for everbearer varieties with a higher N requirement • Excess levels limit Ca uptake and affect fruit firmness and colour
Potassium (K), mg/L	-	• Excessively high levels are unlikely to be encountered
Phosphorous (P), mg/L	-	• Excessively high levels are unlikely to be encountered
Calcium (Ca), mg/L	-	• Excessively high levels are unlikely to be encountered
Magnesium (Mg), mg/L	-	• Excessively high levels are unlikely to be encountered
Sodium (Na), mg/L	35-72	• Substrate grown crops are most susceptible • Excess causes scorch of petioles and sepals and yield reduction at higher levels
Chloride (Cl), mg/L	52-140	• Higher levels (towards the upper limits) acceptable for soil grown crops on trickle irrigation • Excess causes damage to roots and yield reduction but level depends on climate, substrate and plant type
Boron (B), mg/L	0.22-0.33	• Some authorities suggest <0.22 for substrate crops
Iron (Fe), mg/L	1.0	• High levels of iron in source water can lead to oxides forming which will block drippers • Feed solutions for substrate crops use iron chelates and can have higher levels (<1.7)
Manganese (Mn), mg/L	27.0	
Zinc (Zn), mg/L	0.35	• Some authorities suggest a higher limit - up to 1.3 can be allowed for substrate crops • At very high levels, leaf toxicity symptoms can be seen
Copper (Cu), mg/L	0.5	• General recommendation, not specific to strawberries
Molybdenum (Mo), mg/L	0.1	
Aluminium (Al), mg/L	2.0	• General recommendation, not specific to strawberries
Fluoride (Fl), mg/L	1.0	• General recommendation, not specific to strawberries
Silicon (Si), mg/L	22.0	• Excess causes albino fruits and reduced yield

Substrate analysis

Normal ranges for substrate production of strawberries

Parameter	Range	Notes
Electrical Conductivity (EC) (uS, 20°C)	660-1100	• Indicated range refers to substrate EC when reported by laboratory analysis, **not** the EC of the feed solution within the substrate as measured by portable probes such as the WET sensor. The latter will give a higher reading equivalent to the run-off solution • High conductivities reduce water uptake and increase fruit firmess and flavour but can reduce yields and in extreme cases cause marginal scorch to the foliage • Excessive ECs can be reduced by flushing with Calcium nitrate solution (for excess NaCl) or plain water
Nitrate (NO_3) N, mg/L	31-92	• Deficiency causes small, yellow or reddish leaves and poor growth • High levels can cause excessive growth
Ammonium (NH_4) N, mg/L	<3.3	• Excess levels limit Ca uptake and affect fruit firmness and colour
Potassium (K), mg/L	65-129	• Deficiency causes poorer flavoured fruit and brown leaf margins • Excess levels limit Ca uptake and affects fruit firmness and colour
Phosphorous (P), mg/L	7-20	• Deficiency causes small pale leaves, small fruit and lower yields
Calcium (Ca), mg/L	53-110	• Deficiency causes tip-burn on the young leaves and soft fruit particularly when associated with high K or Mg levels • Excessive calcium is not normally a problem
Magnesium (Mg), mg/L	13-26	• Deficiency causes interveinal reddening of older leaves • Excessive magnesium is not normally a problem but could reduce K uptake
Sodium (Na), mg/L	<51	• To reduce excess salts flush through with Calcium nitrate solution
Chloride (Cl), mg/L	<77	• To reduce excess salts flush through with Calcium nitrate solution
Boron (B), mg/L	0.12-0.19	• Deficiency causes yellowed leaves and small malformed fruit • Excess causes leaf burn and in extreme cases sepal and calyx scorch
Iron (Fe), mg/L	0.62 -1.54	• Deficiency causes interveinal yellowed young leaves, in extreme cases completely bleached, but symptoms more often caused by poor root uptake than low levels in substrate
Manganese (Mn), mg/L	0.24-0.48	• Deficiency causes interveinal leaf yellowing, more diffuse than with Fe deficiency
Zinc (Zn), mg/L	0.72 -1.07	• Deficiencies cause pale green leaves with narrow concave blades – some authorities also report poorer flavoured fruit • Excess causes leaf scorch and reduces Fe uptake
Copper (Cu), mg/L	0.02-0.04	• Deficiency causes yellowed leaves, shoot die-back and small fruit
Molybdenum (Mo), mg/L	<0.02	• Deficiency or excess symptoms are not normally seen in substrate strawberries

Note: Guideline ranges from Lieten (2003) for peat, based on 1:1.5 extraction method, increased by 10% to take account of the 1:5 extraction method used in UK laboratories.

Leaf analysis

Recommended ranges – Soil grown strawberry crops

	Parameter	Range: Deficiency	Range: Satisfactory	Range: Toxicity	Notes
% of dry matter	**Nitrogen (N)**	<1.5	2.6-3.0		• Deficiency causes small, yellow or reddish leaves and poor growth • High levels can cause excessive growth
	Phosphorous (P)	<0.2	0.25-0.30		• Deficiency causes small pale leaves, small fruit and lower yields
	Potassium (K)	<1.5	1.5-2.0		• Deficiency causes poorer flavoured fruit and brown leaf margins • Excess levels limit Ca uptake and affect fruit firmness and colour
	Magnesium (Mg)	<0.15	0.15-0.20		• Deficiency causes interveinal reddening of older leaves • Excessive magnesium is not normally a problem but could reduce K uptake
mg/kg of dry matter	**Iron (Fe)**	<45	45-250		• Deficiency causes interveinal yellowed young leaves – in extreme cases completely bleached • Deficiency can be due to poor root growth, waterlogging, or high pH • To correct, improve drainage, moderate irrigation, consider using Iron EDTA sprays • Excess symptoms are not normally seen
	Zinc (Zn)	<10	15-30	>50	• Deficiencies cause pale green leaves with narrow concave blades – some authorities also report poorer flavoured fruit • Excess causes leaf scorch and reduces Fe uptake
	Boron (B)	<15	20-40	>40	• Deficiency causes yellowed leaves and small malformed fruit • Excess causes leaf burn and in extreme cases sepal and calyx scorch
	Manganese (Mn)	<20	30-100	>100	• Deficiency causes interveinal leaf yellowing, more diffuse than with Fe deficiency • Deficiency can be due to poor root growth or high pH
	Copper (Cu)	<5	7-15	>15	• Deficiency causes yellowed leaves, shoot die-back and small fruit

Leaf analysis

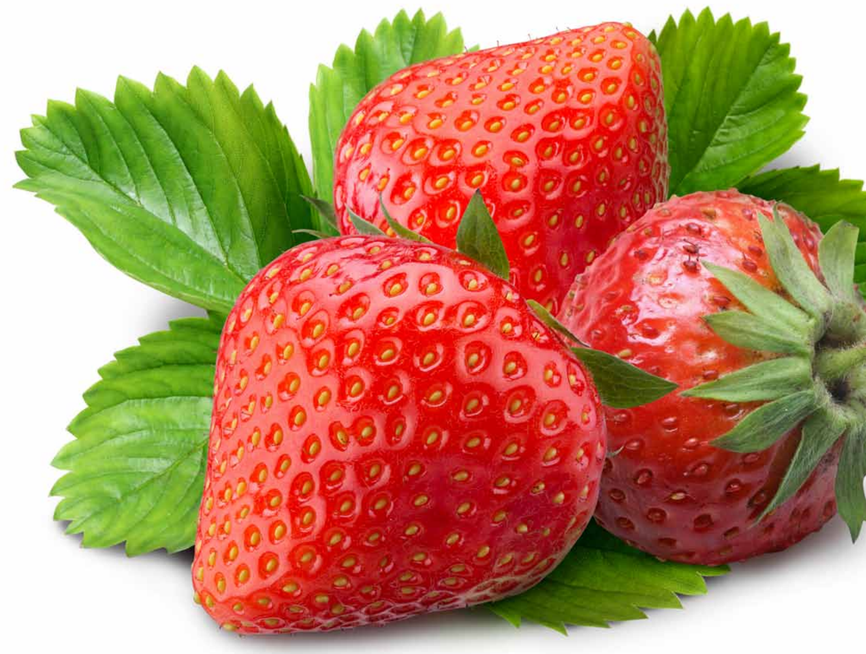
Recommended ranges – Substrate grown strawberry crops

	Parameter	Range: Deficiency	Range: Satisfactory	Range: Toxicity	Notes
% of dry matter	**Nitrogen (N)**	<1.5	2.0 -3.5		• Deficiency causes small, yellow or reddish leaves and poor growth • High levels can cause excessive growth
	Phosphorous (P)	<0.2	0.3-0.6		• Deficiency causes small pale leaves, small fruit and lower yields
	Potassium (K)	<1.5	1.5-3.0		• Deficiency causes poorer flavoured fruit and brown leaf margins • Excess levels limit Ca uptake and affect fruit firmness and colour
	Magnesium (Mg)	<0.2	0.3-0.5		• Deficiency causes interveinal reddening of older leaves • Excessive magnesium is not normally a problem but could reduce K uptake
	Calcium (Ca)	<0.8	1.0-2.0		• Deficiency causes tip-burn on the young leaves and soft fruit particularly when associated with high K or Mg levels • Excessive calcium is not normally a problem
	Sodium (Na)			>0.1-0.3	• Substrate grown crops are most susceptible • Excess causes scorch of petioles and sepals and yield reduction at higher levels • Reduce by flushing with Calcium nitrate solution
	Chloride (Cl)			>0.5	• Excess causes damage to roots and yield reduction but level depends on climate, substrate and plant type • Reduce by flushing with Calcium nitrate solution
mg/kg of dry matter	**Iron (Fe)**	<45	50-200	>350	
	Zinc (Zn)	<20	20-65	>120	• Deficiencies cause pale green leaves with narrow concave blades – some authorities also report poorer flavoured fruit • Excess causes leaf scorch and reduces Fe uptake
	Boron (B)	<30	30-50	>65	• Deficiency causes yellowed leaves and small malformed fruit • Excess causes leaf burn and in extreme cases sepal and calyx scorch
	Manganese (Mn)	<20	50-250	>250	• Deficiency causes interveinal leaf yellowing, more diffuse than with Fe deficiency • Deficiency can be due to poor root growth or high pH • Excess symptoms are not normally seen in substrate strawberries
	Copper (Cu)	<2	5-20	>25	• Deficiency causes yellowed leaves, shoot die-back and small fruit • Excess symptoms are not normally seen in substrate strawberries
	Molybdenum (Mo)	<0.3	0.5		• Deficiency or excess symptoms are not normally seen in substrate strawberries

Feed analysis

Recommended nutrient ratios for substrate production of strawberries

Parameter	Range	Notes
Ammonium (NH_4) N as % of Total N	5 – 20 %	• During flowering and fruiting the % ammonium N should be restricted as it can reduce Ca uptake and affect fruit firmness and colour • Higher levels can be allowed in feed solutions for everbearer varieties with a high N requirement
Potassium (K) : Calcium (Ca) ratio	0.35 –1.9	• Lower K:Ca ratios are recommended during the vegetative phase and higher during fruiting • Variety requirements vary – some require higher K for fruit flavour



Feed analysis

Normal ranges for substrate production of strawberries

Parameter	Range	Notes
Electrical Conductivity (uS, 20°C)	1000-2000	• High conductivities reduce water uptake and improve fruit firmness and flavour but can reduce yields and in extreme cases cause marginal scorch to the foliage • Excessive ECs can be reduced by flushing with Calcium nitrate solution or plain water
Bicarbonate Hardness, mg/L	50-150	• Levels below 50 mg/L can result in excessive acidity • High levels are often associated with high pHs which can in turn lead to low availability of Fe and P and formation of insoluble precipitates which block drippers • Excessive bicarbonate hardness can be reduced by the addition of acids such as nitric, phosphoric or sulphuric • Small reductions in hardness can also be achieved by the use of acidifying fertilisers such as urea phosphate or fertilisers containing ammonium N
Nitrate (NO_3) N, mg/L	110-140	• Deficiency causes small, yellow or reddish leaves and poor growth • Higher levels can be allowed in feed solutions for everbearer varieties with a high N requirement • High levels can cause excessive growth
Ammonium (NH_4) N, mg/L	7-14	• Higher levels can be allowed in feed solutions for everbearer varieties with a high N requirement • Some authorities advise zero NH_4 N during fruiting • Excess levels limit Ca uptake and affect fruit firmness and colour
Potassium (K), mg/L	140-250	• Deficiency causes poorer flavoured fruit and brown leaf margins • Higher levels can be allowed in feed solutions for certain everbearer varieties • Excess levels limit Ca uptake and affect fruit firmness and colour
Phosphorous (P), mg/L	31-46	• Deficiency causes small pale leaves, small fruit and lower yields
Calcium (Ca), mg/L	140-180	• Deficiency causes tip-burn on the young leaves and soft fruit particularly when associated with high K or Mg levels • Excessive calcium is not normally a problem
Magnesium (Mg), mg/L	30-40	• Deficiency causes interveinal reddening of older leaves • Excessive magnesium is not normally a problem but could reduce K uptake
Boron (B), mg/L	0.11-0.17	• Deficiency causes yellowed leaves and small malformed fruit • Excess causes leaf burn and in extreme cases sepal and calyx scorch
Iron (Fe), mg/L	1.1-1.7	• Deficiency causes interveinal yellowed young leaves, in extreme cases completely bleached • Deficiency can be due to poor root growth, waterlogging, or high pH • To correct, improve drainage, moderate irrigation, consider using Iron EDDHA instead of EDTA if the pH cannot be reduced easily • Excess symptoms are not normally seen
Manganese (Mn), mg/L	0.55-1.11	• Deficiency causes interveinal leaf yellowing, more diffuse than with Fe deficiency • Deficiency can be due to poor root growth or high pH. • Excess symptoms are not normally seen in substrate strawberries
Zinc (Zn), mg/L	0.46-0.65	• Deficiencies cause pale green leaves with narrow concave blades – some authorities also report poorer flavoured fruit • Excess causes leaf scorch and reduces Fe uptake
Copper (Cu), mg/L	0.03	• Deficiency causes yellowed leaves, shoot die-back and small fruit • Excess symptoms are not normally seen in substrate strawberries
Molybdenum (Mo), mg/L	0.05	• Deficiency or excess symptoms are not normally seen in substrate strawberries

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