



Ontario Hop Soil Fertility Guideline

Prepared by Dr. Mehdi Sharifi,
AAFC Summerland, BC.



This Fertility Guideline is the outcome of, “Soil Fertility Management for Hopyards in Southern Ontario – A Literature Review”, sponsored by OHGA, OCB, and Canada Summer Jobs (CSJ) and supported by OMAFRA, Trent University, and Agriculture and Agri-Food Canada. It contains general guidelines to assist hop growers in managing soil fertility.

In using the Guideline, please note:

- Soil properties affect nutrient availability and plant growth. Soil properties need to be determined through proper testing and, if not optimum, adjusted through a multi-year management program.
- Granular fertilizer should be broadcasted and incorporation in the top 6 inches of soil.
- The Guideline assumes conventional practices. When alternative practices are used (i.e. soil amendments, mulch, and cover crops) fertilizer rates must be adjusted accordingly.
- While plant testing is usually more suitable for micronutrients, optimum ranges for hops have not yet been developed.
- Use soil and plant sampling protocols recommended by the accredited laboratory of your choice – see <http://www.omafra.gov.on.ca/english/crops/resource/soillabs.htm>.

Soil Properties

Soil Properties	Optimum range for Hopyards		Sources	Remarks
	Soil texture ⁽¹⁾			
	Coarse soil texture	Medium/Fine soil texture		
pH	6 - 6.5	6 - 6.5	<p>pH reduction:</p> <ul style="list-style-type: none"> • Elemental sulfur • ammonium • sulfate based fertilizers <p>pH increase:</p> <ul style="list-style-type: none"> • calcite (lime) and dolomite • dolomite ⁽⁴⁾ 	pH of 5 - 7.5 can be tolerated by the plant with no reduction in yield <ul style="list-style-type: none"> • Mn toxicity risk in low pH • Zn and Fe deficiencies risk in high pH
Soil Organic Matter (SOM) ⁽²⁾	3 - 4%	4 - 6%	composts, manures, cover crops, and other organic mulches	Maintenance of SOM in a medium texture soil requires input of about 4,850 lb/ac of organic matter annually. Addition of high C:N ratio (> 20) organic material will tie up N and recommended N rates need to be increased.
Cation Exchange Capacity (CEC) (meq/100g) ⁽³⁾	10 - 16	16 - 30	Organic matter	Soil with high clay and organic matter have high CEC CEC goes up 2 points for every 1% increase in organic
Electrical conductivity (EC) (µS/cm)	0.75 - 1.50	0.75 - 1.50	Not Applicable	Some soil amendments have high salt level (EC) and can damage plants

{1} Coarse textured soils: sand, loamy sand and sandy loam; Medium textured soils: loam, silt loam and silt; Fine textured soils: sandy clay, sandy clay loam, clay loam, silty clay loam, silty clay, clay.

{2} www.omafra.gov.on.ca/english/crops/pub811/8building.htm

{3} www.omafra.gov.on.ca/english/crops/hort/news/hortmatt/2015/11hrt15a1.htm

{4} www.omafra.gov.on.ca/english/crops/pub811/9fertilizer.htm

Drainage: hops prefer well-drained conditions. Adding SOM and installing drainage will improve wet soils.

Topography: if slopes are more than 2%, erosion can be reduced by no-tillage, using cover crops, and contour line planting. However, uneven or sloped hopyards are inherently unsafe and should be avoided.

Plant Testing

Nutrient	Unit	Petiole Sufficiency Range ⁽¹⁾	Nutrient	Unit	Petiole Sufficiency Range ⁽¹⁾
Macronutrients			Micronutrients		
Nitrate (NO₃⁻)	ppm	4,999 - 12,000	Boron (B)	ppm	24 - 75
Phosphorous (P)	%	0.29 - 0.60	Iron (Fe)	ppm	30 - 60
Potassium (K)	%	1.49 - 2.50	Zinc (Zn)	ppm	24 - 54
Calcium (Ca)	%	0.79 - 1.20	Copper (Cu)	ppm	10 - 25
Magnesium (Mg)	%	0.24 - 0.80	Manganese (Mn)	ppm	25 - 150
Sulfur (S)	%	0.16 - 0.32			

Source: Sara Del Moro, 2014 Great Lakes Hop & Barley Conference

{1} Hop petioles from mature leaves (5-6 ft. off the ground) should be collected just prior to the plant reaching the wire.

Macronutrients

Nutrient	Plant Removal (lb / ac)	Soil Test (ppm)	Establishment	Fertilizer Rate (lbs nutrient / ac) ⁽⁷⁾				Source (N-P-K)	Application Method			Remarks
				Coarse soil texture ⁽⁸⁾	Medium/Fine soil texture	Soil	Fertigation		Foliar			
Nitrogen (N)	104 - 243	N/A ⁽¹⁾	Full	SOM < 3 125 - 175	SOM 3 to 9 100 - 125	SOM < 4 100 - 150	SOM 4 to 9 80 - 100	Conventional: • Urea (46-0-0) • Ammonium sulphate (21-0-0) • Calcium nitrate (16-0-0) • Potassium nitrate (13-0-44)	✓	✓		One percent organic matter in soil releases 10-20 lbs/ac of N Soil test for N are unreliable in humid environments ⁽²⁾ N should be applied starting 30 to 45 day after emergence (late May) N should not be applied at more than 22 lbs/ac at any one time.
		N/A	New	60 - 90	50 - 60	50 - 75	40 - 50	Alternative Sources: • Compost, manure, vine / crop residues • legume cover crops			Only for critical high demand period	
Phosphorous (P)	34 - 67	≤ 15 Low	Full	Low 60 - 100	Medium 40 - 60	High 20 - 30	Conventional: • Triple superphosphate (0-46-0) • Di-ammonium phosphate (18-46-0) • Mono-ammonium phosphate (11-48-0)	✓	✓		Soils with high levels of Al and Fe may need additional P for optimum growth	
		16 - 40 Medium > 40 High ⁽³⁾	New	85 - 140	55 - 85	30 - 40	Alternative Sources: • Compost, manure					
Potassium (K)	98-229	≤ 100 Low	Full	Low 120 - 140	Medium 95 - 120	High 50 - 70 ⁽⁵⁾	Conventional: • Potassium chloride (0-0-60) • Potassium sulfate (0-0-50) • Potassium magnesium sulfate (0-0-22, 11.2% Mg, 22.7% S) • Potassium nitrate (13-0-44)	✓	✓	✓	Supplemental application for foliar	
		101 - 180 Medium > 180 High ⁽⁴⁾	New	100 - 120	80 - 100	40 - 60	Alternative Sources: • kelp mill, woodash					
Calcium (Ca)	137 - 264	> 1800		Data not available				Conventional: • lime (CaCO ₃) • Gypsum (CaSO ₄)	✓		✓	In pH range of 6 - 8 Ca and Mg are usually in sufficient level. The ratio of Mg:Ca should be around 1:6.
Magnesium (Mg) ⁽⁶⁾	24 - 67	< 20 Low 20 - 39 Medium 40-100 High		Low 27	Medium if K >250 ppm and pH < 6.5, apply 27 lbs/ac	High 0	Conventional: • Magnesium sulfate (MgSO ₄ , 9%) • Dolomite (MgCO ₃ -CaCO ₃ , 6-20%)	✓				
Sulfur (S)	N/A	≤ 20 Low ⁽⁹⁾ 30 Optimum		general application of 30 lb S/ac if below 30 ppm				Conventional: • Elemental sulfur (90-95%) • Ammonium sulfate (24%), Potassium sulfate (40-44%), Magnesium sulfate (13%), Zinc sulphate (14%) • Gypsum (17%), Potassium magnesium sulfate (22%), Single superphosphate (11-12%)	✓			30 to 40 lbs S/acre on annual basis if soil rpon to S deficiency.
							Alternative Sources: • manure, compost • legume based green manure					

{1} N/A=Not applicable

{2} www.omafr.gov.on.ca/english/crops/facts/info_nitrogen.htm

{3} Based on Ontario accredited P test (Olsen P)

{4} Based on Ontario accredited K test (Ammonium Acetate pH=7)

{5} 20% K leaching in neutral soils is assumed.

{6} Ammonium acetate method

{7} lbs/ac x 1.12 = Kg/ha

{8} Coarse textured soils: Sand, loamy sand and sandy loam; Medium textured soils: Loam, silt loam and silt; Fine textured soils: sandy clay, sandy clay loam, clay loam, silty clay loam, silty clay, clay

{9} Sulfate (SO₄ - S) level

Micronutrients

Nutrient ⁽¹⁾	Soil Test (ppm) ⁽²⁾		Fertilizer rate (lbs nutrient / ac) ⁽³⁾	Source	Application Method		Remarks
	DTPA	Mehlich-3 or 0.1N HCl			Soil	Foliar	
Boron (B)	Hot water extraction: 1 - 2		1 - 1.5 lb B/ac soil application 0.25 lbs B/ac foliar application	Conventional: • Borax Na ₂ B ₄ O ₇ ·10H ₂ O • Boric acid H ₃ BO ₃ • Solubor (Na ₂ B ₄ O ₇ ·4H ₂ O + Na ₂ B ₁₀ O ₁₆ ·10H ₂ O) Alternative Sources: • manures, compost, woodash • superphosphate, liming materials	✓	✓	• Boron becomes toxic in excess quantities and can cause plant toxicities quickly. • Foliar spray and broadcast on the row are preferred methods of application.
Iron (Fe)	17 - 25	25 - 50	2 - 4 lbs Fe/ac soil application 0.25 lbs Fe/ac foliar application (follow instructions on the product label)	• Ferrous ammonium phosphate • Ferrous ammonium sulfate • Ferrous sulfate, Ferric sulfate • Iron chelates	✓	✓	Fe is very sensitive to pH. Each unit increase in pH reduces the Fe solubility by 1,000 times. Use Fe-chelate for foliar application.
Zinc (Zn)	1.5 - 2	5 - 8	4 - 6 lbs Zn/ac	• Zinc chelate • Zinc oxide • Zinc oxysulfate • Zinc sulfate	✓	✓	Foliar application of Zn sulphate or chelate (0.15-0.18%) 3 - 5 sprays from tying to flowering.
Copper (Cu)	1 - 2	2 - 3	1 - 3 lbs Cu/ac soil application	• Copper sulfate • Copper chelates • Cupric ammonium phosphate	✓	✓	
Manganese (Mn)	13 - 30	33 - 50	2 - 5 lbs Mn/ac soil application	• Manganese sulfate • Manganese chelate • Manganese oxide	✓	✓	High level of soil Mn is toxic for the plant.

{1} Hot water extraction method for B; DTPA or 0.1N HCl extraction method for Fe, Zn, Cu and Mn.

{2} Soil test levels are the general optimum levels recommended by A&L lab. Soil application should be on the hop row (3 - 4 ft wide).

{3} lbs/ac x 1.12 = Kg/ha