

# Macronutrient Management in Hazelnuts: Comparison of Oregon and OMAFRA's Guidelines over Farmer's Practice in Ontario

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Ontario

# Presentation Outline

- Essential Plant Nutrient Management in Hazelnuts
  1. Primary nutrients
  2: Secondary nutrients
  3: Micronutrients
- Hazelnut Fertility Trials in Ontario
  1: Objectives
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- Take Home Messages
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# Essential Plant Nutrient Management in Hazelnuts

# Essential Plant Nutrients

## Macro (Primary) Nutrients:

**Nitrogen (N), Phosphorus (P) and Potassium (K)**

### Secondary

- Calcium (Ca)
- Magnesium (Mg), and
- Sulphur (S)

### Micro-nutrients

- Boron (B)
- Zinc (Zn)
- Molybdenum (Mo)
- Manganese (Mn)
- Iron (Fe)
- Cupper (Cu), and
- Chloride (Cl)

**From the air and water:** Carbon, Hydrogen and Oxygen

# Deficiency Symptoms: Some Facts

## Symptoms can be confusing…

- Symptoms first apparent in young leaves: **S, Fe, Cu and Mn**
- Symptoms first apparent in old leaves: **N, P, K, Mg, Zn and Mo**
- Symptoms seldom apparent on older growth: **Ca and B**
- Retarded growth with leaf chlorosis: **N, S, Cu**
- Retarded growth without leaf chlorosis: **P**
- Yellowing of older leaves: **N**
- Yellowing of younger leaves: **S**

# Macro-nutrients: Nitrogen Management

**Nitrogen**

Yellowing of older leaves (chlorosis), thin stems, stunted growth are major symptoms of deficiency.

- Apply N in small amount starting 3rd year of planting, full rate in 8-10 years.
- Apply in early spring as a banded ring around each tree under the drip line.
- Split application improves N utilization.
- Avoid N fertilizers contacting the trunk.

| Age (year) | Apply this amount of N (lb/tree) |
|---|---|
| 0–2 | 0 (unless time-release N is used) |
| 3–5 | 0.25–0.33 |
| 6–7 | 0.33–0.50 |
| 8–10 | 0.50–0.75 |

Olsen, 2013; OMAFRA Pub 863

# Macro-nutrients: Nitrogen Management

Critical N values in hazelnut leaf tissue and required N: Olsen, 2013

| Leaf N in August (%) | Status | Apply this amount of N (lb/tree) |
|---|---|---|
| Under 1.8 | Severe deficiency | 3.0 (2 years) |
| 1.8–2.2 | Deficiency | 2.0–3.0 |
| 2.2–2.5 | Optimal | 1.5–2.0 |
| Over 2.5 | Excess | 0 |

# Macro-nutrients: Phosphorus Management

**Phosphorus**

Reddish or purplish lower leaves, poor flowering and fruiting, pre-mature nut drop.

- Application rate depends on soil and plant tissue analysis.
- Coarse sandy loam soils (+ manure) often contains high level of phosphorus.
- Fall (October) or early spring (May) application as a banded ring is suggested.
- Not recommended in Oregon.

Critical P value (%) in leaf tissue (August):

**Deficient:** <0.13; **Normal:** 0.14-0.45;

**Excess:** >0.55.

Olsen, 2013; OMAFRA Pub 863

# Macro-nutrients: Potassium Management

- Apply MOP (KCl) in the fall or before mid-February as a banded ring – to avoid chloride toxicity.
- Consider Potassium Sulphate for early spring applications.
- A single application usually is effective for 2 years or more.

**Potassium**

Leaf tips and edges turn yellow to brown, trees become susceptible to stresses.

$K_2O$ rate for new hazelnut orchard

| Soil test for K (ppm) | Apply this amount of $K_2O$ (lb/acre) |
|---|---|
| 0–75 | 300–400 |
| 75–150 | 200–300 |
| Over 150 | 0 |

Olsen, 2013; OMAFRA Pub 863

# Macro-nutrients: Potassium Management

| Leaf K in August (%) | Status | Apply this amount of $K_2O$ (lb/tree) |
|---|---|---|
| Under 0.5 | Severe deficiency | 8–10 |
| 0.5–0.7 | Deficiency | 6–8 |
| 0.7–0.9 | Borderline (test again in 1–2 years) | 0 |
| Over 1.0 | Optimum | 0 |

Critical K value (%) in leaf tissue (August)

Olsen, 2013; OMAFRA Pub 863




# Hazelnut Fertility Trials in Ontario

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*and*
*Tejendra Chapagain*



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# The Problem and Objectives

**Statement of the Problem:**

No fertility recommendations exist for Ontario-grown hazelnuts

**Objectives:**

Look at how four different fertility treatment regimes will impact hazelnut growth and yield in Ontario:

- Ontario's guidelines for other tree fruits
- Modified Oregon's guidelines for hazelnuts
- Grower's practice
- Control (with no external fertilizers)

Variety: Yamhill

# Steps and Timeline

| Phase | Description of Work | Start and End Dates |
|---|---|---|
| **Phase One** | Identified 3 sites (hazelnut orchards) across Ontario. | **February - March 1, 2022** |
| **Phase Two** | Surveyed with growers to collect general and historic information for each site. | **March-April, 2022** |
| **Phase Three** | Baseline soil sampling and analysis to initiate fertility trials. | **April 2022** |
| **Phase Four** | Begun trials with NPK in hazelnut orchards across Ontario. | **May 2022** |
| **Phase Five** | Observed micronutrient deficiencies in Hazelnut during the season. | **June-August 2022** |
| **Phase Six** | Fall soil and plant tissue sampling for analysis | **August, 2022** |
| **Phase Seven** | Developing short communication/radio report to highlight project's findings. | **March 2023** |

# Fertilizer Treatments: OMAFRA vs Modified Oregon

| Nutrients | OMAFRA Tree Fruits | Modified Oregon |
|---|---|---|
| **Actual Nitrogen** | 3–5-year orchard: 54 lbs/acre<br>6–7-year orchard: 87 lbs/acre | 3–5-year orchard: 0.25-0.33 lbs/tree<br>6–7-year orchard: 0.33-0.5 lbs/tree |
| **Phosphorus (Actual $P_2O_5$)** | If soil test Olsen P says 10-12 ppm: 62 lbs/acre; 16-20 ppm: 45 lbs/acre; >41 ppm: no application | |
| **Potassium (Actual $K_2O$)** | If soil test Ammonium Acetate K says 101-120ppm: 62 lbs/acre | If soil test Ammonium Acetate K says 75-150ppm: 200-300 lbs/acre |

# Fertility Treatments for Split Comparison Test

**Orchard 1: $NO_3$-N: 8.5ppm, P: 11ppm, K: 101ppm, pH: 6.9, OM: 3.2; 6yr. old**

| Improved | Grower Management | Control |
|---|---|---|
| N = 150 g/tree<br>$P_2O_5$ = 140 g/tree<br>$K_2O$ = 140 g/tree | 1% GMS (10-20-10), 4 applications, tank-mix with fungicide | Complete Control; No external fertilizers |

**Orchard 2: $NO_3$-N: 4ppm, P: 47ppm, K: 101ppm, pH: 6.3, OM: 3.1; 6yr. old**

| Improved | Grower Management |
|---|---|
| N = 190 g/tree<br>$P_2O_5$ = 0 g/tree<br>$K_2O$ = 140 g/tree | (10-20-10) in fertigation program; 2-3 applications; 10:20 dilution |

# Fertility Treatments for Replicated Experiment

**Orchard 3: $NO_3$-N: 11.7ppm, P: 18ppm, K: 110ppm, pH: 7.3, OM: 4.3; 4yr. old**

Complete Control; No external fertilizers

**Control**

Impact (6-24-6) 1-2 litre in 200 l tank 3-4 applications

**Grower's Practice**

N = 100 g/tree
$P_2O_5$ = 100 g/tree
$K_2O$ = 140 g/tree

**OMAFRA**

N = 135 g/tree
$P_2O_5$ = 100 g/tree
$K_2O$ = 454 g/tree

**Modified Oregon**



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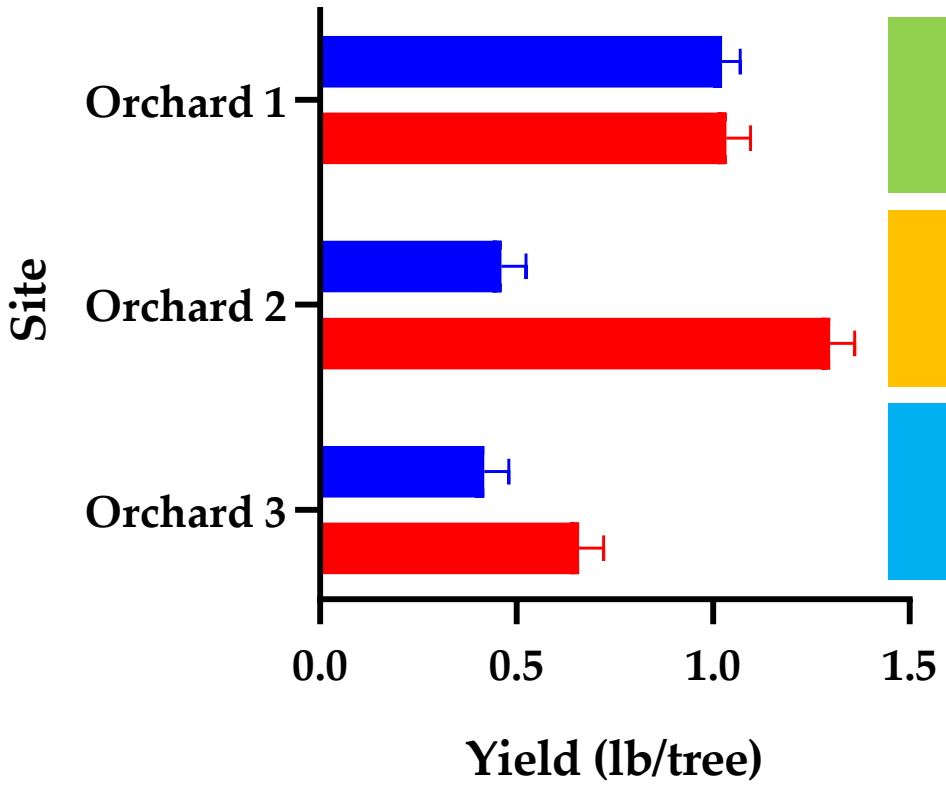
# Results: Yield Data from Split Plot Comparison




**Yield: 330** lbs/acre (Grower)

**334** lbs/acre (OMAFRA)

**Yield: 124** lbs/acre (Grower)

**349** lbs/acre (OMAFRA)

**Yield: 114** lbs/acre (Grower)

**181** lbs/acre (OMAFRA)

OMAFRA recommendations outperformed grower's practice at 2 out of the 3 sites.



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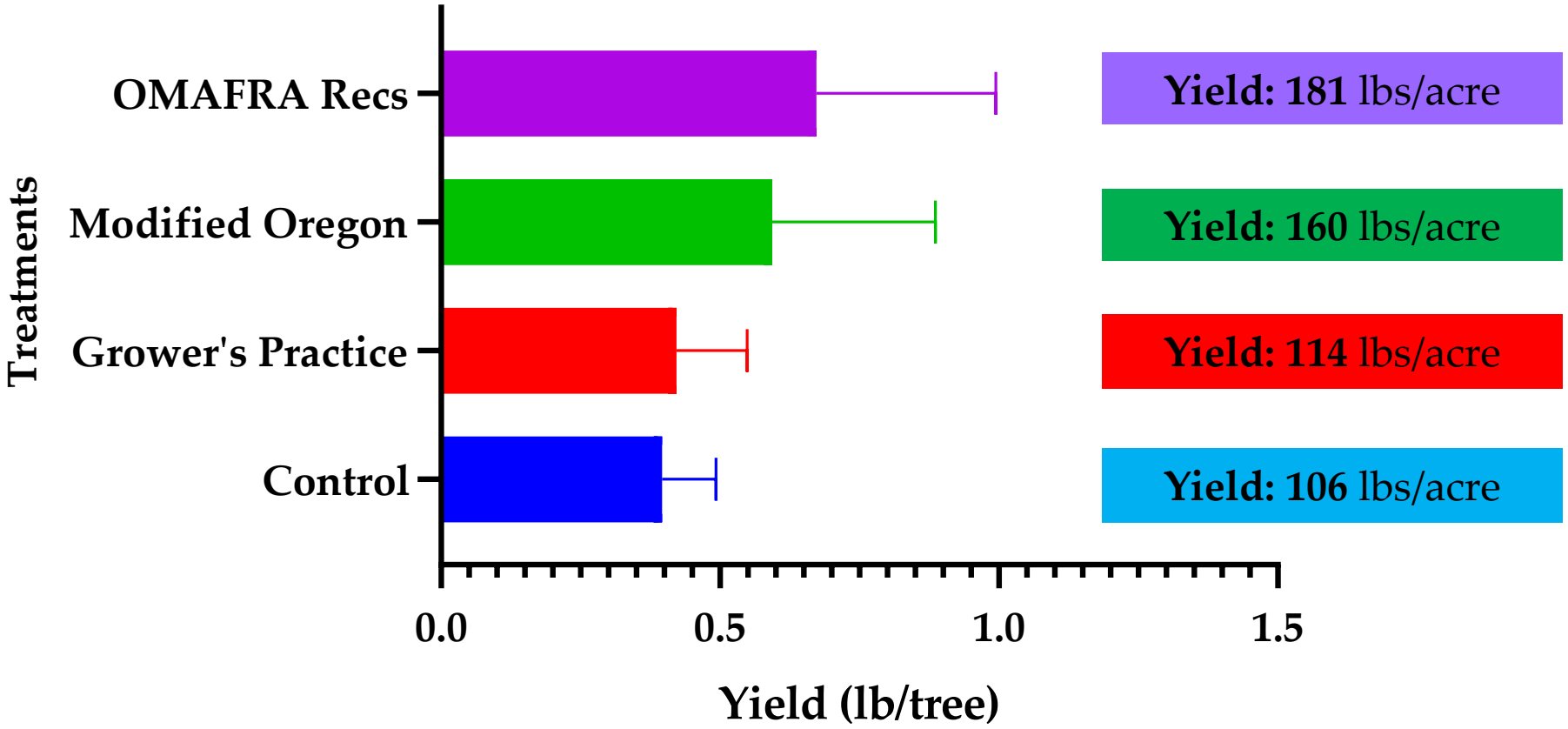
# Results: Yield Data from Replicated Experiment




OMAFRA recommendations resulted in the highest yield, followed by the modified Oregon recommendations.



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# Results: Baseline vs Fall Soil Nutrition

| Site | Treatment | Soil Nutrients (ppm) | | | | | |
|---|---|---|---|---|---|---|---|
| | | $NO_3^-$ Nitrogen | | Phosphorus | | Potassium | |
| | | Baseline | Fall | Baseline | Fall | Baseline | Fall |
| Orchard 1 | Control | 8.48 | - | 11 | 9 | 101 | 86 |
| | Grower | | - | | 6 | | 60 |
| | Improved | | - | | 22 | | 375 |
| Orchard 2 | Grower | 4.04 | - | 47 | 29 | 101 | 91 |
| | Improved | | - | | 30 | | 145 |
| Orchard 3 | Control | 11.74 | - | 18 | 11 | 111 | 102 |
| | Grower | | - | | 12 | | 102 |
| | OMAFRA | | - | | 29 | | 363 |
| | Oregon | | - | | 28 | | 757 |

Except for P in Orchard 2 (which did not receive any phosphate fertilizers), improved management showed higher levels of residual P and K.

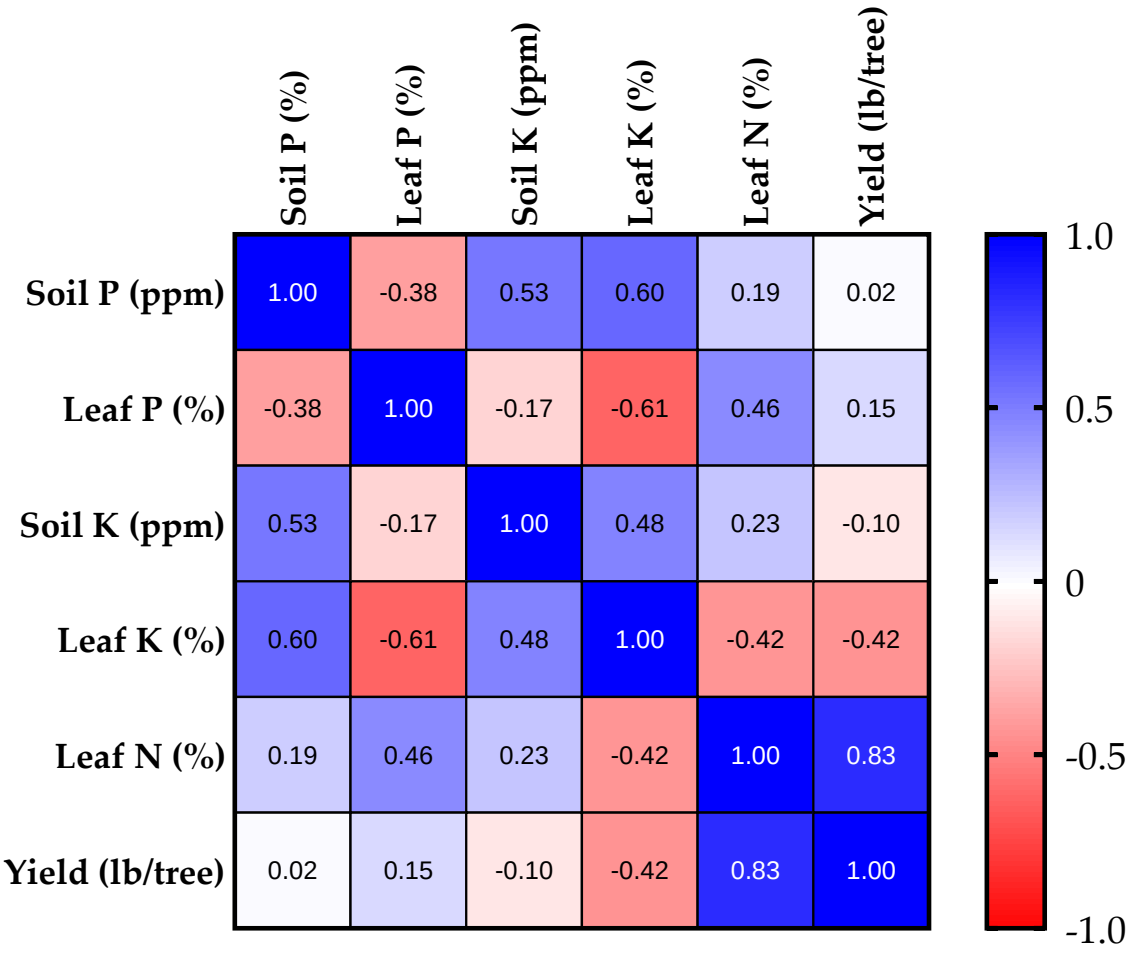
# Results: Fall (August) Leaf Tissue Nutrition

| Site | Treatment | Fall Leaf Tissue (%) | | |
|---|---|---|---|---|
| | | N | P | K |
| Orchard 1 | Control | 2.62 | 0.14 | 0.45 |
| | Grower | 2.65 | 0.16 | 0.47 |
| | Improved | 2.79 | 0.15 | 0.46 |
| Orchard 2 | Grower | 2.47 | 0.15 | 0.63 |
| | Improved | 2.70 | 0.13 | 0.73 |
| Orchard 3 | Control | 2.21 | 0.14 | 0.67 |
| | Grower | 2.20 | 0.13 | 0.68 |
| | OMAFRA | 2.35 | 0.12 | 0.71 |
| | Oregon | 2.59 | 0.14 | 0.82 |

Improved management showed higher N and K in the leaf tissues but the proportion was lower than the soil levels.

Optimum levels: N = 2.2-2.5%, P = 0.14-0.15%, K = Over 1% (Olsen, 2013)

# Results: Correlation Heat Map: Strength of Relationships




Only Tissue N is strongly associated with Yield ($r^2 = 0.7$): Fall leaf N could be a potential determinant of nut yield.



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# Learning

**Control**: Chloride = 0.13%

Potassium = 0.82%

**Modified Oregon**: Chloride = 1.46%

Potassium = 1.50%

Do not use Muriate of Potash (Potassium Chloride) as a source of Potash in the Spring: High salt index (116) and chlorine content (45-47%) leads to chlorine toxicity. Use Potassium Sulphate instead.

# Take Home Messages

Very first year of the trial: Results are preliminary. Economic analysis will be conducted next year.

OMAFRA's recommendations appear to be effective over Oregon's recommendation: Research will be continued for the next few years.

Soil and plant tissue testing will help forecast nutrient demand/adjust soil pH.

Large soil test deficiency can be addressed at pre-plant.

In-season demand can be met through fertilizers and foliar applications (esp. micronutrients).

Consider 4Rs: Knowledge of nutrient management timing, place, rate and source is crucial.

# Acknowledgements


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- Summer students for helping hand: to apply treatments and collect growth data.




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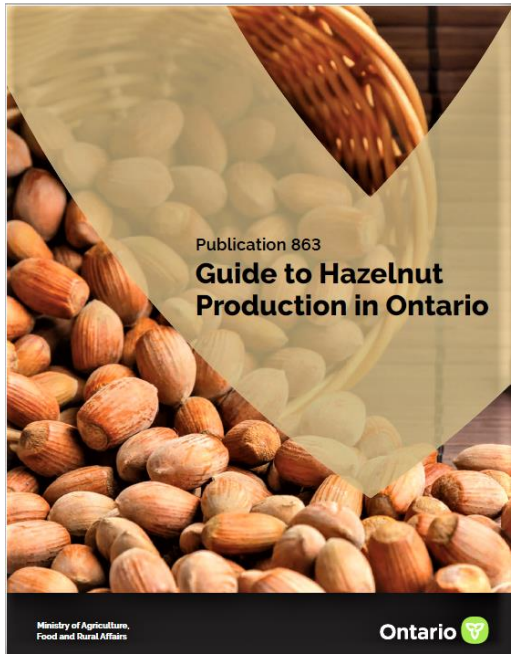
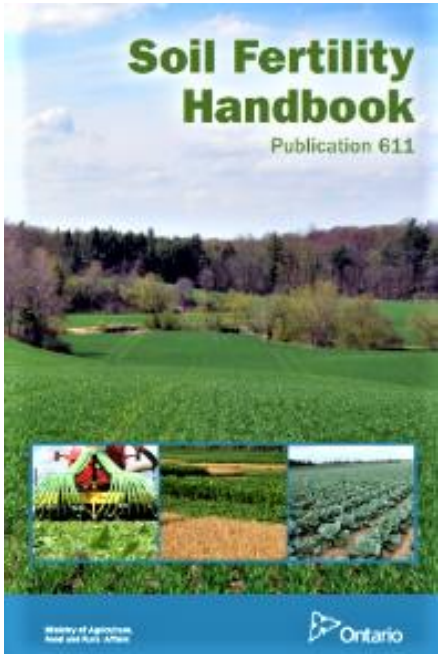
# References/ Additional Online Resources

- Soil Fertility Handbook: OMAFRA Publication 611.
- Guide to Hazelnut Production in Ontario: OMAFRA Publication 863.
- Olsen, J. 2013. Growing Hazelnuts in the Pacific Northwest. OSU Extension Service, Oregon State University.




Growing Hazelnuts in the Pacific Northwest

**Orchard Nutrition**

EM 9080 • November 2013

Jeff Olsen

A comprehensive approach to nutrient management will help you ensure that optimum nutrient levels are available for tree growth. A comprehensive nutrient management strategy includes the following:

- **Soil analysis before planting** (useful in predicting the need for potassium, magnesium, or lime applications)
- **Observations** of annual shoot growth, leaf size and color, and crop yields
- **Leaf analysis** (to indicate which elements are present in adequate, deficient, or excessive amounts)
- **Soil test results in mature orchards** (to check for low pH values and evaluate the need for liming)

Suspect a nutrient deficiency if the cause of poor tree performance is not primarily one or more of the following: lack of pruning, winter injury, poor soil drainage, shallow soil, physical injury, disease, insects, poor weather, poor pollination, rodents, or limited moisture.

**When applying any fertilizer, read and follow the label directions.**

**Leaf Tissue Analysis**

Soil tests are one piece of the picture for predicting fertilizer needs for established orchards. Leaf tissue analysis provides further information about which elements are present in the trees in adequate, deficient, or excessive amounts (Table 1).

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# Thank you.

Feel Free to Reach Out:

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