Soil and Water

Introductory Vegetable Production

Outline

- Basic Site Requirements
- Site / Soil Information
- Soil Preparation
- Soil Fertility
- Water – Uses, Sources, Quality
- Irrigation
- Crop Water Use

Some Basic Site Requirements

- Suitable location
  - Soil (need information)
  - Slope / Drainage
  - Field History
- Access to an adequate quantity of quality water for irrigation
- Access to labour
- Proximity to a market

Site Characteristics

- Shelter
  - Prevailing winds
  - Natural or planted
- Topography
- Other site features

SITE INFORMATION

Field History

- Useful Information:
  - Cropping History
  - Pesticide use (both in crop and in adjacent areas) – especially herbicides
  - Fertilizer or Manure application
  - Crop Rotations
- Knowing field history is important for both new and existing growers
Soil Information

- Need information on several layers
  1. Large / wide scale
     - Topography / slope
     - General suitability
  2. Individual field level
     - Gathered using soil testing
     - Soil texture
     - Soil quality

Soil Information - Resource

- Agriculture Soil Information Database (AGRISID) → Soil Information Viewer
  - Search by Legal Land Location

Soil Testing

- Basic understanding of specific soil quality characteristics
- Provides information
  - Decisions on suitability
  - Baseline for Crop and Fertility Management decisions
- Important for start up and every year

Soil Sampling – General Tips

- Done in fall (after temperatures fall below 5°C) or in spring (prior to seeding)
- May sample more than 1 depth (0-12” & 12-24”)
- Sample from various locations across the field – bulk samples
- Avoid abnormal or unusual locations

Insta-Poll
(Discussion)

“How often should you soil test?”
Soil Testing

- Ensure that appropriate testing is done
- Find out what is included in each test
- Reports vary by company
- There are a number of labs in the province
Soil Preparation

Benefits:
- Incorporation / reduction of trash
- Break up hardened or compacted areas
- Remove lumps/chunks/crusts
- Control weed growth (early / perennial)
- Improve water distribution within seedbed
- Improve likelihood of good seed to soil contact
- Increase soil temperature

Soil Preparation - Equipment

Primary Cultivation
- Deep penetration into soil profile
- Breaks up hardpan layers; stirs soil beyond typical seedbed profile

Secondary Cultivation
- Pulverizes soil
- Levels and firms seedbed

Equipment
- Plows
- Breaking discs
- Rotary Tillers
- Disc harrows
- Cultivators
- Diamond harrows
- Rototillers / Rotovators
- Rolling / Packing
- Bed shaping / Hilling
- Laying plastic mulch &/or drip irrigation

When / How long?
- May occur over 1–2 years, depending on desired outcomes and state of field
- Just before planting, to prepare seedbed

Other Operations

Canada
Alberta
Growing Forward
Bed shaper / Mulch & Drip applicator

Managing Soil Fertility – Soil Improvement
- Manure / Compost
- Green Manuring
- Fertilizer Application
- Macronutrients / Micronutrients
- Range of forms
- Range of application methods/timing
- Crop requirements
  - Varies by crop

SOIL FERTILITY

Soil Fertility – Essential Elements
- Macronutrients
  - Carbon (C)
  - Hydrogen (H)
  - Oxygen (O)
  - Nitrogen (N)
  - Phosphorus (P)
  - Potassium (K)
  - Sulphur (S)
- Micronutrients
  - Calcium (Ca)
  - Magnesium (Mg)
  - Iron (Fe)
  - Manganese (Mn)
  - Zinc (Zn)
  - Copper (Cu)
  - Boron (B)
  - Molybdenum (Mo)
  - Chlorine (Cl)
  - Nickel (Ni)

Soil Fertility - Fertilizers
- Range of Forms
- How much is in a product?
  - E.g. 10-52-10
- Is one form better than another?
  - Depends on:
    - Use
    - Cost
Soil Fertility - Application

- Application Methods
  - Broadcast & Incorporated
  - Side banding
    - CAUTION: Reduce rates
  - Top/Side dressing
  - Foliar
  - Fertigation

Soil Fertility – Crop Requirements

- Each crop is different
  - Too much = bad (lush growth or toxicity)
  - Too little = reduced yields / quality
  - Can use general application guidelines or crop specific (based on soil testing)

Crop Fertility Requirements

<table>
<thead>
<tr>
<th>CROP</th>
<th>General Requirement</th>
<th>Nitrogen (N)</th>
<th>Phosphorus (P)</th>
<th>Potassium (K)</th>
<th>Other Nutrients</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peas</td>
<td>Not much needed – small amount prior to planting</td>
<td>110-140</td>
<td>149-176</td>
<td>105-130</td>
<td>30-60</td>
<td>15-85</td>
</tr>
<tr>
<td>Beans</td>
<td>Apply based on soil tests</td>
<td>121-160</td>
<td>150-180</td>
<td>105-188</td>
<td>25-50</td>
<td>28-50</td>
</tr>
<tr>
<td>Cole Crops</td>
<td>Can side dress some N1 month after seeding</td>
<td>130-160</td>
<td>149-176</td>
<td>105-188</td>
<td>25-50</td>
<td>28-50</td>
</tr>
<tr>
<td>Carrots</td>
<td>Split application 60-70% broadcast prior to planting; band remainders at 6-12 inches</td>
<td>80-100</td>
<td>88-110</td>
<td>400-440</td>
<td>20-22</td>
<td></td>
</tr>
<tr>
<td>Potatoes</td>
<td>Apply P&amp;K at or pre-planting; N side dress some N at 6-12 inches</td>
<td>80-100</td>
<td>88-110</td>
<td>400-440</td>
<td>20-22</td>
<td></td>
</tr>
<tr>
<td>Lettuce</td>
<td>Micro deficiencies on different soil types</td>
<td>55-60</td>
<td>105-130</td>
<td>115-150</td>
<td>25-50</td>
<td>28-50</td>
</tr>
<tr>
<td>Cucurbits</td>
<td>Side dress 25-30 lb N when planting</td>
<td>63</td>
<td>105-130</td>
<td>115-150</td>
<td>25-50</td>
<td>28-50</td>
</tr>
<tr>
<td>Onions</td>
<td>Some side dress mid July</td>
<td>100</td>
<td>105-130</td>
<td>115-150</td>
<td>25-50</td>
<td>28-50</td>
</tr>
<tr>
<td>Sweet Corn</td>
<td>Apply P&amp;K at or pre-planting; N side dress some N at 6-12 inches</td>
<td>135</td>
<td>149</td>
<td>25-40</td>
<td>28-44</td>
<td>100</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>35-70</td>
<td>10-77</td>
<td>135-160</td>
<td>149-176</td>
<td>115-150</td>
<td>25-50</td>
</tr>
</tbody>
</table>

Crop Fertility – Excess

<table>
<thead>
<tr>
<th>CROP</th>
<th>Excess</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peas</td>
<td>Sensitive to Boron</td>
</tr>
<tr>
<td>Beans</td>
<td>Excess top growth = increased disease</td>
</tr>
<tr>
<td>Cole Crops</td>
<td>Excess vegetative top growth; poor tuber set</td>
</tr>
<tr>
<td>Carrots</td>
<td>Delayed maturity; reduced storage potential</td>
</tr>
<tr>
<td>Potatoes</td>
<td>Lush, vegetative growth, poor fruit set</td>
</tr>
</tbody>
</table>

WATER
Uses of Water

- Irrigation
- Washing
- Post-harvest Cooling
- Other
  - frost protection
  - crop cooling

Water Sources

- Natural Water Bodies
  - Rivers / Streams
  - Lakes / Ponds
- Irrigation Canals
- Dugouts
  - Naturally filled (rain/snow/runoff)
  - Pump filled
- Wells

Water Source - Considerations

- Quality (Is it good enough?)
- Legal Access (Can I use it, legally?)
  - Water License
  - Owning land does not = access to water sources
- License required for anything other than a pond or dugout filled completely by rain/snow/runoff
- Quantity (how much do you need?)
  - On average, approximately 12 inches (30cm) of water is required (this varies by crop)

Water Quality

- All water sources are not equal
- Long and short term impacts

Insta-Poll (Discussion)

“What are some bad things that you don’t want in the water?”
Water Quality - Testing

- Submit sample to accredited laboratory for analysis
- There are a number of labs across province

Water Quality

<table>
<thead>
<tr>
<th>Element</th>
<th>Unit</th>
<th>Acceptable Limit for Continuous use</th>
<th>Potential Problems (long term use – up to 20yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E.C.</td>
<td>dS/m</td>
<td>Less than 1</td>
<td></td>
</tr>
<tr>
<td>Sodium (Na)</td>
<td>mg/L</td>
<td>Less than 4</td>
<td></td>
</tr>
<tr>
<td>Aluminum (Al)</td>
<td>mg/L</td>
<td>5 – 20</td>
<td></td>
</tr>
<tr>
<td>Boron (B)</td>
<td>mg/L</td>
<td>Less than 1*</td>
<td></td>
</tr>
<tr>
<td>Chloride (Cl)</td>
<td>mg/L</td>
<td>100 – 700</td>
<td></td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>mg/L</td>
<td>0.02 – 1</td>
<td></td>
</tr>
<tr>
<td>Iron (Fe)</td>
<td>mg/L</td>
<td>5 – 20</td>
<td></td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>mg/L</td>
<td>0.2 – 10</td>
<td></td>
</tr>
<tr>
<td>Molybdenum (Mo)</td>
<td>mg/L</td>
<td>0.01 – 0.05</td>
<td></td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>mg/L</td>
<td>1 – 5</td>
<td></td>
</tr>
<tr>
<td>TDS</td>
<td>mg/L</td>
<td>Less than 480</td>
<td>Up to 3500</td>
</tr>
</tbody>
</table>

* Varies with crop

Water Quality - Resources

Rural Water Quality Information Tool
- Ropin’ the Web → Decision Making Tools → R.W.Q.I.T
- Calculator for irrigation, livestock, spray tank, drinking

Water License – Irrigation Districts

Only in the South

Water License – Private

1. Land Classification
- Land is evaluated for suitability for irrigation
2. Ag Feasibility Report
- Evaluates project’s potential impact on land from irrigation
3. Department of Fisheries and Oceans Review
- Determines potential impact on wildlife or natural areas
4. Application to Alberta Environment
Water Quantity

- How much do you need?
- How much is typically available?
- Recharge/replenishment?
- Discuss this with an Agriculture Water Specialist
  - Plan ahead

IRRIGATION

Insta-Poll (Discussion)

“What are the Pros/Cons of irrigating?”

Dryland vs. Irrigated

Dryland
- Must rely on the weather to deliver moisture (when and how much)
- Increased risk

Irrigated
- Increased yields
- Reduced moisture stress
  - Moisture is delivered when & in the quantity needed
- Improved quality
- Improved control of rate of maturity
- Potential for introduction of poor quality water onto land

Irrigation Considerations

- Irrigation Method
  - Capital costs of system
    - Delivery system
    - Pump system
    - Water supply
  - Costs of running system
    - Fuel
    - Water?
- Irrigation Management – How much? / When?

Irrigation Methods

- Sprinkler
- Pivot
- Wheel-move
- Solid Set
- Drip / Trickle
- Flood
  - Consider the advantages / disadvantages of each system
Centre Pivot
Wheel Move
Solid Set
Mobile Sprinkler
Travelling Gun / Cannon
Drip / Trickle
System Considerations

- What do you want your system to accomplish?
- How much water?
- Compatible with crop(s)?
- Flexibility?

Irrigation Systems – Other Component Parts

- Supply system
  - Main / lateral lines
- Pump
- Filtration
- Power source / unit
- Monitoring equipment
  - Consult a professional for design assistance

Irrigation Management

- Matching crop needs with available water
  - Amount of water
  - Timing of application
  - Soil storage capacity → consider
- Efficiency

Crop Water Use Requirements

- Crop water demand increases or decreases based on a number of interrelated factors
Crop Water Use Requirements

- **Climatic Factors**
  - Temperature
  - Humidity
  - Wind
  - Sunlight
  - Natural precipitation
  - Other factors?

- **Crop Factors**
  - Crop type (e.g., corn vs. cucumbers vs. onions)
  - Rooting depth
  - Crop Stage
  - Yield
  - Application relationship (optimum amounts)

- **Soil Factors**
  - Soil texture – clay v.s. sand
  - Water holding capacity
  - Soil reserves

- **Timing**
  - Sensitivity to deficit at specific times
  - Varies with crop
  - Critical Periods (Peak Use Periods)
    - Establishment
    - Flowering
    - Fruit set through to fruit fill / enlargement
    - Tuber initiation / Sizing / Root Fill
    - Opportunity to save water (if necessary) by applying at critical periods

Crop Water Use Requirements – Rooting Depth

<table>
<thead>
<tr>
<th>Shallow (18-24 inches)</th>
<th>Moderately deep (36-48 inches)</th>
<th>Deep (&gt;48 inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lettuce</td>
<td>Beans</td>
<td>Asparagus</td>
</tr>
<tr>
<td>Cole crops</td>
<td>Beets</td>
<td>Parsnip</td>
</tr>
<tr>
<td>Bulb Veg</td>
<td>Carrots</td>
<td>Pumpkin</td>
</tr>
<tr>
<td>Radish</td>
<td>Cucumbers</td>
<td>Winter Squash</td>
</tr>
<tr>
<td>Potato</td>
<td>Peas</td>
<td>Tomato</td>
</tr>
<tr>
<td>Spinach</td>
<td>Zucchini</td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Crop Water Use Requirements

<table>
<thead>
<tr>
<th>Crop</th>
<th>Critical Period</th>
<th>Water Requirement*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peas</td>
<td>Flowering, pod set and fill</td>
<td>Will use 5.5 to 6 mm per day (during peak use); will use 375 mm during the season*</td>
</tr>
<tr>
<td>Beans</td>
<td>Flowering / Pod set</td>
<td>25-38mm/week</td>
</tr>
<tr>
<td>Cole Crops</td>
<td>Head formation &amp; enlargement</td>
<td>380-500mm/season</td>
</tr>
<tr>
<td>Carrots</td>
<td>Emergence / Root sizing &amp; filling</td>
<td>4-6mm/day</td>
</tr>
<tr>
<td>Potatoes</td>
<td>Tuber initiation &amp; sizing</td>
<td>Up to 550mm/season</td>
</tr>
<tr>
<td>Leafy Veg</td>
<td>Germination &amp; throughout growth</td>
<td>Don’t allow to dry out</td>
</tr>
<tr>
<td>Cucurbits</td>
<td>Flowering / Fruit set / Enlargement</td>
<td>25mm/week</td>
</tr>
<tr>
<td>Onions</td>
<td>Bulb formation &amp; enlargement</td>
<td>350-500mm/season (25mm/week)</td>
</tr>
<tr>
<td>Sweet Corn</td>
<td>Tasselling / Pollination / Ear filling</td>
<td>510mm/season (up to 6mm/day)</td>
</tr>
<tr>
<td>Tomatoes / Peppers</td>
<td>Flowering / Fruit set / Enlargement</td>
<td>Up to 25mm/week</td>
</tr>
</tbody>
</table>
QUESTIONS???

Rob Spencer, BSA, MSc, P.Ag.
Commercial Horticulture Specialist
Alberta Ag-Info Centre
robert.spencer@gov.ab.ca
310-FARM