The Care and Fertilization of Cannabis for Optimum Production

Brent Rouppet, Ph.D., Soil Fertility Scientist

**Introduction:** The use of fertilizer and soil amendments contributes in a big way to food and nutrition security. It is estimated that at least half of the world's population now depends on fertilizer and amendments for growing their crops. Increasing agricultural productivity continues to contribute to making agriculture more secure than ever before and this certainly applies to growing cannabis as it does to growing all agricultural crops.

Cannabis, a flowering annual plant, belongs to the genus *Cannabis* in the family Cannabaceae and includes three main species, *C. sativa*, *C. indica*, and *C. ruderalis*. Cannabis is typically a dioecious plant (each individual is either male or female), with its growing season life period generally between April and September. People have cultivated cannabis throughout recorded history as a source, of fiber, food, recreation, religious purposes, spiritual moods, and medicine. Each part of the plant is harvested differently, depending on the purpose of its use.

**Nutrient Requirements:** Cannabis, like all annual broadleaf plants, needs certain nutrients and soil conditions to flourish. The nutrients are divided into two major groups: (1) macronutrients (carbon, oxygen, hydrogen, nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur); and (2) micronutrients (boron, chlorine, copper, iron, manganese, molybdenum, and zinc). In addition to the essential nutrients, certain soil amendments are critical for good cannabis growth and development. Most nutrients are taken up by plants from the soil. During the vegetative stage cannabis uses more nitrogen than other nutrients, while during the flowering stage, phosphorus is more critical. However, the presence and availability of all essential nutrients is required.

Most agricultural soils contain sufficient macro- and micro-nutrients to establish a cannabis crop, but some soils may have toxic levels of certain salts and/or soil structure problems; and pre-plant soil and irrigation water testing is the primary tool for assessing nutritional and soil structure needs. Depending on the need, fertilizers and soil amendments may be applied pre-plant, or any time up to flowering. Plant tissue testing is a useful technique to confirm the adequacy of fertilization. Higher than required rates of all nutrients, especially nitrogen and phosphorus can be both detrimental to the crop and the environment through...
run-off into waterways. To avoid runoff of fertilizer, take measures to reduce adverse water quality problems from surface runoff.

**Pre-plant Fertilization:** Pre-plant fertilization should be based on soil test nutrient levels. For the most accurate estimation of soil nutrient availability, collect and analyze soil from throughout the rooting zone, which for cannabis is the top foot of soil. Collect a composite sample of a minimum of 12 soil cores from each field; if zones of different soil texture exist within the same field, take separate samples to represent each major soil type. The following table suggests appropriate soil analysis procedures, and interpretation of certain laboratory results.

### SOIL ANALYSIS INTERPRETATION OF RESULTS

<table>
<thead>
<tr>
<th>ELEMENTS</th>
<th>SOIL TEST</th>
<th>Nitrate-Nitrogen</th>
<th>Phosphorus (Olsen)</th>
<th>Potassium</th>
<th>Zinc</th>
<th>Soluble Salts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LOW</td>
<td>&lt;20</td>
<td>&lt;10</td>
<td>&lt;130</td>
<td>&lt;0.5</td>
<td>&lt;2</td>
</tr>
<tr>
<td></td>
<td>MEDIUM</td>
<td>20-40</td>
<td>10-15</td>
<td>130-250</td>
<td>0.5-1.0</td>
<td>2-4</td>
</tr>
<tr>
<td></td>
<td>HIGH</td>
<td>40-70</td>
<td>15-40</td>
<td>250</td>
<td>&gt;1.0</td>
<td>&gt;4</td>
</tr>
<tr>
<td></td>
<td>EXCESSIVE</td>
<td>&gt;70</td>
<td>&gt;40</td>
<td>&gt;250</td>
<td>&gt;2.0</td>
<td></td>
</tr>
</tbody>
</table>

For all nutrients, a low soil test value suggests the need to fertilize; with medium soil levels yield response to fertilizer application is achievable; at high soil levels yield response is unlikely. Fertilization is best done preplant or as a starter solution at seeding or transplanting; water soluble fertilizers can be applied preplant, at side dressing, or fertigated (injected into drip irrigation water) during the growing season.

For optimum nutrient availability, the pH of soils should be adjusted to approximately pH = 6.1-6.3 prior to planting. Also, for soluble salts (salinity) the issue generally is not whether enough is present, but whether soil levels are high enough to be detrimental. As salinity levels increase, the likelihood of damage to cannabis increases; when high levels of either soluble salts or boron are present, remedial actions are necessary.

**Fertilizer Application at Planting:** Traditionally, the majority of fertilizers for cannabis production have been applied in a single side dressing at planting time. Many replicated trials have demonstrated that seasonal nitrogen applications of about 150 lbs./acre are nearly always adequate for maximum yield and quality. Factoring in nitrogen applied pre-plant with phosphorus fertilizers, a single side dress application of 100–120 lbs. nitrogen per acre during the growing season is
normally sufficient to finish the crop. Use of higher seasonal nitrogen rates can be both detrimental to the environment (nitrogen-rich tailwater or drain-tile effluent can stimulate algae growth in the receiving water body) and to the crop.

Fields with significant residual soil nitrate-nitrogen (NO\textsubscript{3}-N) require little, if any, side dress nitrogen application. Research has shown that fields with soil NO\textsubscript{3}-N greater than 15 ppm in the top foot of soil before side dressing generally require no more than 50 lbs. nitrogen per acre at side dressing; this level of residual NO\textsubscript{3}-N is quite common in commercial cannabis fields in the Colorado.

A side dress potassium application can be an effective practice in fields with limited potassium supply. Because many soils tend to fix applied potassium over time (making it only marginally available to the crop), a banded side dress potassium application may be more effective than pre-plant application. Side dressing can be done any time from pre-bloom through early bloom. For drip-irrigated fields, water-soluble fertilizer such as potassium sulfate is applied through the irrigation system from early bloom until first buds appear.

**EcoGEM® Soil Enhancer:** Soil Enhancer’s nutrient blend is of key importance to worldwide sustainable agriculture including cannabis production. Considering the broad impacts Soil Enhancer has on soils and plants, it is no wonder that better soil management with Soil Enhancer’s use is the most significant practice that can be implemented to improve soil and crop production around the world.

Soil Enhancer has the unique distinction of being the only natural nutrient blend marketed for agricultural and horticultural application that qualifies as a: (1) soil amendment, (2) fertilizer, and (3) soil conditioner. The previous common opinion was that Soil Enhancer’s only use was for correction of high sodium, or sodic soil, problems. It is now understood that sustainable and productive farming, especially under irrigation, depends on Soil Enhancer’s use. Additionally, the long-term, sustainability of all agriculture land worldwide is contingent upon Soil Enhancer’s permanent and continuous application.

**Major Benefits of the Addition of High-Quality Soil Enhancer’s Nutrient Blend to the Soils Growing Cannabis:**

- An excellent fertilizer source for calcium and sulfur. There are 16 essential nutrients required or essential for plants. Calcium and sulfur are two of these nutrients. Calcium and sulfur deficiencies are appearing more and more frequently in arid agricultural soils, and Soil Enhancer is a practical and cost-effective source of these essential nutrients. Calcium is essential for many plant functions including:
  1. Proper cell division and elongation
  2. Proper cell wall and membrane development and integrity
  3. Nitrate-nitrogen uptake and metabolism
4. Enzyme activity
5. Starch metabolism

Sulfur is a component in three of the nearly two-dozen amino acids, and is, therefore, an essential part of plant proteins.

✓ Improves soil structure and compacted soils. Calcium provided to the root zone flocculates (or combines) sand, silt, clay and humus particles together, thus improving water and air movement and plant root growth in the soil medium. Water penetration problems cause ponding and runoff, depriving root systems of needed moisture and oxygen, while resulting in wasted water and nutrients...important worldwide environmental issues.

✓ Amends and reclaims soils high in destructive sodium and magnesium. Higher levels of soil sodium and magnesium will displace calcium and lead to calcium leaching from the root zone. This results in poorer soil structure and possible sodium toxicity to the plants. Conversely, applications of soluble Soil Enhancer are commonly used to desalinate sodic soils through the displacement principle in reverse.

    Note: There should be 16 times more calcium in the soil than sodium, and 8 times more calcium than magnesium

✓ Replaces harmful salts. sodium, chlorine, boron and many other chemicals found in arid soils are detrimental to plant growth and development since they rupture and destroy plant cells.

    Note: One-fifth of irrigated agriculture worldwide is adversely affected by soil salinity and these toxic salts harmfully affect practically all irrigated agriculture.

✓ Reduces runoff, erosion and soil crusting, problems often found in arid soils. Erosion begins when rain or irrigation drops strike bare soil detaching soil particles. Aggregates stabilized by Soil Enhancer is much less prone to crusting and erosion, and there is limited runoff due to larger, more stable aggregates.

✓ Counteracts acidity in subsurface soils. Calcium leaches into the subsoil replacing aluminum and other acid forming ions, thus allowing roots to penetrate the hostile subsoil more readily.

✓ Along with composts, manures, and other plant materials, use of Soil Enhancer helps rebuild the supply of soil organic matter and is a major means for increasing the efficiency of its accumulation.
Determining Soil Enhancer Requirements for Optimum Cannabis Production: By using the information from soil and water laboratory analyses, Soil Enhancer requirements for cannabis can be determined so nutrient deficiencies, toxic ion concentrations, and soil compaction and/or water infiltration problems can be rectified.

Soil Analyses:
1. ECe (electrical conductivity of soil extract)
   a. If less than 0.60 ds/m (decisiemens per meter), then Soil Enhancer is needed to help with water infiltration problems.
   b. If greater than 2.00 decisiemens per meter, then Soil Enhancer is needed to help with high salt problems.
2. Sodium and magnesium both contribute to soil deflocculating (loss of soil structure). It is necessary for there to be 8 times as much exchangeable calcium in the soil as magnesium. If not, the addition of Soil Enhancer is required to help flocculate the soil.
3. Sodium alone is the most harmful element there is in regard to plant health and crop production. There should be 16 times more exchangeable calcium in the soil than sodium; if not, then additional Soil Enhancer must be added.
4. ESP (exchangeable sodium percentage) and SAR (sodium adsorption ratio). If either of these soil tests is above “5”, then Soil Enhancer must be added to help with the problems associated with high sodium.
5. In order for soil analyses to be complete and accurate, they should also include the amounts of “exchangeable cations” present in the soil. The exchangeable cations are calcium, magnesium, sodium and potassium. The following amounts shown on Table 3.12. are required for healthy plant growth plus good soil structure

Table 3.12. Optimum Basic Cation Saturation

<table>
<thead>
<tr>
<th>Exchangeable Cations</th>
<th>Recommended (%)</th>
<th>Recommended (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>80 or greater</td>
<td>Greater than 2000</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Less than 10</td>
<td>Less than 400</td>
</tr>
<tr>
<td>Potassium</td>
<td>Greater than 5</td>
<td>Greater than 150</td>
</tr>
<tr>
<td>Sodium</td>
<td>Less than 5</td>
<td>Less than 150</td>
</tr>
</tbody>
</table>

When there is less than 80% or 2000-ppm calcium, the addition of Soil Enhancer is required. When there is more than 10% or 400-ppm magnesium, the addition of
Soil Enhancer is required. When there is more than 5% or 150-ppm sodium, the addition of Soil Enhancer is required to help with the problems.

6. Chloride, an anion, is toxic to crops in higher amounts. When there is greater than 10 milliequivalents per liter present in the soil, Soil Enhancer must be added to help with the associated salt problems and to help flush the chloride below the root zone.

7. Boron is also toxic to crops when present in higher amounts in the soil. Anytime there is greater than 1.5-ppm present, Soil Enhancer must be added to help leach the boron below the root zone.

**Water Analyses:**

1. ECw (electrical conductivity of irrigation water).
   - a. If less than 0.50 ds/m (decisiemens per meter), then Soil Enhancer is needed to help with water infiltration problems.
   - b. If greater than 3.0 decisiemens per meter, then Soil Enhancer is also needed with high salt associated problems.

2. Calcium.
   - a. There should be greater than 2.0 milliequivalents per liter calcium in all irrigation water.
   - b. If less than 2.0 milliequivalents per liter, then Soil Enhancer should be added to the water or soil each year.

3. Sodium.
   - a. There should be less than 2.0 milliequivalents per liter sodium in the irrigation water. If there are more than 2.0 milliequivalents per liter, then Soil Enhancer should be added to the water or soil each year.
   - b. Sodium and magnesium both contribute to poor soil structure and water infiltration problems. The preferred ratio with irrigation water in respect to calcium to sodium and magnesium combined is as follows:

     $$\text{Calcium: (sodium plus magnesium) } = 2:1 \text{ (preferred)}$$
     $$= 1:1 \text{ (minimum)}$$

     If less than a 2:1 ratio, Soil Enhancer can help, if less than a 1:1 ratio, Soil Enhancer is required.

   Bicarbonate is the most toxic anion that exists in relation to plant health. There should be less than 2.0 milliequivalents per liter carbonate plus bicarbonate in irrigation water. If greater than this amount, the addition of Soil Enhancer will replace any calcium precipitated as free lime and will remove any bicarbonates from the soil solution.
6. Chloride.
   There should be less than 1.0-milliequivalent per liter chloride in irrigation water. If greater than 1.0-milliequivalent per liter, Soil Enhancer must be added to the irrigation water or soil.

7. Boron.
   There should be less than 0.5-milliequivalents per liter boron in irrigation water. If greater than 0.5-milliequivalents per liter, Soil Enhancer must be added to the irrigation water or soil.