e-GRO Nutritional Monitoring

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Volume 3 Number 4 May 2020

Nutritional Monitoring Series

Cannabis Mother Stock Plants

(Cannabis sativa)

American Floral Endowment
Funding Generations of Progress Through Research and Scholarships
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Cannabis plants grown as mother stock require a customized approach to nutrient management. Due to the fact that plants always remain vegetative and go through different growth stages from establishment to cutting harvest which depletes the nutrient reserves in the plant. Thus a fertility program must be designed to reflect those varying requirements (see summary box, page 3).

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Cannabis plant being established for mother stock.

Target Nutrition Parameters:

Growing Out of Mother Plants

pH Category III:
5.8 to 6.2

Fertility Category:
Medium
150 to 200 ppm N

EC Category A:
1:2 Extraction:
0.6 to 0.9 mS/cm
SME:
1.3 to 2.0 mS/cm
PourThru:
2.0 to 3.0 mS/cm

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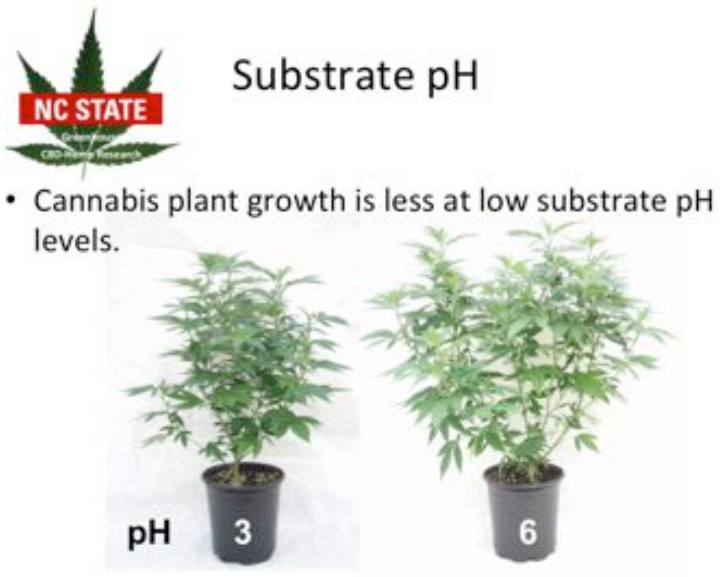

Figure 1. In initial experiments conducted at North Carolina State University, we did not observe symptomology of lower leaf blackening or bronzing, only stunted growth. Photo by: Brian Whipker

Figure 2. Cannabis plants with symptoms of iron (Fe) deficiency. This situation is the result of restricted root growth during propagation and excessive irrigation, not elevated substrate pH. Photo by: Brian Whipker

Fertility Management of Cannabis

Substrate pH. The recommended substrate pH for cannabis varies widely. A recommended substrate pH of 6.0 to 6.5 is often cited as the standard. During visits to commercial greenhouses growing cannabis, pH ranges between 4 and 5 or greater than 7 have been observed. Plants grown at the lower pH appear to have normal growth and lack the symptomology of lower leaf blackening or bronzing that one typically observes with other greenhouse species at low substrate pH. In experiments conducted at North Carolina State University (NC State), symptomology of lower leaf blackening or bronzing was not observed, only stunted growth (Fig. 1) (Whipker et al., 2019a). These preliminary results suggest that cannabis can regulate uptake of micronutrients under low substrate pH conditions in a similar fashion as poinsettia.

When the substrate pH becomes too high, many species develop interveinal yellowing (chlorosis) on the youngest leaves. This is a common situation that occurs with many greenhouse-grown species when elevated substrate pH makes micronutrients such as iron (Fe) unavailable to the plant (even if adequate levels are being provided in the fertilizer). In initial experiments conducted at NC State, we did not observe symptomology of interveinal chlorosis in cannabis plants grown at a pH 7. Iron uptake can also be hindered by overirrigation, cold substrate temperatures, or root disease such as *Pythium*. Figure 2 illustrates interveinal chlorosis of cannabis and was the result of restricted root growth during propagation and excessive irrigation. In other experiments at NC State, we observed the development of interveinal chlorosis on plants with a pH of 7.8. This helps provide a little more refinement of the upper limit of pH, and would suggest that the pH should be lower than 7.5.

Target nutrition parameters for cannabis mother stock plants by growth stage.

pH Category: III
5.8 to 6.2

Establishment of Cuttings for Mother Stock
Newly transplanted cuttings (clones) that are grown for future mother stock plants only require a low level of fertility while they are getting established during the first few weeks.

Fertility Category: Low
100 - 150 ppm N

EC Category: A
1:2 Extraction - 0.4 to 0.6 mS/cm
SME - 0.9 to 1.3 mS/cm
PourThru - 0.9 to 2.0 mS/cm

Grow Out of Mother Plants
As mother plants begin to bulk, nutrient levels should be increased to accommodate new growth requirements. Additionally, the new shoots which become cuttings are huge nutrient sinks and by removing these resources from the plant you will deplete nutrient reserves quickly.

Fertility Category: Medium
150 to 200 ppm N

EC Category B:
1:2 Extraction - 0.6 to 0.9 mS/cm
SME - 1.3 to 2.0 mS/cm
PourThru - 2.0 to 3.0 mS/cm

Cutting Harvest from Mother Plants
Large mother plants, prior to when cuttings are being taken, require higher levels of fertility to support the mass of vegetative growth. In addition, once cutting harvest begins, each cutting that is being harvested also removes nutrient reserves. These reserves need to be replaced in order to support new growth, and to ensure that fertility levels are adequate in future cuttings because nutrient reserves will influence rooting.

Fertility Category: Medium to High
150 to 300 ppm N

EC Category B - C During Active Growth:
1:2 Extraction - 0.6 to 1.5 mS/cm
SME - 1.3 to 3.3 mS/cm
PourThru - 1.3 to 4.3 mS/cm

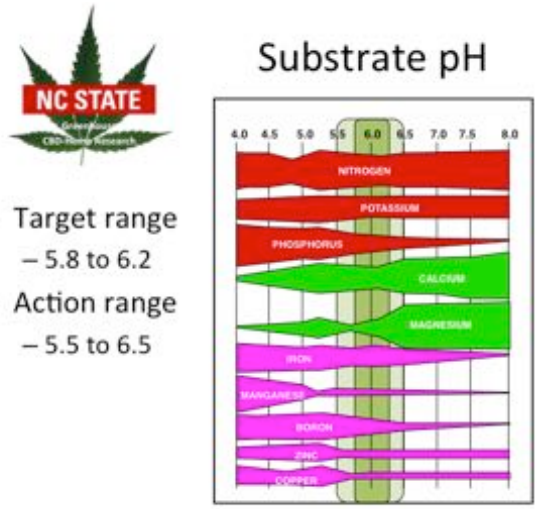

Figure 3. Substrate pH affects nutrient availability in cannabis. The pH range recommended for cannabis is indicated by the dark green shaded area. Photo by: Brian Whipker

Figure 4. Lower leaves with a lighter green coloration indicate inadequate nitrogen (N) is being provided to the plant. Photo copyright Brian Whipker

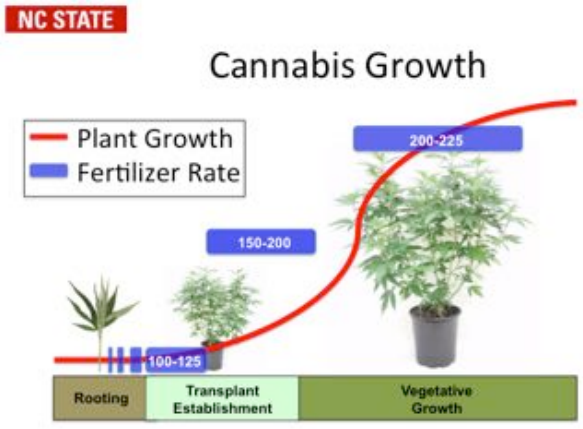

Figure 5. The nutrient demands of cannabis vary over the plant's life cycle. It is important to match your fertilizer rate with the growth rate to optimize growth. Photo by: Brian Whipker

NC STATE

Recommended Fertilization Rate by Crop Stage

Development Stage	Fertilizer Rate (ppm N)
Clonal Propagation (roots visible ~day 14)	50 to 75
Early Vegetative	100 to 125
Late Vegetative	150 to 200
Cutting Harvest	200 to 225

Figure 6. Recommended fertilization rates based on cannabis plant growth. Photo by: Brian Whipker

Figure 7. Symptoms of inadequate fertility quickly develop in cannabis stock plants. Photo: Brian Whipker

Based on the preliminary results of research conducted at NC State, it implies that vegetative stock plants of cannabis have a wide substrate pH range in which the plants will optimally grow. That range appears to be as wide as pH 5.0 to 7.0. Based on experience with other species, a narrower range 5.5 to 6.5 may be more appropriate to target, as this will allow growers to make adjustments as pH approaches the ends of the targeted range. For growers, adapting these pH values to a monitoring system implies that the safe substrate pH zone to target would be a narrower 5.8 to 6.2 (Fig. 3). If the pH drops below 5.8, corrective procedures should begin to slightly increase the pH back into the 5.8 to 6.2 range. On the opposite end of the spectrum, if the substrate pH increases to above 6.2, corrective procedures should begin to slightly decrease the pH back into the 5.8 to 6.2 range. By monitoring the substrate pH over time, one can assure that the plants are within the optimal range.

Fertility

A recommended substrate fertility range varies. In order to standardize production practices Whipker et al. (2019b) suggested guidelines for nutritional practices. Too low of a fertility rate will result in the development of lower leaf chlorosis (Fig. 4&7).

Propagation. The concentration of nitrogen (N) to provide plants varies with the stage of development (Figs. 5&6). During cutting propagation, nutrient reserves in the unrooted cutting can be easily leached out with mist or fog. Added to this, as the mother stock plants age, the nutrient reserves in the plant also diminish over time. It is important to supply a dose of essential nutrients to the cuttings to restore the nutrient reserves. Therefore, once roots are visible provide the cuttings with 50 to 75 ppm N two to three times a week to help restore the nutrient levels within the cuttings.

Transplant. For smaller or recently transplanted clones, lower fertility levels of 100 to 125 ppm N are required and will help jump start growth and assist in root system establishment.

Vegetative Fill Out. Once the roots have reached the edge of the container and the root system has developed, the plant will start producing vegetative growth. During periods of rapid vegetative growth, cannabis plants require a higher concentration of N. Therefore, consider increase fertility levels to 150 to 200 ppm N during the vegetative stage and increase to 200 to 225 ppm N during cuttings harvest. This will help ensure that adequate levels of fertility are provided as the plant bulks.

Target leaf tissue analysis values are listed in Table 1.

Summary

Customizing fertility rates based on the stage of plant growth is required to maximize cutting yield and maintaining a substrate pH of 5.8 to 6.2 will help prevent most nutritional disorders.

Literature Cited

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Table 1. Leaf tissue survey ranges for cannabis. Values published by Bryson and Mills are for nursery-based plants and it is not identified as whether or not they are based on CBD or THC type plants. Values reported by Landis et al. (2019) are for greenhouse-grown cannabis stock mother plants.

Element	Unit	Sufficiency Range[1]	Greenhouse Mother Stock Plants Sufficiency Range. [Means in (x.xx)[2]]
Nitrogen (N)	%	3.3-4.76	2.65-4.47 (3.75)
Phosphorus (P)	%	0.24-0.49	0.31-0.44 (0.35)
Potassium (K)	%	1.83-2.35	1.84-2.98 (2.42)
Calcium (Ca)	%	1.47-4.42	0.53-1.40 (0.88)
Magnesium (Mg)	%	0.40-0.81	0.25-0.46 (0.32)
Sulfur (S)	%	0.17-0.26	0.19-0.29 (0.24)
Boron (B)	ppm	56-105	22.6-57.3 (35.9)
Copper (Cu)	ppm	5-7.1	1.83-11.4 (3.46)
Iron (Fe)	ppm	100-150	59-132 (82.2)
Manganese (Mn)	ppm	41-93	24.3-71.9 (37.2)
Molybdenum (Mo)	ppm	0.50-1.5	0.53-2.36 (1.29)
Zinc (Zn)	ppm	24-52	23.2-46.2 (31.0)

[1]Source: Bryson, G.M. and H.A. Mills. 2015. Plant analysis handbook IV. Micro-Macro Publ., Athens, GA.
[2]Source: Landis, H., Hicks, K., Cockson, P., Henry, J.B., Smith, J.T. and Whipker, B.E., 2019. Expanding Leaf Tissue Nutrient Survey Ranges for Greenhouse Cannabidiol-Hemp. *Crop, Forage & Turfgrass Management*, 5(1).

Corrective Procedures for Modifying Substrate pH and Electrical Conductivity (EC)

When the pH or substrate electrical conductivity (EC) drifts into unwanted territory, adjustments must be made. Below are the standard corrective procedures used to modify the substrate pH and EC for greenhouse grown crops in soilless substrates.

1. Low Substrate pH Correction

When Fe and Mn toxicity becomes a problem, adjust (raising) substrate pH to the recommended pH range. Corrective procedures to raise low pH levels are listed below. Switching to a basic fertilizer when the substrate pH is nearing the lower limit will help stabilize the pH. If the pH is below the recommended range, then corrective procedures will need to be implemented. Flowable lime is one option. Using a rate of 2 quarts per 100 gallons of water will typically increase the substrate pH by roughly 0.5 pH units. Two quarts can be used through an injector. Additional applications can be made if needed. Potassium bicarbonate ($KHCO_3$) can also be applied. A rate of 2 pounds per 100 gallons of water will increase the substrate pH by roughly 0.8 pH units. This treatment will also provide excessive potassium (K) and cause a spike in the substrate EC. A leaching irrigation with clear water is required the following day to restore the nutrient balance (the ratio of K:Ca:Mg) and lower the EC. As always, remember to recheck your substrate pH to determine if reapplications are needed.

pH Adjustment Recommendations

Flowable Lime

- Use 1 to 2 quarts per 100 gallons of water.
  Rinse foliage.
- Avoid damage to your injector by using rates of 2 quarts per 100 gallons of water, or less.
- Can split applications.

Hydrated Lime

- Mix 1 pound in 3 to 5 gallons of WARM water. Mix twice. Let settle. Decant liquid and apply through injector at 1:15.
- Caustic (rinse foliage ASAP and avoid skin contact)

Potassium Bicarbonate ($KHCO_3$)

- Use 2 pounds per 100 gallons of water
- Rinse foliage immediately.
- *Provides 933 ppm K.*
- Leach heavily the following day with a complete fertilizer to reduce substrate EC and restore nutrient balance.
- Rates greater than 2 pounds per 100 gallons of water can cause phytotoxicity!

2. High Substrate pH Correction

The target pH for many species is between 5.8 and 6.2. Higher pH values will result in Fe deficiency and lead to the development of interveinal chlorosis on the upper leaves. Check the substrate pH to determine if it is too high. Be careful when lowering the substrate pH, because going too low can be much more problematic and difficult to deal with.

Acid-based Fertilizer
If the substrate pH is just beginning to increase, then first consider switching to an acidic-based fertilizer. These ammoniacal-nitrogen (N) based fertilizers are naturally acidic and plant nitrogen uptake will help moderate the substrate pH over a week or two.

Acid Water Drench
Some growers use this intermediate correction if pH levels are not excessively high and a quick lower of the substrate pH is desired. Use sulfuric acid to acidify your irrigation water to a pH 4.0 to 4.5. Apply this acid water as a substrate drench providing 5 to 10% excessive leaching of the substrate. Rinse the foliage to avoid phytotoxicity. Results should be visible within 5 days. Retest the substrate pH and repeat if needed.

Iron Drench
If the levels are excessively high, then an Fe chelate application can be made to the substrate.
Below are the options.

Iron Chelate Drench (options)
- Iron-EDDHA: mix 5 ounces in 100 gallons of water
- Iron-DTPA: mix 5 ounces in 100 gallons of water
- Iron sulfate: mix 4-8 ounces in 100 gallons of water

- Apply as a substrate drench with sufficient volume to leach the pot.
- Rinse foliage immediately.
- Avoid use on iron efficient plants (geraniums).

3. Low EC Correction

If low EC problems occur, increase the fertilization rate to 300 ppm N for a few applications before returning to the recommend fertilization rate for the crop.

4. High EC Correction

Excessively high fertilization rates will result in a marginal leaf burn. Check the substrate EC to confirm your diagnosis. Values greater than 6.0 mS/cm based on the PourThru sampling method can be problematic for many plants.

Switch to Clear Water Irrigations
If the substrate EC is just beginning to increase over time, then leach with a few clear water irrigations to lower EC levels by flushing out the salts.

Clear Water Leaching
If the EC values are excessively high, leach the substrate twice with back-to-back clear water irrigations. Then allow the substrate to dry down normally before retesting the EC. If EC levels are still too high, repeat the double leach. Once the substrate EC is back within the normal range, use a balanced fertilizer at a rate of 150 to 200 ppm N.

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