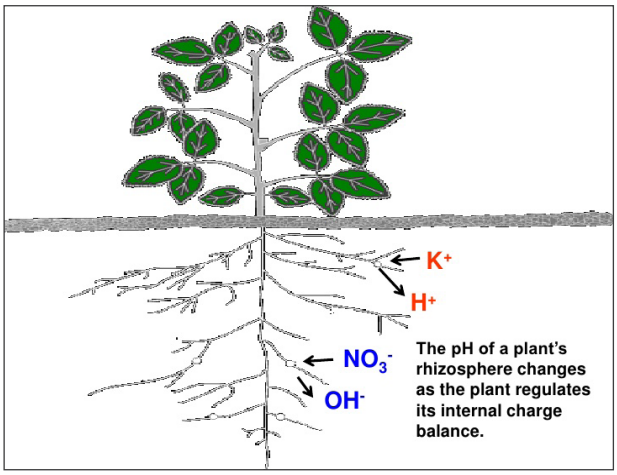
WHITEPAPER

RHIZOSPHERE PH AND NUTRIENT AVAILABILITY

WHAT IS pH?

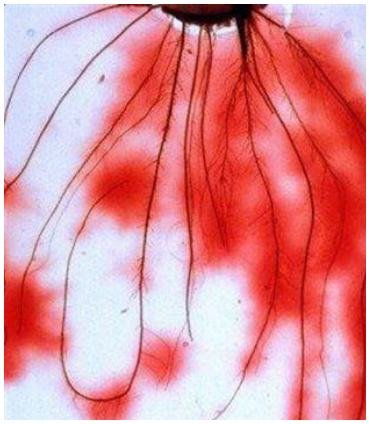
Potential hydrogen, or pH, is a measure of the solution concentration of hydrogen ions, or H+. There are two types of ions: a cation (positively charged particle) and anion (negatively charged particle). Cations and anions are attracted to each other (think of magnetics) to form ionic compounds. These compounds form familiar mineral nutrients such as calcium nitrate or potassium phosphate. The plant cannot uptake these complex mineral nutrients until they are broken into either cations (calcium, potassium) or anions (nitrate, phosphate). When water is added to the mix, these compounds break apart, or dissociate, into cations or anions that the roots can absorb. A plant always maintains a balanced pH inside its cells and will do this by putting off excess cations or anions after it absorbs what it needs. Changes in rhizosphere pH are associated with differential anion and cation uptake, thus pH at the plant's rhizosphere is constantly changing; this is an important concept to understand when considering nutrient uptake.



Ionic compounds[1]

UNDERSTANDING RHIZOSPHERE pH

The rhizosphere is the area of soil directly surrounding the plant's roots. Root secretions and microorganisms affect the soil chemistry and biology of this area. Compounds found in root exudates consist of water, amino acids, organic acids, carbohydrates, proteins and vitamins. Many of these compounds serve as food sources for microorganisms in the region, making the rhizosphere an extremely bioactive environment. This bioactivity changes the pH of the area, which in turn affects the nutrient solubility and availability to plants. Soil pH is a key chemical property that influences nutrient availability, but it is important to understand that rhizosphere pH tends to be lower than the bulk soil pH.



Plant exudates

> *Plant exudates can adjust pH and nutrient supply, and even affect soil quality, by supporting the organisms of the soil food web.*[2]

[1] *http://image.slidesharecdn.com/soilacidity-110110144937-phpapp01/95/soil-acidity-24-728.jpg?cb=1294671008*

[2] *Teaming With Nutrients (2013)*

SOLUTION pH DOES NOT EQUAL RUNOFF pH

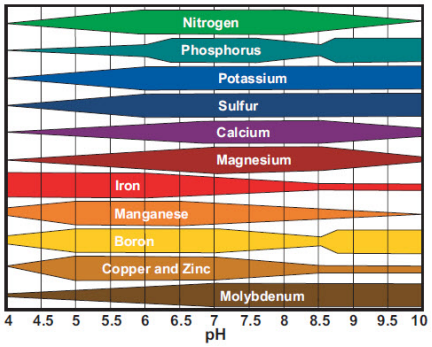
When using a soilless medium, the pH of the nutrient solution in the reservoir will likely not be the same pH after it is fed to the plant. For example, we mixed up a nutrient solution that went into solution at a 4.1 pH and then fed a cannabis plant in a peat-based growing medium; the pH of the runoff in the bottom of the tray was 5.8. The plant and soilless medium naturally buffered the pH of the nutrient solution.

pH level of runoff before feeding

pH level of runoff after feeding

SOILLESS CULTIVATION VS DIRT FARMING

Everyone has seen the common soil pH charts. It is important to understand that these charts depict soil pH in traditional farming, not the pH of the rhizosphere in soilless media or hydroponic cultivation. When cultivating in field soil, growers do not typically feed on a daily basis and therefore rely on the nutrients tied up in the soil to feed the plant. The pH of the soil in this type of farming is very important as pH imbalance can cause nutrient lockout. When adding nutrients to a soilless medium, plants are fed more frequently to consistently deliver nutrients to the plant's rhizosphere, which naturally adjusts the pH for optimal nutrient uptake.



Nutrient availability at different pH levels in dirt farming[3]

WHAT ABOUT TRUE HYDROPONIC SYSTEMS?

We know soilless media like coco or peat acts as a buffer and helps to adjust the pH, but what about a hydroponic system? The plants shown below were grown in clay pebbles in a recirculating hydroponic system. The nutrient solution in the reservoir of the red plant had a pH of 4.4, and the nutrient solution of the reservoir of the blue plant was a 5.8. Both reservoirs were adjusted back to their starting pH levels daily, since both would rise every time the plants fed. There is no noticeable difference between the two plants.

The nutrient solution in the reservoir of the red plant had a pH of 4.4, and the nutrient solution of the reservoir of the blue plant was a 5.8.

[3] *http://msue.anr.msu.edu/news/more_reasons_for_soil_testing*

RX GREEN TECHNOLOGIES TRIAL

Purpose:
To understand how cannabis yields are affected when grown with solution at conventional pH levels (5.6 -5.8), versus solution that is not pH adjusted at all (4.3-5.0).

Protocols:
One test group was pH adjusted to conventional levels (5.6 during the vegetative stage and 5.8 during the flower stage), while the other group was not pH adjusted at all. All other factors in the trial were the same. All plants were grown in a coco/perlite media.

Pictures:

(3.7.15)

ph Adjusted **Not ph Adjusted**

(7.24.15)

ph Adjusted **Not ph Adjusted**

Yield Data & Conclusion:
The plants that were not pH adjusted showed a 12.64% increase in average wet weight, a 11.60% increase in average dry bud weight, a 20.26% increase in average trim weight, and a 0.96% increase in THC content over the control group that was pH adjusted.

The plants with no pH adjustment showed a slightly larger canopy and shorter internodes than the pH-adjusted plants. Because the plants in this trial were treated identically in all respects, except for pH adjustment, we believe the increase in performance can be attributed to the plants' ability to absorb micronutrients more easily at a lower pH. Also, the coco/perlite media works as a good buffer, wherein the macronutrients will be more available for the plants.

Disclaimer:
This trial was just tested with Rx Green Technologies' nutrients; using other nutrients without pH-ing your solution may not yield the same results. See the full trial write up on our website: www.rxgreentechnologies.com/trials.

WHAT ARE CUSTOMERS SAYING?

> *I was amazed when I was told 'no need to worry' about the low PH that RX mixes at. It goes against what I had learned and experienced with PH buffering over the years. I used to keep my PH between 5.8-6.2 and now with Rx it is between 3.8-4.7. I ran the nutrient line with out any adjustment or concern for it and low and behold, it worked perfectly and I saw no negative effects from running it at a low PH.*
>
> *-Tom S. from Bonsai Wholesale (38,000 sq. feet/712 lights)*

Bonsai Wholesale

> *Well I'm at 4.0 ph on all my bloom feedings with @rxgreentechnologies nutrients. Amazing things I'm seeing here, grown in @botanicare #readygro #coco under @hortilux hps @plantinumled*
>
> *-@duttypanty: Rx Customer*

> *The pH game is looking right…. 4.0 pH week 3 flower and I have never seen results like this. I understand the high acidity especially when combined. But, your new pk additive #bulk is a home run, and with a ph this low. I have the cleanest tanks and lines I have ever seen…*
>
> *-@realmccoy_farms: Head Grower at @ boringweed*

ADDITIONAL SOURCES

Fageria, N., Stone L. (2006). Physical, chemical, and biological changes in the rhizosphere and nutrient availability. Journal of Plant Nutrition.

Hinsinger P., et al. (2003) Origins of root-mediated pH changes in the rhizosphere and their responses to environmental constraints: A review. Plant and Soil.

Plant Physiology 5th ed. (2010) Taiz L., Zeiger E.; Sinauer Associates

Teaming With Nutrients (2013) Lowenfels J.; Timber Press Inc.