UF UNIVERSITY of FLORIDA
IFAS Extension

HS1207

Soil pH Range for Optimum Commercial Vegetable Production[1]

Guodong Liu and Edward Hanlon[2]

Introduction

Soil pH is a measure of soil acidity or basicity, and it is defined as the negative logarithm of the proton (H^+) activity. The pH ranges from 0 to 14. A pH of 7.0 is defined as neutral, while a pH of less than 7.0 is described as acidic, and a pH of greater than 7.0 is described as basic (Figure 1). According to the USDA Natural Resources Conservation Service (1993), soil pH ranges roughly from acidic (pH < 3.5) to very strongly alkaline (pH > 9.0). Soil pH is a master characteristic in soil chemical properties because it governs many chemical processes. The pH specifically affects nutrient bioavailability by controlling the chemical forms of nutrients. For example, ferrous iron is a bioavailable form of iron for most crop species, but ferric iron is not. At a relatively high pH, ferric iron is the primary form of the nutrient, and crop plants may experience iron deficiency.

As one of the most important soil chemical properties for optimal crop production, soil pH determines nutrient sufficiency, deficiency, toxicity, and need for liming (Fageria and Zimmermann 1998) or addition of sulfur. The pH range of most of the Florida's soils is approximately between 4.0 and 9.0 (Figure 1; Tables 1–4). Because nutrient solubility is highly pH dependent, soil pH near 4.0 or 9.0 is usually not suitable for commercial vegetable production. A pH range from 5.5 to 7.0 is suitable for most vegetable crops (Figure 2). This pH range can assure high bioavailability of most nutrients essential for vegetable growth and development (Ronen 2007). For example, at soil pH 8.0 or higher, iron and/or manganese bioavailability can't satisfy most vegetable crops' requirements. However, when soil pH reaches 5.0 or lower, aluminum, iron, manganese, and/or zinc solubility in soil solution becomes toxic to most vegetable crops (Osakia, Watanabe, and Tadano 1997).

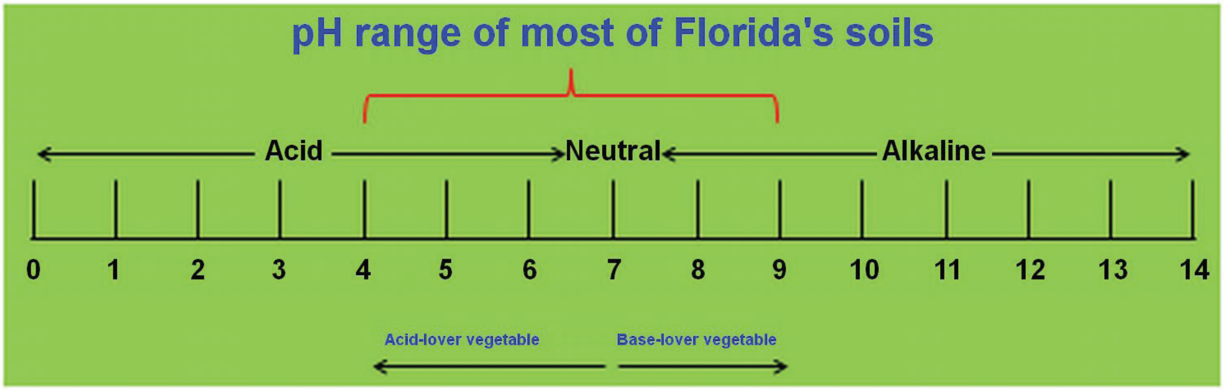

Figure 1. The pH scale and vegetable categories. The pH is measured on a logarithm scale from 0 to 14.
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2. Guodong Liu, assistant professor, Horticultural Sciences Department, and Edward Hanlon, professor, Soil and Water Science Department, University of Florida Institute of Food and Agricultural Sciences, Gainesville, FL 32611

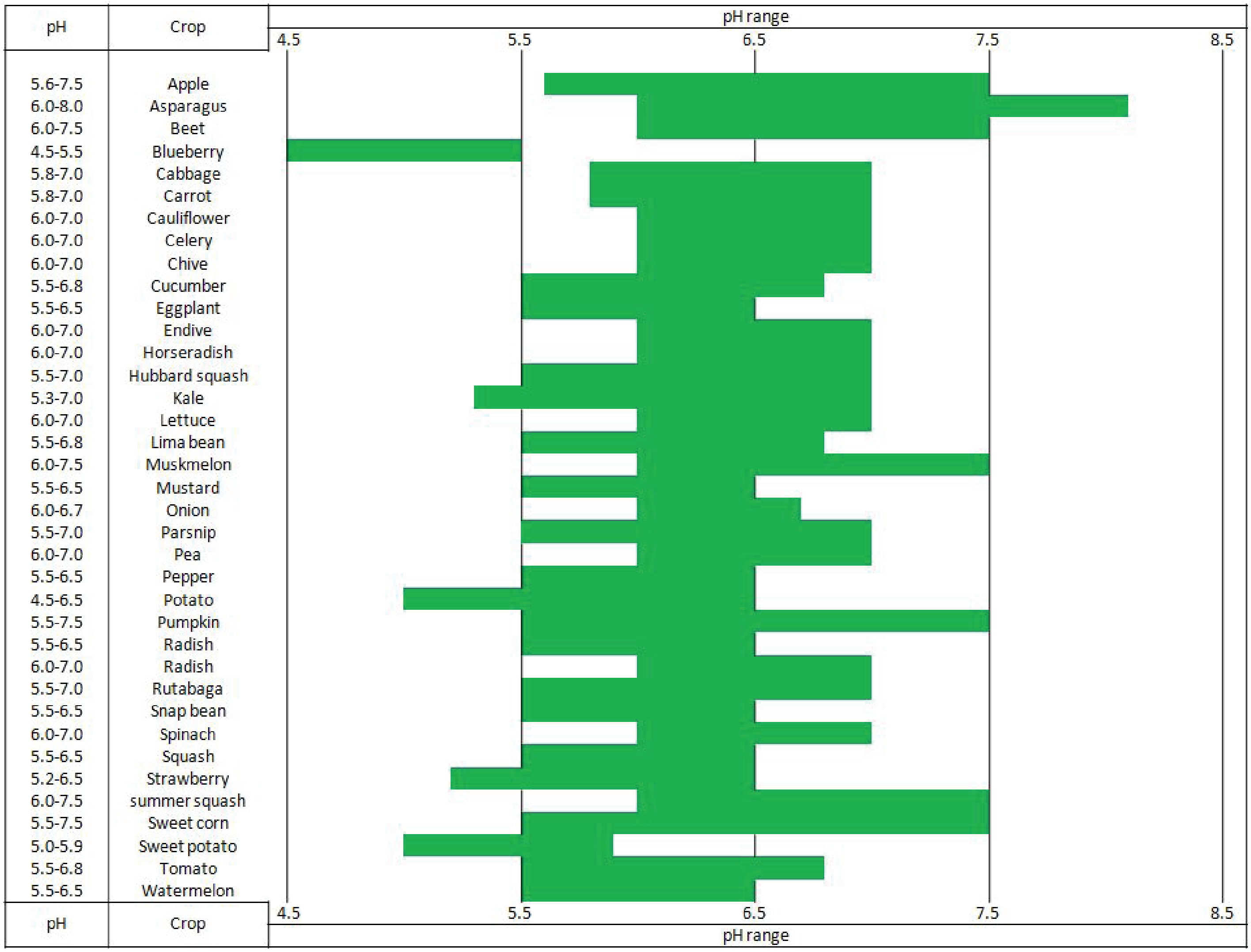

Figure 2. Soil pH range for optimal growth of selected vegetable crops (*Source*: Havlin et al. 2005; Splittstoesser 1990)

This publication is intended to provide information about soil pH basics to commercial growers, county Extension agents, and college students specializing in vegetable production.

Effects of soil pH on vegetable crop growth and development

Effects on cation and anion nutrients: Soil pH determines the solubility and bioavailability of nutrients essential for crop production. There are seventeen elements essential for normal growth and development of vegetable crops. Based on the source, the seventeen nutrient elements can be roughly categorized into two groups: three nutrients from air and water, which are carbon (C), hydrogen (H), and oxygen (O), and fourteen soil nutrients, which are nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe), zinc (Zn), copper (Cu), manganese (Mn), boron (B), chlorine (Cl), molybdenum (Mo), and nickel (Ni). The bioavailable forms of all the soil nutrients are ionic—some are anionic (negatively charged, such as nitrate ions), some cationic (positively charged, such as ammonium ions), and some are both. For example, P, S, Cl, and Mo are typical anion nutrients, and K, Ca, Mg, Fe, Zn, Cu, Mn, and Ni are typical cation nutrients, but N can be either anions or cations. Boron is predominately undissociated boric acid (H_3BO_3 or $B(OH)_3$), but less than 2% of B is in the form of an anion $B(OH)_{4^-}$ at pH 7.5 or lower. The solubility (i.e., bioavailability) of each of these fourteen nutrient elements is closely related to soil pH. At pH lower than 5.0, Fe, Cu, Mn, and Zn are highly soluble. These micronutrients can form precipitates with phosphate at this low pH, and P becomes unavailable accordingly. However, at pH greater than 7.0, Ca and Mg have high solubility, and they can fix P as well. Thus, comprehensively speaking, in the pH range from 5.5 to 7.0, all of the nutrients have favorable usability to vegetable plants (Figure 3).

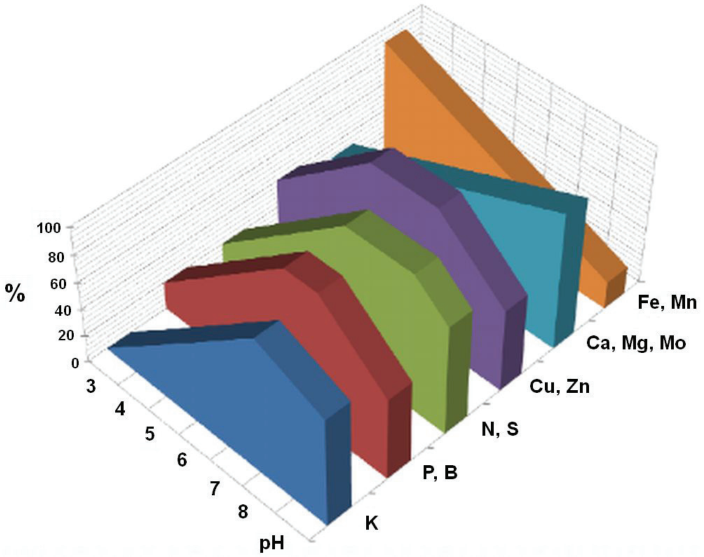

Figure 3. The pH and bioavailability (%) of listed nutrients in soil solution (*Source*: Finck 1976)

Effects on nutrient uptake near the root zone: Soil pH also affects nutrient uptake by vegetable plants because it can change soil particle property. For example, if soil pH is unfavorably low, the positive charges on soil particle surfaces can tightly hold up nutrients like P, potentially causing P deficiency in vegetable plants. However, if soil pH is adversely high, then Fe, Mn, and Zn will become difficult for vegetable plants to use. In one study, bean (*Phaseolus vulgaris* L.) absorbed 93.3% more P, 53.8%, more Fe, and 44.1% more Zn at pH 5.4 than at pH 7.3, respectively (Thomson, Marschner, and Römheld 1993). The lower pH favors P, Fe, and Zn uptake because the bioavailability of P, Fe, and Zn is greater at pH 5.4 than at pH 7.3 (Figure 3).

Effects on metal toxicity: Basically, metal toxicity occurs at soil pH lower than 5.0 when elements such as Al, Fe, Mn, and Cu have much greater solubility than plants need. To avoid this problem, lime is needed to increase soil pH and decrease the potential for toxicity.

Effects on plant pathogens: Some soilborne diseases are closely associated with soil pH. For example, clubroot disease of mustard, cabbage, or other crucifers caused by *Plasmodiophora brassicae* is a major epidemic disease when soil pH is lower than 5.7 but is dramatically reduced in a pH range from 5.7 to 6.2. This disease is virtually eliminated when the soil pH is greater than 7.3. Similarly, common scab of potato is favored when the pH is greater than 5.2 but significantly reduced at less than 5.2 (Kioke et al. 2003).

Statewide overview of soil pH

Florida is a unique state in terms of soil diversity. Its soil pH significantly differs in the entire state from north to south and east to west. Even in the same county, soil pH can differ by as much as 6 pH units, according to the USDA soil survey (USDA 1976, 1979, 1983, 1996). For example, soil pH ranges from 3.6 to 9.0, from 3.6 to 9.0, from 3.3 to 9.0, and from 3.6 to 8.4 for Dade County, Palm Beach County, St. Johns County, and Jackson County, respectively (Tables 1 through 4). These extremes are all unfavorable for vegetable production.

Nutrients and soil pH

Nutrient bioavailability: Nutrient bioavailability is usually a limiting factor in commercial crop production because of solubility limitation or immobilization of plant nutrients by soil colloids. A nutrient's bioavailability is the proportion of that particular nutrient that is soluble or mobilized by root exudates, including protons (directly related to soil pH), chelates, mucilage and mucigel, or microbial products (Neumann and Römheld 2012). For instance, in the Everglades Agricultural Area, total P in cultivated soil is up to 1227 parts per million (ppm), but bioavailable P is only 1.3 ppm (Wright, Hanlon, and McCray 2009). The bioavailability of that particular soil is only 0.1% of the total P. Thus, P deficiency does not mean lack of P in that particular soil, but it does mean lack of absorbable or usable P for crop plants. In fact, the bioavailability of most nutrients is controlled by soil pH. As soil pH increases, the bioavailability decreases for P, Fe, Mn, B, Zn, and Cu. As soil pH decreases, the bioavailability decreases for Ca, Mg, and Mo (Figure 3).

Nutrients needed in large amounts by vegetable plants are called macronutrients, such as N, P, K, Ca, Mg, and S, whereas those needed in trace amounts are referred to as micronutrients or trace nutrients, such as Fe, Mn, B, Zn, Cu, Cl, Mo, and Ni. Soil pH affects both macronutrient and micronutrient solubility (Figure 3) and bioavailability. For example, the primary form of iron in dry soil is ferric hydroxide ($Fe(OH)_3$) because ferrous iron is easily oxidized and little ferrous iron exists in dry soil, particularly at soil pH 7.3 or higher. The solubility of ferric hydroxide is only 6.3×10^{-20} mol/L (i.e., only 1.34×10^{-11} mg Fe per 1000 gallons of water at pH 7.3). However, its solubility is 1.34×10^{-5} mg Fe per 1000 gallons of water at pH 5.3. The solubility increases one million times when soil pH is lowered just three pH units. This dramatic change in solubility can explain why iron deficiency symptoms often occur when soil pH is 7.3 or higher. If the soil is appropriately wet and soil pH is neutral or slightly acidic, a considerable proportion of iron exists in the form of ferrous iron, usually enough to satisfy crop nutrient requirements for Fe.

Soil pH influence on uptake of cation and anion nutrients: In low-pH soils, the hydrogen ion exists as a hydrated proton and may become a toxicant if soil pH is lower than 3.0 (Liu et al. 2007). However, the effects of soil pH on nutrient intake are mainly indirect, caused by increasing the solubility of toxic metals, such as aluminum (Al). Aluminum solubility is also a function of soil pH. The solubility of Al increases as soil pH decreases. At pH 5.5 or lower, the solubility of Al increases 1000-fold for every pH unit decrease. For example, at pH 5.0, Al solubility is only 0.05 ppm, but at pH 4.0, Al solubility increases to a toxic 51 ppm.

Such high concentrations of Al can damage root morphology and induce P deficiency in soil (Figure 3). The root system of corn can be seriously damaged or its growth retarded when Al concentration is greater than 9 ppm (Lidon and Barreiro 1998). This negative effect on plants is evidence of Al toxicity. Aluminum and phosphate precipitate in low-pH soil. Both Al and P have a reciprocal relationship. As mentioned above, Al solubility is 1000-fold greater at pH 4.0 than at pH 5.0. Because of the Al concentration increase, the bioavailability of P at pH 4.0 reduces to one thousandth of the concentration present at pH 5.0, having been precipitated by the increase in Al. Similar effects for other elements can be seen in Figure 3.

Low pH exacerbates nutrient leaching problems because cation nutrients adsorbed by soil particles may be replaced by protons in soil solution. The nutrient leaching reduces nutrient uptake and nutrient use efficiency of vegetable crops.

Effects on nutrient uptake near the root zone: In the presence of toxic concentrations of elements such as Al at low pH, root growth and water uptake are inhibited and plants may show symptoms of P deficiency and drought stress. Aluminum-stressed plants cannot efficiently absorb nutrients from soil solution. There are two other reasons for inhibition of cation nutrient uptake and induction of nutrient deficiency: (a) impairment of net excretion of protons and (b) decrease of bioavailable cation nutrients, such as Ca, Mg, Zn, and Mn in soil solution.

Effects of soil pH on microbial activity

The pH affects microbial activities, which in turn can affect the bioavailability of both macronutrients and micronutrients. Most soil microbes thrive in a range of slightly acidic pH (6–7) because of the high bioavailability of most nutrients in that pH range (Sylvia et al. 2005). Because microbes can increase nutrient bioavailability and promote plant nutrient uptake, vegetable crops can also thrive in such environments (Das et al. 2010).

Nutrient sources affect soil pH in root zones

Acid-forming or basic-forming fertilizers: Acid-forming fertilizers are defined as those that lower rhizosphere pH after being absorbed by plants. All fertilizers containing cation nutrients, such as ammoniacal-N, K, Ca, and Mg, are acid forming, whereas those having anion nutrients, such as nitrate N, P, and S, are basic forming. For instance, ammonium chloride, potassium chloride, calcium chloride, and magnesium chloride are acid-forming fertilizers. However, sodium nitrate, sodium dihydrogen phosphate, and sodium sulfate are basic-forming fertilizers.

Acid- or basic-forming fertilizer is *NOT* related to the acidity or basicity of the applied fertilizer itself. The acidity or basicity results from the selective uptake of nutrients by crop plants. For example, potassium chloride is chemically neutral. Potassium and chlorine (Cl) are both essential for vegetable crop growth and development. However, the ratio of plants' K requirement to Cl requirement is greater than 80. This ratio shows that plants need to absorb more than 80 K^+ ions when they take up one Cl^- ion. These two nutrients are either positively or negatively charged. If plants take these two kinds of cation and anion ions without electrical neutralization, plant cells would accumulate tremendous positive charges. These unbalanced charges can kill the cells immediately. To avoid this, plant cells have developed two strategies. In the first strategy, they stoichiometrically release the same type of charges, such as protons (H^+), when they intake K. In the second strategy, the cells can also neutralize the unbalanced charges by absorbing the same amount of other ions with counter charges, such as OH^- or HCO_3^-, in this case when they take up K^+ ions. Regardless of strategy, the net consequence is the same: The pH in the growth medium, particularly in the root zone, is decreased. Similarly, sodium nitrate is chemically neutral, but the pH in the root zone is increased when the plant takes up N from sodium nitrate because nitrate N is negatively charged and the primary nutrient in crop production, but sodium is not essential for crop plant growth and development. Therefore, intentional selection of fertilizers, such as potassium chloride or sodium nitrate, can effectively adjust soil pH in the root zone, if needed.

Soil pH vs. nutrient losses

Ammonia volatilization: Ammonium-N is one of the two primary forms of commercial N fertilizers. Ammonium and ammonia can form a dynamic chemical equilibrium in soil solution. The shift direction of the chemical equilibrium between ammonium and ammonia is determined by the pH of soil solution. At pH 9.2, both ammonium and ammonia are equal in concentrations. Ammonium is aqueous, but ammonia is both aqueous and gaseous in solution. The solubility of ammonia in water is 31% at 77°F (25°C). This dissolved ammonia can easily be converted into gaseous ammonia that is ultimately released into the atmosphere. This gas emission is called ammonia volatilization. Soil pH mainly determines the extent of the ammonia's volatilization. High soil pH (greater than 7.2) causes ammonia volatilization from fertilized soils with ammoniacal-N sources, such as ammonium sulfate, or ammonium-forming fertilizers, such as urea. In Florida, ammonia volatilization was up to 26% of the applied N fertilizer in Krome Very Gravelly Loam soil in Homestead for potato production (Liu et al. 2007).

Anionic nutrient leaching: At soil pH greater than 7.0, hydroxide ions can replace anionic nutrients from soil particles with positive charges and reduce soil particles' anionic nutrient-holding ability. Nitrate leaching increases proportionately as soil pH increases (Costa and Seidel 2010). Therefore, high soil pH exacerbates anionic nutrient leaching and reduces nutrient use efficiency. To alleviate leaching problems and improve the profitability of vegetable production, soil pH needs to be effectively managed.

Micronutrients: In addition to soil pH, micronutrients are affected by ionic charge (some can have more than one, like Mn and Fe), which is often determined by microsite conditions and oxidation-reduction potential. For example, in appropriately wet soil (between field capacity and wilting point), Fe and Mn are more bioavailable than in dry soil because wet soil has lower oxidation-reduction potential than dry soil. In the same soil, the oxidation-reduction potential increases with pH. This process explains Fe or Mn deficiency in high pH soils, namely as a function of pH greater than 7.0 and during drier soil moisture conditions, which favor deficiency.

Nutrient use efficiency

Nutrient use efficiency is defined as vegetable yield per unit of nutrient input. It is much more important than ever because fertilizer prices have risen and profit margins have become thin. Nutrient use efficiency can be measured by calculating the productivity of each unit of a particular nutrient. In 2012, two snap bean trials were done in Lake Harbor and Belle Glade in Palm Beach County. The two trials both showed that 120 lb. phosphorus pentoxide (P_2O_5) per acre was the most efficient P rate. The P use efficiency in snap bean production varied with the trial locations. In Lake Harbor, 1 lb. of P fertilizer yielded 11 lb. of beans. The P use efficiency for this particular trial in Lake Harbor was 11 (lb./lb.). However, in Belle Glade, 1 lb. of P yielded 22 lb. of beans. The P use efficiency in Belle Glade was 22 (lb./lb.). This difference in P use efficiency can be attributed to the bioavailability of P in soil background. The Mehlich 3 P concentration in the muck soil was 82.3±5.7 ppm (Lake Harbor) and only 37.8±1.9 ppm in the fine sandy soil (Belle Glade).

Modifying soil pH or choosing plants that will thrive in soil

Adjusting soil pH usually involves raising the soil pH by adding agricultural lime if soil pH is too low.

Acidic soils: The bioavailability of Ca, Mg, and Mo is often low and may adversely affect vegetable production. Additionally, toxicity effects discussed previously may also be a factor. An increased soil pH can improve nutrient availability and help avoid toxicity.

Lime and lime requirement: The most common soil additive to increase soil pH is agricultural lime, usually finely ground. The amount of lime required to increase soil pH is determined by the size of the limestone particles being used and, most importantly, the buffering capacity of the soil. The buffering capacity refers to the soil's ability to minimize change in the acidity of a solution when an acid or base is added into the solution. The finer the ground lime, the quicker the neutralization reaction. Buffering capacity is controlled by the soil's clay content and the amount of organic matter present. Soils with more clay content have a greater buffering capacity than soils with less clay content. Similarly, soils with more organic matter have higher buffering capacity than those with lower organic matter. Soils with great buffering capacity need more agricultural lime to adjust soil pH than those with lower buffering capacity for the same incremental change in soil pH. However, sandy soils have lower buffering capacity and need less lime for the same incremental change in pH than clay soils.

The best way to determine the lime requirement for a particular soil is to take a soil sample to the Extension Soil Testing Laboratory at the University of Florida. County Extension faculty members can also help. For more information, see *Soil pH and the Home Landscape or Garden* (http://edis.ifas.ufl.edu/ss480), *Managing pH in the Everglades Agricultural Soils* (http://edis.ifas.ufl.edu/ss500), The Vegetarian Newsletter, Issue 573 (http://hos.ufl.edu/newsletters/vegetarian/issue-no-573), and *The Soil Test Handbook for Georgia* (http://aesl.ces.uga.edu/publications/soil/STHandbook.pdf).

Other amendments, such as dolomite (a white or light-colored mineral, essentially $CaMg(CO_3)_2$), wood ash, industrial burnt lime (calcium oxide), and oyster shells can also increase soil pH. These sources increase soil pH through the reaction of carbonate and protons to produce carbon dioxide and water. However, some wood ash may contain sodium or heavy metals. Before using any of these sources, consult your county Extension agent. Applying calcium silicate can also neutralize active acidity in soil. Local organic sources, such as yard-trash compost and sphagnum moss peat, are all acidic. The pH range can be as low as 3.6–4.2. These sources can be used to neutralize free hydroxide and/or bicarbonate ions.

Use nitrate nitrogen fertilizers: Liming can change the whole soil layer's pH. If nitrate nitrogen fertilizers are used, the root zone's pH can be increased without additional cost because vegetable crops need to balance electrically after absorbing nitrate ions, which are negatively charged. Since N should be added according to recommended fertilizer rates, this process works slowly for the entire soil profile, but it does improve the plant root zone pH in a short time.

Alkaline soils: The bioavailability of P, Fe, Mn, Zn, Cu, and Ni is low and may adversely affect vegetable growth and development. To ensure that vegetable crops will grow well, soil pH may need to be reduced if the high pH was caused by overliming or poor irrigation water quality. If the high pH was caused by a natural condition, usually limestone or beach shells in Florida, the change is too costly. Selection of appropriate cultivars is a must in such a case.

Sulfur and sulfur requirement: The most common soil additives to decrease soil pH are elemental sulfur (S), iron sulfate or aluminum sulfate, peat moss, or any cation nutrients, such as ammonium, potassium, calcium, and magnesium. Therefore, these fertilizers can all decrease soil pH: urea, urea phosphate, ammonium nitrate, ammonium phosphates, ammonium sulfate, and monopotassium phosphate. Organic matter in the form of plant litter, compost, and manure all decrease soil pH through the decomposition process. Certain acidic organic matter, such as pine needles, is also effective at reducing pH.

Applying elemental sulfur can decrease soil pH because the applied sulfur can form sulfuric acid and neutralize free hydroxide or bicarbonate ions in the soil. Similar to the lime requirement for low-pH soils, sulfur requirement for high-pH soil is closely related to the buffering capacity of the target soil. Kissel and Sonon (2008) provide an informative reference to determine the actual amount needed for a particular high-pH soil. It is better to discuss lowering soil pH with a local county Extension agent before taking any action.

Use ammonium nitrogen fertilizers: Ammoniacal-N fertilizers, such as ammonium sulfate and ammonium chloride, and ammonium-forming fertilizers, such as urea, can significantly decrease root zone pH after plants take up ammonium ions from soil. Using suitable fertilizers to adjust soil pH doesn't necessarily incur any additional cost and may improve the profitability of vegetable production. Applying organic matter, such as compost, manure, and pine sawdust, is also effective at reducing soil pH. If soil pH is too low, refer to *Soil Fertility Management for Wildlife Food Plots* (http://edis.ifas.ufl.edu/ss468) and *Diagnostic Nutrient Testing for Commercial Citrus in Florida* (http://edis.ifas.ufl.edu/ss492).

Optimal soil pH

To enhance vegetable production productivity, optimal soil pH range is essential. Tables 1 through 4 indicate the soil pH ranges in selected counties. The pH ranges for other counties can be found at http://soils.usda.gov/survey/online_surveys/florida/. Figure 1 contains the pH scale and vegetable category based on their tolerance to acidity levels. Figure 2 lists the range in soil pH for optimal growth of selected vegetable crops. Figure 3 indicates the relationship between nutrient bioavailability and soil pH.

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Table 1. Dade County soil pH[z]

Soil name	Depth (inches)	Soil pH
Basinger	0–6	3.6–8.4
Biscayne	0–7	7.4–8.4
Canaveral	0–80	6.6–8.4
Cardsound	0–4	6.1–7.3
Chekika	0–5	7.4–8.4
Dade	0–24	6.1–8.4
Dania	0–15	5.6–7.3
Demory	0–7	6.1–7.3
Hallandale	0–4	5.1–6.5
Kesson	0–33	7.4–9.0
Krome	0–7	7.4–8.4
Lauderhill	0–30	5.6–7.8
Margate	0–9	4.5–6.0
Matecumbe	0–3	5.6–7.3
Opalocka	0–6	6.1–7.3
Pahokee	0–46	5.6–7.3
Pennsuco	0–8	7.9–8.4
Perrine	0–10	7.9–8.4
Plantation	0–14	4.5–7.3
Pomello	0–35	4.5–6.0
St. Augustine	0–80	6.1–8.4
Tamiami	0–12	6.6–7.8
Terra Ceia	0–80	4.5–8.4
Vizcaya	0–15	6.6–7.8

[z] Soil reaction at soil:water=1:1 (*Source:* USDA 1996)

Table 2. Palm Beach County soil pH[z]

Soil name	Depth (inches)	Soil pH
Anclote	0–17	5.6–6.1
Basinger	0–14	5.7–5.9
Beaches	0–60	7.4–9.0
Boca	0–12	5.9–6.2
Chobee	0–26	3.6–7.3
Dania	0–10	6.2–6.3
Hallandale	0–15	5.7
Holopaw	0–14	5.5–6.1
Immokalee	0–11	5.8–6.9
Jupiter	0–11	6.6
Lauderhill	0–18	6.2–6.3
Myakka	0–7	5.0–5.3
Okeelanta	0–8	5.4
Oldsmar	0–8	5.0
Pahokee	0–10	6.1
Palm Beach	0–6	7.9
Paola	0–21	4.9–6.2
Pineda	0–14	5.7–5.9
Placid	0–10	4.6
Pomello	0–16	4.9–5.7
Pompano	0–8	4.4
Riviera	0–28	6.0–6.6
Sanibel	0–20	6.3–6.4
St. Lucie	0–20	4.6–5.9
Tequesta	0–13	6.8
Terra Ceia	0–8	5.7
Torry	0–30	6.4
Wabasso	0–22	3.8–4.2
Winder	0–16	6.3–7.3

[z] Soil reaction at soil:water=1:1 (*Source*: USDA 1976)

Table 3. St. Johns County soil pH[z]

Soil name	Depth (inches)	Soil pH
Adamsville	0–19	5.2–5.3
Astatula	0–14	5.8
Bluff sandy	0–13	6.1–7.6
Cassia	0–18	4.6–5.1
Durbin muck	0–25	4.0–4.6
EauGallie	0–17	4.5–4.9
Ellzey	0–19	6.2–6.3
Fripp	0–9	4.7–5.4
Holopaw	0–13	5.1–5.4
Hontoon muck	0–16	3.3–3.5
Immolalee	0–15	4.0–4.6
Jonathan	0–9	5.2–5.3
Manatee	0–13	5.3–6.3
Moultrie	0–22	6.3–7.6
Myakka	0–14	3.6–4.6
Marcoossee	0–12	4.0–6.3
Orsino	0–18	3.9–4.8
Palm Beach	0–28	7.7–8.2
Paola	0–32	4.4–5.0
Parkwood	0–18	6.8–8.0
Pellicer	0–55	3.4
Placid	0–26	5.4–6.2
Pomello	0–19	4.7–4.9
Pompano	0–28	5.6–6.6
Pottsburg	0–20	4.4–5.0
Riviera	0–23	5.4–6.0
Satellite	0–33	5.6–6.1
Smyrna	0–18	4.7–5.4
Sparr	0–20	4.7–5.4
St. Augustine	0–10	7.4–8.5
St. Johns	0–15	3.6–4.2
Tavares	0–32	4.2–5.4
Tocoi	0–23	5.0–5.1
Tomoka muck	0–21	3.3–3.5
Zolfo	0–19	5.9–6.2

[z] Soil reaction at soil:water=1:1 (*Source*: USDA 1983)

Table 4. Jackson County soil pH[z]

Soil name	Depth (inches)	Soil pH
Albany	0–46	5.2–6.1
Apalachee	0–46	5.1–5.2
Blanton	0–41	5.3–5.4
Chipola	0–35	5.3–5.6
Clarendon	0–52	4.0–5.7
Compass	0–40	4.7–5.1
Dothan	0–34	4.6–5.6
Duplin	0–46	4.9–6.0
Esto	0–43	4.8–5.4
Faseville	0–46	4.9–5.5
Fuquay	0–32	5.3–5.7
Greenville	0–52	4.3–5.4
Hornsville	0–43	5.2–5.6
Lakeland	0–40	5.0–5.8
Leefield	0–43	4.7–5.8
Orangeburg	0–48	4.5–6.1
Pamlico	0–36	3.4–4.4
Red Bay	0–49	5.5–5.9
Troup	0–47	5.4–5.9
Yonges	0–72	5.1–8-4

[z] Soil reaction at soil:water=1:1 (*Source*: USDA 1979)