

# BOB LIPPERT'S FREQUENTLY ASKED QUESTIONS REGARDING SOIL TESTING, PLANT ANALYSIS AND FERTILIZERS



*StudyWeb*

## Department of Crop & Soil Environmental Science

### Clemson University Extension Service, South Carolina, U.S.A.

The following is a listing of questions I have been frequently asked during my past 15 years with the Clemson University Extension Service. To find the answer, simply click on the appropriate question. To ask your own question, please send it to me via email [BLPPRT@Clemson.edu](mailto:BLPPRT@Clemson.edu) I would also appreciate any suggestions about how to improve this site to make it as useful as possible. Thanks!

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# **My soil sample has been sitting in the hot cab of my truck for several weeks. If I have it tested by the Ag Service Lab, will the results still be OK?**

YES

This applies, however, only to soil samples being tested for pH and the minerals included in the standard soil test by the Ag Service Lab, i.e., P, K, Ca, Mg, Zn, and Mn. Soil samples to be tested for nitrate nitrogen (rarely necessary) need less abusive treatment. If you're sending in the sample for nematode assay, you might as well throw it away. The nematodes are all dead.



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# CONSERVATION TILLAGE SOIL SAMPLING

(Reduced, Strip-Till, and No-Tillage Systems)

***Note: Soil sampling methodology is still being developed for this type of tillage system. The following represents the best guidelines currently available.***

## TIME OF SAMPLING

Knowledge of crops to be planted in the future rotation is important for planning sampling time. For example, in cropping systems including peanuts, better results are obtained from applying potassium to the crop in the preceding year than on the peanut crop. Also, in double cropping of small grains followed by soybeans, it is often best to add enough fertilizer to the small grain to provide for both crops. It is best to sample soils in the Fall for Spring planted crops and in the Summer for Fall planted crops. It is important to sample annually in the Coastal Plain and Sandhill regions where many nutrients are easily leached through the soil and the pH value can rapidly decrease. This is particularly important when high levels of nitrogen have been added due to its ability to significantly acidify the soil.

## SAMPLING DEPTH AND PATTERN

For fields where surface broadcast fertilizer has been applied in the previous year, sample to a depth of 6 inches and take 15 to 20 cores from each sampling area. An area can be any consistently managed field where the soil properties such as clay content, organic matter content, etc. are fairly uniform.

If phosphorus or potassium has been banded in the previous years, the number of cores collected from random locations throughout the field should be increased from 20 to 40. As in the broadcast situation, sample to a depth of 6 inches.

An alternate sampling approach for phosphorus or potassium banded fields is to make a composite sample consisting of one sample in the band for every 20 samples taken between the bands for wide (30 inch) band spacing. For narrow (12 inch) band spacing, take one sample in the band for every 8 samples between the bands. Sample to a depth of 6 inches.

In no-till situations where the soil is not mixed and the fertilizer and lime applications are all broadcast on the surface, the soil pH tends to be lower near the surface and then increase with depth. Surface broadcast applications of nitrogen do not concentrate at the surface due to its transformations and mobility in the soil but usually it will cause a decrease pH values in surface soil layers. To account for pH differences with soil depth, it may be beneficial periodically to separate samples in to 0 to 3 inch and 3 to 6 inch depth increments. Even though a 0 to 6 inch sampling may indicate an ideal soil pH value, a 0 to 3 inch sampling may show a concentration of acidity near the surface which would warrant a lime application to provide better growth conditions in that rooting zone.



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# HOW TO SAMPLE SOILS FOR PASTURES

## TIME OF SAMPLING

Fields with cool season perennials should be sampled in July or August. Fields with warm season perennials should be sampled in January or February. Fields for growing hay crops should be sampled every year and grazed pasture fields should be sampled every three years. The intensity of land use will dictate the sampling schedule. Sample the soil several months before establishing perennial pastures to allow ample time for the lime to react with the soil.

## SAMPLING PATTERN

Separate the fields according to soil types, cropping history, erosion and past management practices. Follow a random zig-zag pattern over the field and avoid areas of nutrient concentration such as near watering areas and shady spots.

One composite sample of 15 to 20 cores is generally recommended for each 10-15 acres.

## DEPTH OF SAMPLING

The soil should be sampled to the plow depth before seeding and to a depth of 4 inches after establishment. This is helpful in monitoring surface soil acidification and nutrient depletion. Periodic deeper sampling to the root depth will help monitor subsoil levels of the more mobile nutrients such as potassium and prevent over-fertilization.

In all situations, it is imperative to use clean sampling tools. Pesticide or fertilizer residues on the sampling device as well as the container used for mixing cores will create misleading results.



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# What is a general guideline for sampling plant tissue?

It is always best to consult the [guidelines for sampling specific crops](#) but many times a county agent or specialist will be in the field with a client and can't readily access this information. For those situations, the following general sampling guidelines will be helpful.

The concentration of the various nutrients required for optimum plant growth changes throughout the life of a plant. The sufficiency ranges supplied by most plant testing labs assume that the plant material submitted for analysis is sampled at a specific stage of growth. For the sufficiency ranges to be useful, the proper plant parts must also be sampled. The general rule-of-thumb is to sample the youngest mature leaves (also called the youngest fully expanded leaves) when the plant is near maturity but before senescence. This would be, for example, at initial pod filling for soybeans or near the fruit set stage for watermelons. If the petioles are unusually large (larger than a wire), they should be excluded from the leaf sample. Corn is a notable exception to this general rule. Ear leaves should be sampled at silking.

About half a small lunch bag volume of sample is required by the Ag Service Lab for most leaf analysis requests. Paper bags are preferred over plastic bags to prevent moisture condensation within the bag and subsequent problems with fungal growth.

When a nutrient problem is suspected with plants and they cannot be sampled at the proper time, a sampling from a "good" area of the field vs. a "bad" area of the field is useful for making comparisons regarding possible deficient nutrients.



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# LEAF SAMPLING GUIDELINES AND MINERAL SUFFICIENCY RANGES FOR AGRONOMIC, FRUIT AND VEGETABLE CROPS

Choose a crop grouping:

- [Agronomic Crops](#)
- [Fruit Crops](#)
- [Vegetable Crops](#)



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# IS SPLITTING SOIL SAMPLES BETWEEN TWO LABS A GOOD METHOD FOR COMPARING LAB QUALITY?

Every so often a farmer wants to compare the soil test results from two separate labs. A sample is collected from a few spots in the field, mixed in a bucket, and then a portion of the soil is sent to two different labs for comparison. When samples are re split between labs in this manner, there is already some error built in so that the results will likely be quite different.

## It is difficult to mix the soil samples so they are completely uniform

The Clemson University Agricultural Service Lab is annually involved with a regional soil exchange involving approximately 7 state supported labs and 5 privately owned labs. Before the samples are distributed to all these labs for analysis, the bulk sample is first completely air dried to insure thorough mixing, run through a grinder that will completely break up the clods and sieve out any rocks or organic debris, and then it is mixed in a large container for several minutes. When the individual samples are removed, care is taken that there is no settling of the larger soil particles in the container. Then a number of samples are removed and analyzed by one lab to ensure that the mixing was thorough. All these steps are taken to be sure that the sample is as thoroughly mixed and uniform as possible. These procedures are a far cry from simply taking two portions from a soil mixed in a bucket. Mixing soil that is moist or too dry is difficult and studies have shown that samples split in this manner will be significantly different even when measured by the same lab.

## Soil test labs use different extractants

After the exchange samples are analyzed by the various laboratories, the results are grouped by the type of soil extractant used for a proper comparison (there are currently three used in the Southeast). Even the results from samples extracted by laboratories which use the same extractant solution will usually differ by a few pounds-per-acre due to differences in methodology. This is a normal and expected occurrence which you can see on the following table.

Soil phosphorus (in pounds per acre) reported by 6 regional state labs using the Mehlich 1 extractant for the 1997 sample exchange.

Sample #	Lab A	Lab B	Lab C	Clemson	Lab D	Lab E	Average
1	35	21	38	<b>32</b>	32	24	<b>30</b>
2	32	16	45	<b>32</b>	35	22	<b>30</b>
3	58	45	51	<b>59</b>	56	34	<b>51</b>

## Soil test labs use different extractable nutrient rating systems

The rating system which indicates if an extracted level of a nutrient is high, medium or low will differ from lab to lab. Even if two labs extract the same amount of a nutrient using the same extractant, one lab may call that amount medium while another lab will indicate that it is a high level for that nutrient.

## Soil test labs make different recommendations

The fertilizer recommendations may also vary for each lab. The recommendations are ideally derived from Experiment Station data specific for a particular region's climate and soils. Some labs will use data from adjacent states if they don't have data from their own Experiment Station for a particular crop. Some private labs use data from universities.

So, if a farmer gets results back from two separate labs, they may differ because the sample sent to the labs were not mixed properly, the labs may be using different extractants, they may be using a different rating system for the nutrient levels, or they may be following different guidelines for their recommendations. Ultimately, with only two sets of results for comparison, it is extremely difficult to say which is best to follow. Many farmers will choose the lab results that show what they would like to see even though it may not be the most correct for their situation. It is best to stick with one laboratory and develop a long term relationship with their services as many have done with Clemson's Lab. If you have any questions about a sample, the labs will be happy to re-test the sample.

See also ["Can Clemson University's fertilizer recommendations be used with the analytical results from other soil testing laboratories?"](#)



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# HOW DO I SAVE FERTILIZER AND MONEY BY SAMPLING THE SUBSOIL OF COASTAL PLAINS SOILS? HOW SHOULD I DO THE SAMPLING?

Often we buy products and receive a rebate coupon which can be applied towards our next purchase of the same product. If we know it is certain that we will buy the product again, it is like throwing money away to discard the rebate coupon.

This situation is analogous to the rebate of extra plant nutrients in the subsoil clay often waiting to be utilized by crops grown on Coastal Plains soils. If a test of the subsoil indicates that there is a high level of magnesium, then any recommendations for magnesium indicated by the plow layer soil test can be ignored. Likewise, if the subsoil tests at least high in potassium, the recommendation for potassium from the surface soil test can be reduced by as much as one-half. The subsoil test can also indicate if sulfur is needed if a separate test for sulfur is requested. Subsoil samples from fields that have been cropped for several years, however, have usually tested sufficient in sulfur.

To sample the subsoil, take samples from the top 4 inches of the clay layer at several locations in the field. Mix the clay cores in a clean container and take the sample to the nearest Clemson University Extension office for analysis by the Agricultural Service Laboratory. The fee is \$5.00 per sample. The lab report will give the pH, CEC, percent base saturation, amounts of phosphorus, potassium, calcium, magnesium, zinc, manganese, copper and boron plus comments regarding fertilizer application reduction. The test for sulfur requires an additional \$5.00 fee.

For the plants to utilize subsoil nutrients efficiently, subsoiling may be necessary to insure that a hard-pan will not deter access of the roots to the subsoil. The subsoil clay should also be no greater than 15 to 20 inches from the soil surface and have a pH value greater than about 5.0.



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# What is the buffer pH value on the soil test report?

There are two kind of acidity which are important for soil testing. There is the "active" acidity which is the acidity which the roots "see". The active acidity is measured with litmus paper, indicator solutions or a pH electrode. This is the acidity people refer to when they want to know their soil pH value. The other kind of acidity is referred to as the reserve or stored acidity. Clay and organic matter in the soil tends to store acidity. It takes more lime to raise the pH value of a soil with clay or organic matter present than it would for a sandy soil with very little clay or organic matter. Therefore, soils with more clay or organic matter have a greater ability to resist pH changes.

The buffer pH is measured with a weak base that starts out at pH 8.00. Soils that will require lime and have an "active" acidity pH value of 5.8 or below are set aside in the lab to have this solution added. The more the solution decreases from pH 8.00, the more stored acidity the soil sample has. The computer program will then recommend lime according to the determined stored acidity of the soil.

As an example, a sandy soil from the central part of South Carolina and a soil from the Piedmont with plenty of clay each have a pH value of 5.5. This would be the "active" acidity mentioned earlier. The laboratory determination of the buffer pH value of the sandy soil, though, could be 7.80 while the buffer pH value of the soil with clay could easily be 7.30. Since the sandy soil has decreased the buffer solution pH value of 8.00 less than the clay soil (7.80 vs. 7.30), the sandy soil will get a lower lime recommendation since it has a smaller amount of stored acidity. In this particular case, to bring these two soils up to a pH value of 6.5 the sandy soil will get a lime recommendation of 0.50 tons per acre while the lime recommendation for the clay soil will be 1.00 tons of lime per acre...twice as much lime, even though they both have the same pH value.



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# How reliable are the soil test kits found in gardening stores?

Here are the advantage of the garden store soil testing kits:

- They are cheap (provided you use your kit more than once or twice).
- They can give you a very general indication of your soil pH and fertility status if that is all you want.

The advantages of sending a soil sample to a professional laboratory are:

- The results are much more accurate. You will know your soil pH value within a tenth of a pH unit and your nutrient results will accurate within a few parts per million.
- Your soil sample will be handled by a professional staff of technicians who run these types of samples every workday.
- If you only need a couple soil samples tested a year, the cost of the kit will not be a real savings (especially since chemicals age and need to be replaced).
- You will receive recommendations specific for whatever type plant you want to grow. The recommendations are based on the latest university research data base.
- If you need further assistance, an Extension county agent can give you follow-up advice. If you use a kit, it will be very difficult for the agent to help with interpretation since the kits use different extractants and sufficiency ratings.

There are more accurate kits available through such companies as Hach and LaMotte but now we're talking hundreds of dollars.



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# Where and how should I get compost tested?

The Extension Ag Service Lab offers a test called "Animal Waste Analysis for Land Application". Even though it says its for animal waste, it can actually be used for determining nutrient content of any organic substance (with the exception of municipal or industrial waste). The results will come back as pounds of available N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O per ton of organic material. This, of course, can be reduced to a smaller scale for homeowner applications. When possible, try to encourage the client to submit a good representative sample by combining smaller samplings into one single sample.



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# What is the value of the organic matter test for soil samples?

When determining the lime requirement for Carolina Bays or soils with organic matter content greater than 10%, the target pH value should be between 5.0 and 5.5. Most field crops in the southern U.S. are grown on soils with less than 2% organic matter but if you suspect that a soil is unusually high in organic matter, you may want to have it tested by the Ag Service lab to see if the organic matter content is above 10%.

Many times organic gardeners will send soil samples to the Ag Service Lab and request the test for percent organic matter. Probably, many of these gardeners have been adding organic matter to their soil for several years and want the soil tested for organic matter content to serve as a report card. Unfortunately, the soil test for organic matter used by the Ag Service Lab is not able to determine the high levels of organic matter found in soils that have been amended with large quantities of compost or animal waste.

The soil test for organic matter is mostly used by farmers who are about to add herbicides to the soil. The soil organic matter ties up herbicides when they are applied to the soil. Subsequently, the more organic matter that there is in the soil, the more herbicide the farmer will have to apply to compensate for the tie-up. The label on the herbicide container will have a table showing how much extra herbicide is required to compensate for a specified range of soil organic matter. As mentioned earlier, most soils in the southern U.S. are less than 2% organic matter so the herbicide label should be checked to see if an organic matter test is even necessary.



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# The Scoop on Soil Testing for Nitrogen

Nitrogen can be added to soil in many forms. It can be applied as nitrates, ammonium, urea, etc. Soon after the nitrogen is added and if there is some moisture present, the indigenous bacteria called nitrosomonas and nitrobacter convert all forms of nitrogen to the nitrate form. The nitrate form of nitrogen is an ion with a negative charge ( $\text{NO}_3^-$ ). The clays in South Carolina soils also have a negative charge and since similar charges repel, the nitrates are not attracted to the clays like the positively charged calcium, magnesium and potassium ions. Nitrates are also very soluble in water. As a result, the nitrate ions are very mobile in the soil and move through quite readily as water percolates down into the soil. If a soil is sandy, nitrates move through the soil even faster due to the large pore space and faster percolation of water. These factors are the reason for environmental and health concerns regarding nitrate movement into groundwater.

Because of nitrogen's rapid conversion to the nitrate form and its subsequent movement through the soil, it makes the soil test for nitrogen quite difficult to interpret. By the time you receive soil test results for nitrate nitrogen, it may have already moved through the soil if some rain had fallen between sample collection and reporting of lab results. Some soil tests for nitrogen are done for certain crops but it is still in an experimental stage and not widely used or accepted in our region. Researchers will collect soil samples at several depth intervals to monitor the nitrate movement during a crop's growing season.

Because of the mobility of nitrogen in the soil, most states in the Eastern region of the U.S. just make a blanket recommendation for each crop with the assumption that most of the residual nitrogen from the previous crop has moved past the root zone of the new crop. You will notice that for many crops, nitrogen is recommended as a split application. If all of the nitrogen was added at the beginning of a growing season, much of it would move past the root zone before the crop matures. Splitting applications allows the nitrogen to be applied more in accordance to the crop's needs at different stages of growth and thus reduce leaching.



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# WHAT IS THE USE FOR THE CATION EXCHANGE CAPACITY (CEC) AND THE PERCENT BASE SATURATION ON THE SOIL TEST REPORTS?

The **CEC** is the abbreviation for the **cation exchange capacity** of the soil. Any element with a positive charge is called a cation and in this case, it refers to the basic cations, calcium (Ca<sup>+2</sup>), magnesium (Mg<sup>+2</sup>), potassium (K<sup>+1</sup>) and sodium (Na<sup>+1</sup>) and the acidic cations, hydrogen (H<sup>+1</sup>) and aluminum (Al<sup>+3</sup>). The amount of these positively charged cations a soil can hold is described as the CEC and is expressed in milliequivalents per 100 grams (meq/100g) of soil. The larger this number, the more cations the soil can hold. A clay soil will have a larger CEC than a sandy soil. In the Southeast, where we have highly weathered soils, the dominant clay type is kaolinite which has very little capacity to hold cations. A typical CEC for a soil in the Coastal Plains region is about 2.0 meq/100g of soil and the typical CEC for a soil in the Piedmont region is about 5.0 meq/100g of soil. The CEC gives an indication of the soils potential to hold plant nutrients. Increasing the organic matter content of any soil will help to increase the CEC since it also holds cations like the clays. Organic matter has a high CEC but there is typically little organic matter in our soils.

## SAMPLE SOIL TEST REPORT DATA

CEC	ACIDITY	% BASE SATURATION				
	(meq/100g)	Ca	Mg	K	Na	TOTAL
5.0	1.0	50	20	5	5	80

The **percent base saturation** tells what percent of the exchange sites are occupied by the basic cations. If calcium has a base saturation value of 50% and magnesium has a base saturation value of 20% as shown above, then calcium occupies half of the total exchange sites (CEC) and magnesium occupies one-fifth of the total exchange sites (CEC). In our example where the soil has a CEC of 5 meq/100g, 2.5 meq/100g of the CEC is occupied by calcium and 1 meq/100g of the CEC is occupied by magnesium. If all the exchangeable bases (Ca, Mg, K and Na) total 100%, then there is no exchangeable acidity.

The **acidity** on the report is the amount of the total CEC occupied by the acidic cations (H<sup>+1</sup> and Al<sup>+3</sup>). The acidity, like the CEC, is expressed as meq/100g of soil. If the CEC is 5 meq/100g of soil and the acidity is 1 meq/100g of soil (see sample above), then one-fifth of the exchange sites in the soil are occupied by acidic hydrogen and aluminum ions. The remaining 4 meq/100g of soil (or 80% of the CEC) will be occupied by the basic cations. The more acidic a soil is and the lower the soil pH value, the closer the acidity number will be to the CEC number.

You can see a detailed explanation of [how the CEC, exchangeable acidity, and percent base saturation are calculated from the routine soil test data.](#)

**Sodium** is included among the bases to indicate if sodium levels are getting too high. This happens in situations where industrial by-products are applied to the soil or where soils along the coastal region are irrigated with water high in sodium. The acceptable base saturation limit for sodium is 15%. This is also called the Exchangeable Sodium Percent or ESP. Sodium levels higher than 15% on the exchange site could result in soil dispersion, poor water infiltration, and possible sodium toxicity to plants.

So, why do we bother with the CEC, acidity and base saturation? Some consultants and farmers prefer to use the base saturation of the plant nutrients instead of the extractable amounts as a guide for maintaining optimum fertility. For Southeastern soils with kaolinitic clays, a base saturation of 45 to 65 percent will be satisfactory for good plant growth. The following table gives the approximate base saturation for the soils of a given soil pH:

<b>Soil pH</b>	<b>% Base Saturation</b>
<b>3.9</b>	<b>0</b>
<b>4.5</b>	<b>0</b>
<b>5.3</b>	<b>25</b>
<b>6.2</b>	<b>50</b>
<b>7.1</b>	<b>75</b>
<b>7.5</b>	<b>90</b>
<b>8.0</b>	<b>100</b>

In South Carolina, if fertilizer and lime is applied to raise the base saturation of a kaolinitic soil to 85 percent as commonly done in the Midwest, the resulting pH would be between 7.1 and 7.5. Soil pH values in that range would result in a major problem with zinc and manganese deficiency. That is why the Clemson University fertilizer recommendations are determined by the amount of each nutrient extracted from the soil (expressed in pounds per acre) instead of using the percent base saturation as a guide. A favorable base saturation will be obtained if the soil pH is maintained between 5.8 and 6.5. The approach used by Clemson University is also used throughout the Southeast and Mid-Atlantic regions in determining soil fertilizer requirements. The CEC and base saturation is something that many farmers and consultants have asked for to better understand the soil and so it is now available in response to public demand.



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# HOW SHOULD I INTERPRET THE COPPER AND BORON RESULTS ON THE SOIL TEST REPORTS?

Starting October 1, 1996, the Clemson University Agricultural Service Lab began sending out soil test reports with a revised format. In addition, more soil test information has been added to the reports in response to requests from farmers, fertilizer dealers and several county agents.

The two micronutrients which have been added to the soil test report are **copper (Cu)** and **boron (B)**. Neither of these have a sufficiency rating.

Research and experience have shown that **copper** deficiency is rarely a problem in South Carolina. There is also limited research data to interpret soil test results. Soils where copper deficiency may be a problem are the high organic soils (greater than 10% organic matter) or very sandy soils with a high pH value and subsoil clay deeper than 20 inches. Recommendations for copper should be based on plant tissue analysis.

**Boron** deficiency is a concern for certain crops on Coastal Plains soils. The appropriate comment will be triggered in the soil test recommendation according to the specified crop and soil type. For example, comment 103 for commercial watermelons says that applying 0.5 to 1.0 pounds of boron per acre as a foliar spray prior to bloom MAY help fruit set. For cotton, comment 12 says to apply 0.4 pounds of boron per acre in the fertilizer or in the insecticide spray in either one or several applications so long as the total amount applied does not exceed 1.0 pounds per acre. Since boron is mobile in the soil like nitrate, a blanket recommendation is given with the assumption that at the beginning of the cropping season, most of the residual boron from the previous year's crop will have leached through the soil past the root zone. As with copper, a tissue test will give the best assessment of available boron.

We hope that those who have requested this additional information will find it helpful. For those who have been satisfied with the soil test reports issued by the Agricultural Service lab in the past, they will be pleased to find the same information still on the new reports.



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# How are the cation exchange capacity (CEC) and percent base saturation calculated for the soil test report?

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To determine the cation exchange capacity (CEC), calculate the milliequivalents of H, K, Mg, and Ca per 100g of soil (meq/100g soil) by using the following formulas:

$$\text{H, meq/100g soil} = 8 (8.00 - \text{buffer pH})$$

$$\text{K, meq/100g soil} = \text{lbs/acre extracted K} \div 782$$

$$\text{Mg, meq/100g soil} = \text{lbs/acre extracted Mg} \div 240$$

$$\text{Ca, meq/100g soil} = \text{lbs/acre extracted Ca} \div 400$$

The total CEC will be the sum of the calculations from the 4 previous equations.

## EXAMPLE

LAB NO.	SAMPLE NO.	SOIL CODE	SOIL PH	BUF. PH	P	K	MG	CA
113282	3	4	5.1	7.70	168 VH	221 H+	28 L+	400 L+

$$\text{H, meq/100g soil} = 8 (8.00 - 7.70) = 2.4$$

$$\text{K, meq/100g soil} = 221 \div 782 = 0.3$$

$$\text{Mg, meq/100g soil} = 28 \div 240 = 0.1$$

$$\text{Ca, meq/100g soil} = 400 \div 400 = 1.0$$

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**Total CEC = 3.8 meq/100g soil**

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To calculate the percent base saturation, divide the sum of the K, Mg, and Ca (the bases) in meq/100g soil by the CEC (all these values were calculated above). Multiply the result by 100%.

## EXAMPLE

$$\text{K} = 0.3 \text{ meq/100g soil}$$

$$\text{Mg} = 0.1 \text{ meq/100g soil}$$

$$\text{Ca} = 1.0 \text{ meq/100g soil}$$

$$\text{CEC} = 2.4 \text{ meq/100g soil}$$

$$\text{Total for bases} = \text{K} + \text{Mg} + \text{Ca} = 1.4 \text{ meq/100g soil}$$

**Percent base saturation** =  $(1.4 \div 3.8)(100\%) = \mathbf{37\%}$



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# CAN CLEMSON UNIVERSITY'S FERTILIZER RECOMMENDATIONS BE USED WITH THE ANALYTICAL RESULTS FROM OTHER SOIL TESTING LABORATORIES?

Instead of submitting a soil sample to the Clemson University Agricultural Service Lab, a farmer may sometimes choose to send his sample to a private soil test lab or to another state lab for analysis. Fertilizer dealers or consultants will also choose to send soil samples to a private lab for analysis. Often when a farmer gets the results back from a lab other than the Agricultural Service Lab, he will try to figure out what the fertilizer recommendation would have been if he had sent the sample to the Clemson Lab. This could lead to significant errors.

When a lab receives a soil sample, they use an extractant solution to remove a portion of the available plant nutrients from the soil. The extractant containing the nutrients is then analyzed with laboratory equipment to determine how much of the various elements are present. Unfortunately, there are several different accepted extractants used in the United States which extract different amounts of each nutrient. In our region, the most common extractants are Mehlich 1 and Mehlich 3. Some labs may additionally use a Bray extractant for phosphorus.

Results from any extractant can be used to make good fertilizer recommendations but you can't use the data from one extractant and apply recommendations which were calibrated for a different extractant. For example, the Clemson University soil test recommendations for phosphorus, potassium, calcium, magnesium, zinc, manganese, copper and boron are calibrated for extractions done with the Mehlich 1 extractant. A sample sent to the state lab in North Carolina will be extracted with the Mehlich 3 extractant and subsequently the Clemson University recommendations can't be used. It would be like mixing apples and oranges. So before trying to apply Clemson's soil test recommendations to soil test results from another lab, it is extremely important to determine which extractant they use.

If you know that the other lab uses the Mehlich 1 extractant as the Clemson lab, be aware that the other lab may use a scale different from Clemson's when rating the pounds-per-acre of extractable nutrients as high, medium or low. An extractable amount of nutrient that the Clemson lab labels as "high" might be labeled as "medium" by another lab. The "medium" soil test rating would call for more of that particular nutrient than would be recommended with a "high" soil test rating. In this case, if you want to use Clemson University's recommendations based on another lab's analytical report and you know that both labs are using the same soil extractant, the best way to make comparisons is to use the pounds per acre extractable value for each nutrient and convert it to a high, medium or low rating using the interpretation guidelines provided by Clemson University in Circular 476 "Lime and Fertilizer Recommendations Based on Soil Test Results". Then the Clemson recommendations can be properly used with the other lab's soil test results. The Clemson University county Extension agent can help you with this.

The easiest thing to do, of course, is to insure that the soil samples are sent to the Clemson University Lab through your local Extension office. You will receive quality analysis and Clemson's recommendations without the worry of future problems due to mixing apples and oranges.

See also ["Is splitting soil samples between two labs a good method for comparing lab quality?"](#)



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# What is a soil test extractant?

A soil test utilizes an extractant to determine the amount of plant nutrients in the soil. A soil extractant is a solution made up of water and a certain concentration of chemicals. The extractant is added to a fixed amount of soil and the two are shaken together for a prescribed length of time. The mixture is then poured through a filter paper. The soil is retained on the filter paper and the extractant, now containing the dissolved plant nutrients, is caught in a vial. The plant nutrients in the extractant are then analyzed using the appropriate laboratory instruments to see how much was removed from the soil. The amount of the nutrients extracted will represent a fraction of the total nutrients available to the plants throughout the growing season. Calibration data from previous field experiments serve as a guide in rating the amount of extractable nutrients as low, medium or high. These ratings are then used to determine the amount and type of fertilizer, e.g., phosphorus ( $P_2O_5$ ) and potash ( $K_2O$ ), needed for optimum crop production. Note: Soil testing for nitrogen is a special situation which is not included as a routine test in all the Southeastern states due to the mobile nature of nitrate-nitrogen.

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# What is the Mehlich-1 extractant?

The Mehlich-1 extractant (implemented in 1953) was developed by Dr. Adolph Mehlich for the North Carolina Department of Agriculture Soil Testing Division. It is a versatile soil extractant that is used for determining the amounts of phosphorus, potassium, calcium, magnesium, zinc, manganese, copper and boron. It is made up of a dilute solution of hydrochloric and sulfuric acids, thus it is often referred to as the "double acid" extractant. It works well for acidic, low cation exchange capacity (CEC) soils which encompasses essentially all of the soils in the Southeast. The Mehlich-1 extractant is used by Alabama, Florida, Tennessee, Virginia, Georgia and South Carolina as well as many private laboratories.



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# What is the Mehlich-3 extractant?

In an attempt to make a universal extractant that could be used for any soil in the world, Dr. Mehlich developed the Mehlich-2 extractant which was used for about 2 years. The Mehlich-2 contained 4 different chemicals but the chloride in the extractant was causing laboratory instrument problems. Subsequently, Dr. Mehlich developed the Mehlich-3 extractant by changing the chemical composition of the Mehlich-2 extractant slightly to exclude the chloride component. In addition, he added a chelating agent to increase the amount of micronutrients extracted, particularly copper. The Mehlich-3 extractant was adopted in 1984 and is being used throughout the world. In the Southeast, the Mehlich-3 extractant is used by Virginia, Kentucky and North Carolina .



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# What is the Bray P-1 extractant and is it used in the Southeast?

The Bray P-1 extractant was developed before the Mehlich-1 extractant and was widely used by the Southeastern states. Even though it works well on acid soils, it is only useful for extracting phosphorus. Therefore, an additional extractant must be used for determining other plant nutrients such as potassium, calcium and magnesium. As the demand for soil testing increased and laboratory instrumentation improved, it became desirable to have an extractant that could be used for a wide range of plant nutrients, including the micronutrients. When the Mehlich-1 extractant was developed, many of the Southeastern states switched to the Mehlich-1 since it could be used as a single extractant for many plant nutrients of interest and not just for phosphorus like the Bray P-1. The only time the Bray P-1 is used on Southeastern soils is when the soil samples are analyzed by a private laboratory which also services farms from the Central region of the U.S. where the Bray P-1 soil extractant is still commonly used. The Southeastern Land Grant Universities have no current information for interpreting soil phosphorus levels using the Bray P-1 extractant so it is recommended that this extractant not be used.



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# **Why do some states use the Mehlich-1 extractant and other states use the Mehlich-3 extractant?**

The Mehlich-1 extractant works very well as a soil extractant but some states in the Southeast have switched to the Mehlich-3 extractant. These states have significant acerages of calcareous soils with pH values greater than 7.0. For these soils, the Mehlich-3 extractant performs much better than the Mehlich-1 extractant. Soils with a pH value greater than 7.0 are relatively limited in South Carolina occurring only with over-liming, long-term use of hen manure or frequent irrigation with high bicarbonate water common to the coastal region.

# How does the Mehlich-3 extractant compare to the Mehlich-1 extractant?

On the soil test reports, the amount of phosphorus extracted by the Mehlich-3 extractant will be approximately 1.5 times to twice the amount extracted by Mehlich-1. For the other plant nutrients, the two extractants will extract about equal amounts. It is not recommended that this information be used to derive Mehlich-1 based recommendations with Mehlich-3 extractant results or vice versa. These are only rough comparisons and do not apply to all soil types.



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# Is there a problem with loss of urea when used as a source of nitrogen?

When considering a good source of nitrogen to use, urea is often the most tempting due to its competitive price compared to other nitrogen sources. It is also easy to handle and its high analysis means less bulk to transport and distribute. Despite the competitive price of urea, many farmers are concerned about nitrogen loss by its conversion to ammonia and subsequent loss to the atmosphere. Several factors play a role in the amount of nitrogen lost from urea. If a farmer is aware of these factors and how they affect nitrogen volatilization, the broadcasting of urea can be timed to minimize loss.

Acidic soils, especially those with clay on the surface and subsequently a large reservoir of stored acidity, are less likely to lose nitrogen from urea. Most soils in the Southeast tend to be acidic (pH value less than 7.0) and in the Piedmont where clay is present at the soil surface, there is a large reservoir of stored acidity. Therefore, unless a soil is overlimed, it is safe to assume that there will be minimal nitrogen loss due to high soil pH values. The higher cation exchange capacity (CEC) of clay soils also helps retain the ammonium produced from urea and keeps it from escaping as ammonia gas. Sandy soils which have a lesser reservoir of stored acidity are more prone to nitrogen loss from urea.

Urease, an enzyme which can be found in amounts proportional to the organic matter content of a soil, is most effective in converting urea to ammonia. Soils in the Southeast tend to be low in organic matter but higher than normal levels can be found in soils in Piedmont pastures. Urease activity in Piedmont soils could potentially be a problem but the following environmental factors will play an even more important role.

If urea is broadcast when the soil is very dry, there can be no significant enzymatic conversion to the more volatile forms since the urea must first dissolve before it can be changed. If the urea is broadcast on damp or wet soil which then slowly dries over several days, nitrogen loss will be significant. This occurs because the urea can now dissolve, be in contact with the soil for conversion to volatile nitrogen, and easily escape to the atmosphere due to its proximity to the soil surface. If rainfall moves the urea into the soil, nitrogen loss ceases. One-half to 3/4 inch of rainfall is sufficient for most soils.

As the soil temperature increases above 50 F, so too the loss of nitrogen from urea will increase. As the temperature rises, the enzymatic reactions that breakdown the urea speed up and the urease activity will increase with temperature. Higher temperatures also allow more of the urea that has been converted to ammonia to escape as a gas.

The key to minimizing nitrogen loss from urea is to apply it soon before rain is anticipated. If the urea moves into the soil below the soil surface, there will be minimal nitrogen loss. If the urea must be applied and no rainfall is expected soon, the loss of nitrogen will be in proportion to the length of time it stays on the surface of a wet soil.

These factors should also be considered when using N-30 solution (which contains 41.5% ammonium nitrate and 33% urea) and N-32 solution (which contains 44% ammonium nitrate and 35% urea). Research shows that liquid solutions of urea are slightly more susceptible to nitrogen loss than the solid form when broadcast on the soil.



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# WHY IS PHOSPHORUS EXPRESSED AS P<sub>2</sub>O<sub>5</sub> AND POTASSIUM EXPRESSED AS K<sub>2</sub>O IN THE SOIL TEST REPORT RECOMMENDATIONS AND BY THE FERTILIZER COMPANIES?

In earlier times, before current lab instrumentation was developed, chemists used a gravimetric (weighing) method after ignition to determine the phosphorus and potassium content of fertilizers in the form of phosphorus oxide (P<sub>2</sub>O<sub>5</sub>) and potassium oxide (K<sub>2</sub>O). By convention, the amounts (or analysis grade) of phosphorus and potassium in fertilizers are still expressed in this oxide form. The Association of American Plant Food Control officials have developed a uniform state fertilizer bill which says that available P<sub>2</sub>O<sub>5</sub> and soluble K<sub>2</sub>O must be guaranteed by the manufacturer and so the guaranteed analysis must still be expressed in the oxide form. Nitrogen content has always been expressed as simply N.

According to the conventional fertilizer standards, a 100 pound bag of 10-10-10 contains 10% or 10 pounds of nitrogen, 10% or 10 pounds of P<sub>2</sub>O<sub>5</sub> and 10% or 10 pounds of K<sub>2</sub>O. Since P<sub>2</sub>O<sub>5</sub> is really only 44% actual elemental phosphorus and K<sub>2</sub>O is only 83% actual elemental potassium, a 100 pound bag of 10-10-10 contains 10% or 10 pounds of nitrogen, 4.4% or 4.4 pounds of elemental phosphorus and 8.3% or 8.3 pounds of elemental potassium.

Perhaps the reluctance of the fertilizer industry to convert to expressing the nutrients in the elemental forms is due to the perception that less fertilizer is being purchased for the same amount of money. A 100 pound bag of 10-10-10 containing N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O would be equivalent to a 100 pound bag of 10-4.4-8.3 containing N, P and K.

Once the fertilizer is added to the soil, the oxide forms, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O, are no longer used when discussing these two nutrients. The amount of these nutrients analyzed in the soil is expressed as the pounds per acre of P and K. [The plant content is expressed as the percentage of P and K.](#)



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# Starter Fertilizers: Proper Use and Precautions

## Definition and Purpose:

Small amounts of fertilizer applied near the seed at planting to stimulate early season plant growth and development with the intent of ultimately increasing yield.

## Precautions:

1. Fertilizer should never be placed in contact with the seed or within 6 inches of the seed if placed directly under the seed.
2. Too high a fertilizer rate can damage seedlings even when properly placed.
3. Starter fertilizers can be part of an overall fertility program but they should never be considered as a replacement for soil testing and subsequent fertility maintenance.

## Nutrients applied:

N and P are the plant nutrients most frequently applied in starter fertilizers. Either liquid or dry fertilizers can be used. The primary advantage of liquid fertilizers is their ease of application. The main advantage of dry forms is the larger choice of N:P ratios.

N and P are commonly applied together because P availability is enhanced when combined in a band with ammonium nitrogen. The ammonium causes root proliferation which enables greater P uptake.

Sulfur is almost always recommended at 10 to 15 lbs/acre, so it may be convenient to include some or all of it in the starter fertilizer. Micronutrients such as zinc, manganese and copper can also be combined with starter fertilizers. Micronutrients applied in a band with an acid forming N fertilizer become more plant available due to the increased acidity and subsequent micronutrient solubility in the band.

## Nutrient rates: General guidelines are:

1. Nitrogen = 20 to 40 lbs. N per acre. Dependent on the crop to be
2. Phosphorus
  - a. Low P and Medium P soils = 15 to 50 lbs.  $P_2O_5$  per acre in the band with the remainder of the recommended P fertilizer applied broadcast.
  - b. High P soils = 10 to 15 lbs.  $P_2O_5$  per acre.
3. Starter fertilizer should be used as a part of the total recommended broadcast and sidedress fertilizer applications. It is not a substitute for established, good fertilizer practices.

## Reasons for starter fertilizer responses on soils testing high in P:

Limited root systems of seedling plants cannot accumulate enough P from soil P to support maximum crop growth, especially when rooting is reduced by cold soil temperatures or soil compaction.

## Common problems:

1. Fertilizer placed too close to the seed will cause seedling damage or death.
  - a. Salt toxicity. Fertilizers are salts. High salt concentrations close to the

seed will frequently result in seedling damage or death by desiccation of the seed or seedling.

b. Ammonia toxicity. Ammonia toxicity is possible with any ammonium source. This includes commonly used N fertilizers such as urea, diammonium phosphate (18-46-0), and ammonium polyphosphates (such as 10-34-0), and UAN solutions (28, 30 and 32% N solutions).

2. Improper rates of N or P when 10-34-0 or 18-46-0 is used alone.
3. Reduced crop growth if starter fertilizer is used to supply the entire N recommendation or the entire P recommendation on low P soils.

**Responses are most likely to occur with corn, cotton and other non-legume crops in:**

1. Irrigated fields
2. Cool wet soils
3. No-tillage or reduced-tillage situations
4. Compacted soils
5. Soils testing low or medium in P

**Placement methods:**

1. 2 X 2 (two inches beside and two inches below the seed). This is the best way to supply starter fertilizer.
2. Surface applications directly on top of row (behind the press wheel) is an option, but a response should not be expected without rain to move the nutrients down into the rooting zone. The fertilizer band should be as narrow as possible (less than 3 inches). Although research has shown that plants may respond to surface applied P, the primary response with surface applications will most likely be to N. Beneficial effects on crop growth are less consistent with this method than with 2 X 2 application.

**Summary**

- Yield increases due to starter N are likely under all conditions.
- Yield increases due to starter P are unlikely for non-irrigated crops except in no-tillage plantings or when P is recommended by soil test analysis.
- Practices such as subsoiling and environmental factors such as adequate soil moisture are more critical than the benefits from starter fertilizers.
- Starter fertilizers often hasten early season corn growth and grain maturity even when there is no yield increase.
- Responses to banded phosphorus are enhanced when combined with ammonium.
- Recommended placement is 2 inches to the side and 2 inches below the seed.
- Adding other nutrients such as sulfur and micronutrients in starter fertilizer provides a convenient method of application.



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# WHAT IS CALCIUM CARBONATE EQUIVALENT?

In the interest of saving money or finding a use for waste materials, many farmers ask about the possibility of using by-products as a substitute for limestone. Some suppliers will tell the farmer the calcium carbonate equivalent of the material. Pure calcium carbonate has a calcium carbonate equivalent of 100 and is used as the bench-mark by which all other materials are compared.

If the soil test report calls for 1 ton of lime per acre, it is assuming that you are using state certified calcitic or dolomitic limestone which has a calcium carbonate equivalent of about 100. If you use another material that has a calcium carbonate equivalent of 50, then it has only half of the soil acid neutralizing value of calcitic or dolomitic limestone and, therefore, twice as much (in this case 2 tons) should be applied. If you have a material that has a calcium carbonate equivalent of 150, then you need only 67% or  $2/3$  as much of this material on your fields as regular limestone. If you know the calcium carbonate equivalent of any material, just divide 100 by that number ( $100 \div X$ ) and multiply it times the lime recommendation of the soils report to determine the amount you need to apply per acre.

As an example of the calcium carbonate equivalent of some commercially available materials, calcium oxide, also known as quick lime or burnt lime has a calcium carbonate equivalent of at least 140. Calcium hydroxide, also known as slaked lime, hydrated lime, or builder's lime has a calcium carbonate equivalent of at least 110.

Many materials that are a by-product of some other manufactured material can vary greatly in the calcium carbonate equivalent. For this reason it would be wise to question the supplier to insure that the material was properly sampled and sent to a certified laboratory. Also material that is very coarse can have a high calcium carbonate equivalent but will take several months to completely break down and be adequately effective. When appropriate, EPA guidelines should be followed when materials contain heavy metals.

Your choice of alternative liming materials will then be based on your confidence in the claimed liming value of the material (as expressed by the calcium carbonate equivalent and its fineness) and the possible savings if used in place of commercial dolomitic limestone.



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# How safe is it to use wood ashes as a liming material?

Wood ashes provide a good source of potassium for plant growth. It also is an alkaline material that will reduce the acidity of the soil. It is not as effective as limestone but with repeated use, it can drastically raise the pH value of a soil, especially if the soil is primarily sandy in texture.

The ideal soil pH range for most plants is 5.8 to 6.5. Soils which are too alkaline will tie up many of the micro-nutrients such as zinc and manganese which are needed for good plant growth. Often at the soil testing lab, when we came across a soil sample with a pH value in the range of 8.0 to 11.0, we would find out that it came from the garden of a homeowner who was routinely adding wood ashes during the winter as they became available from the wood stove.

I recommend that before applying wood ashes to the soil, that a soil sample be submitted to the Ag Service Lab for assessment of the current pH status. If the soil is already in the 5.8 to 6.5 pH range and no lime is recommended, it would be best to avoid putting wood ashes in that area. If the soil pH value is below 5.8 and there is a lime recommendation on the soil test report then put a dusting of the wood ashes over the soil surface and work it into the soil. If you add the wood ashes, don't add the recommended lime or you will raise the pH too high. Since wood ashes are low in calcium compared to limestone, some supplemental gypsum (a source of calcium) will be needed if the calcium level indicated on the soil test report is medium or low. Add about 1 or 2 pounds of gypsum per 100 square feet to compensate for the lack of calcium.



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# Can lime and fertilizer be applied at the same time?

Yes. There is no problem with interaction.



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# The Story About Gypsum

Gypsum ( $\text{CaSO}_4$ ) is considered both a soil amendment and a source of plant nutrients.

When soils have been exposed to too much sodium (usually in the coastal areas), two concerns arise. One is that sodium on the exchange sites of clays and organic matter tends to make them disperse and the soil becomes impermeable as the clays clog up the pore spaces. This is not really a problem in the coastal region where the soils are very sandy and have essentially no clay. The second concern with sodium is that excessive amounts in the soil can exclude the uptake of other nutrients such as calcium and magnesium. Too much uptake of sodium by a plant can cause toxicity problems usually manifest by necrosis of leaf edges. An application of gypsum to the soil will help to exclude the uptake of so much sodium by the roots just by the fact that the calcium ions will vastly out-number the sodium ions.

Often when the soil pH tests less than 5.8, the calcium level in the soil will also test only "low" or "medium". There are instances, however, when the soil pH value will be adequate (between 5.8 and 6.5) yet the calcium level will still test less than the optimum "high". In this case, the addition of lime to provide the needed calcium will raise the pH value too high and likely cause other problems such as a micronutrient deficiency. Gypsum can be added to the soil to supply the needed calcium without altering the soil pH value. The alternative method of adding more calcium without raising the pH value is to use fertilizers which contain calcium.

Gypsum also is a good source of sulfur but this is only a side benefit from its use. In the rare instances where sulfur is needed in the soil, most people will add elemental sulfur or use a fertilizer with some form of sulfur in it.

There are no easily accessible guidelines regarding the application rate of gypsum in a homeowner situation. It is sparingly soluble and so it is nearly impossible to over-apply. In the Western part of the United States, many crops grow just fine in soils that have naturally occurring, undissolved accumulations of gypsum throughout the soil. Generally, a homeowner can just sprinkle a fine layer over the soil surface and work it in. A general application rate is 100 to 150 pounds per 1,000 square feet. Gypsum is a must for tomato growers in our South Carolina to prevent "blossom end rot". In an agricultural situation, enough gypsum should be applied to supply 100 pounds of calcium per acre when the soil test report does not call for lime but the calcium level tests "medium" or "low".



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# MY SOIL PH IS TOO HIGH. HOW CAN I BRING IT BACK DOWN TO THE OPTIMUM PH RANGE?

The addition of alkaline materials such as lime, poultry manure or wood ashes to the soil can raise the pH value to levels which are higher than the optimum range (5.8 to 6.5 for most plants) to insure good plant growth. This will occur if excessive amounts of these materials are added to a soil either all at once or over a long period of time. For plants that thrive best in the pH range of 5.8 to 6.5, soil pH values above 6.5 can cause plant deficiencies of important micronutrients such as zinc and manganese which are still in the soil but "tied-up" and unavailable to the plant.

In addition, blueberries, azaleas, camellias, rhododendron and other acid loving plants require a soil environment more acidic than other plants. In this case, the ideal pH range is 5.0 to 6.0. If the soil is already in the pH range of 5.8 to 6.5, it should be further lowered for the best growth of these plants.

Two materials commonly used for lowering soil pH are aluminum sulfate and sulfur which can be found at any garden supply center. Both materials will do the job. Aluminum sulfate will change the soil pH instantly because the aluminum produces the acidity as soon as it dissolves in the soil. Sulfur, however, requires some time for the conversion to sulfuric acid with the aid of soil bacteria. The conversion rate of the sulfur is dependent on the fineness of the sulfur, the amount of soil moisture, soil temperature and the presence of the bacteria. Depending on these soil factors, the conversion rate of sulfur may be very slow and take several months if the conditions are not ideal. For this reason, most people use the aluminum sulfate. Both materials should be worked into the soil if possible after application to be most effective. If these materials are in contact with plant leaves as when applied to a lawn, they should be washed off the leaves immediately after application. **Be extremely careful not to over-apply the aluminum sulfate or the sulfur.**

You can use the following tables to calculate the application rates for both the aluminum sulfate and the sulfur. The rates are in **pounds per 10 square feet for a loamy soil**. *Reduce the rate by one-third for sandy soils and increase by one-half for clays.*

Pounds of Aluminum Sulfate to Lower the Soil pH

Present pH	Desired pH				
	6.5	6.0	5.5	5.0	4.5
8.0	1.8	2.4	3.3	4.2	4.8
7.5	1.2	2.1	2.7	3.6	4.2
7.0	0.6	1.2	2.1	3.0	3.6
6.5		0.6	1.5	2.4	2.7
6.0			0.6	1.5	2.1

Pounds of Sulfur to Lower the Soil pH

Present pH	Desired pH
------------	------------

	<u>6.5</u>	<u>6.0</u>	<u>5.5</u>	<u>5.0</u>	<u>4.5</u>
<b>8.0</b>	<b>0.3</b>	<b>0.4</b>	<b>0.5</b>	<b>0.6</b>	<b>0.7</b>
<b>7.5</b>	<b>0.2</b>	<b>0.3</b>	<b>0.4</b>	<b>0.5</b>	<b>0.6</b>
<b>7.0</b>	<b>0.1</b>	<b>0.2</b>	<b>0.3</b>	<b>0.4</b>	<b>0.5</b>
<b>6.5</b>		<b>0.1</b>	<b>0.2</b>	<b>0.3</b>	<b>0.4</b>
<b>6.0</b>			<b>0.1</b>	<b>0.2</b>	<b>0.3</b>



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# How does flooded soil conditions affect the soil pH value and plant nutrient availability?

Soils which have been saturated with water for a prolonged period of time may show an increased soil test pH value. The main reason for the change is the denitrification of soil nitrate to nitrogen gas which occurs under anaerobic conditions. For each atom of nitrate nitrogen which is converted to nitrogen gas, 6 atoms of acidic hydrogen are neutralized by forming water molecules as part of the bio-chemical reaction. The amount of pH change may be an increase of several tenths of a pH unit. Since this change in soil pH is due to a non-reversible bio-chemical reaction, we suggest that farmers follow the soil test lime recommendations from samples collected from these flooded soils and make no adjustments to the recommended lime application rate.

Manganese will become more soluble under flooded conditions but will return to its normal level of availability as the soil dries out for Spring planting. Likewise, the manganese in the soil sample will revert to its normal level of availability as the sample is dried and analyzed by the Agricultural Service Laboratory and will reflect the amount of available manganese in the field.

A portion of some nutrients such as potassium and magnesium may have been leached out of the plow layer by excessive rainfall. If there is no appreciable hard pan and the subsoil is within 15 to 20 inches of the surface, the crop will still have access to these nutrients later in the growing season. If leaching is suspected, it would be worthwhile to obtain a soil analysis from a subsoil sample. Samples should be collected from the top 4 inches of subsoil clay. Several cores should be collected within a field and combined to make one composite sample. The test results can be used to reduce the recommended rates of potassium and magnesium if high levels are found in the subsoil.



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# How does the chlorine in pool water affect nearby plants?

I consulted with Dr. Jerry Kidder at the University of Florida about this. I figured that since his state is significantly covered with water (primarily from swimming pools and not from the Everglades!) that he could speak from experience:

There should be no effect of pool water splashed on nearby plants from normal pool use. The form of chlorine most often added to pool water is solid calcium hypochlorite which forms hypochlorous acid (HOCl) when placed in water. Sodium hypochlorite is the active ingredient of common household bleach. Hypochlorous acid is the effective agent that controls algae growths in pools. Larger plants (and animals) can tolerate the concentrations that are recommended for pool water.



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