Soil Mineral Balancing using Standard Soil Test Results

(based on information from Logan Labs
& adapted by **Kris Johnson**)

BALANCE CHEMISTRY & FEED THE SOIL!

Dr. William Albrecht did much of the research on the base saturation methodology. Dr. Albrecht was the Head of Agronomy at the University of Missouri and founder of Brookside Labs. Logan Labs is one of several companies that are using Dr. Albrecht's philosophies and formulas for recommendations. He taught that until the chemistry of the soil is in balance that soil couldn't provide the environment for an adequate population of beneficial soil microorganisms. For example, if the Ca:Mg ratio is not 7:1 (by weight), equaling 80% base saturation, the movement of air and water into the soil will be significantly restricted. This imbalance will limit the growth of needed microbes. Feeding the soil is very important but will be significantly limited by poor, unbalanced soil chemistry, thus the motto – "Balance the Chemistry – Feed the Soil."

Logan Labs offers a host of important soil tests. The "**Standard Soil Test**" is the basic soil colloid test, which measures the mineral "**savings account**." The lab also runs a **Paste Extract Test**, which is a water-soluble soil test and shows what may be mobile (available) in the soil or the chemical "**checking account**." The two together provides tremendous information as to the overall health of the soil and can be a significant tool in balancing the soil. When comparing the two side by side, it is easy to see how nutrient mobility is affected by the health of the soil. Soil microorganisms have a major effect on nutrient availability, hence the mandate to "Feed the Soil."

How to Read the Standard Soil Test Report:

TOTAL EXCHANGE CAPACITY (TEC) is the soil's capacity to hold and exchange cations (positively charged ions). (Sometime referred to as Cation Exchange Capacity (CEC))

TEC represents the ability of the soil to hold nutrients (positively charged cations) on colloidal sites, which are negatively charged (anions). Colloidal sites are plate-like structures made up of mostly clay and organic matter, although there are other elements that can increase TEC. In soils, such as sands, where clay and organic matter are low, the TEC is low and fewer nutrients will be available. In heavy soil the TEC will be greater as will be the pounds per acre of most nutrients.

CATIONS are the positively charged nutrient ions and molecules: Calcium (Ca), magnesium (Mg), potassium (K), sodium (Na), hydrogen (H), and ammonium (NH_4)

pH – Measure of acidity or alkalinity of the soil pH represents the "percentage of Hydrogen" on the soil colloid and represents the acidity and/or the alkalinity of the soil. Maximum biological activity in the soil occurs at a pH of about 6.2 – 6.7 (ideal varies with the lab). It is very important to understand that pH should not be the focus of any management program. pH only represents the **balance** of the basic cations found in the base saturation and is adjusted by managing Ca, Mg, K, Na and the other cations. Always ask "what is driving pH," it may not always be Ca.

ORGANIC MATTER, PERCENTAGE – This shows the percentage of readily oxidizable organic matter (Humus).

SULFUR (S) – Sulfur is shown in parts per million (ppm). Sulfur should be at least 25 ppm and can be as high as 50 ppm. Grass plants will use about the same amount of sulfur as they do phosphorous. It is essential in uptake of nitrogen and the development of many amino acid, enzyme and protein systems. Sulfur plays a major role in mobilizing excessive nutrients out of the soil.

EASILY EXTRACTED PHOSPHOROUS – Shown here as P_2O_5 in pounds per acre. P levels should be at least 250 pounds per acre but can afford to be even higher in heavy soils. Phosphorous is not very available in most soils - because of its negative charge it can "lock up" with other nutrients. Active soil microorganisms are essential for making P available. Phosphorous is an essential building block for sugar development, the development of healthy roots and the transportation of other nutrients into the plant. [mychorrhiza & phosphorus availability - see below]

CALCIUM (Ca) – Used more in weight and volume than any other nutrient and perhaps the most over- looked. Calcium is noted here in pounds per acre but more importantly is found in the base saturation percent that shows the balance of calcium with other cations. It's this balance that is so important and Ca should be 68% or more base saturation on heavy soils and 60% base saturation on sandy soils. (See exceptions below) The recommendations offered are decided by elaborate formulation that will allow for the optimum Ca levels. Sources for Ca include high calcium lime (low Mg), dolomitic lime (high Mg) and gypsum (calcium sulfate) and many liquid products. Depending on how much Ca is needed, a combination of high calcium and dolomitic lime may be needed so not to push out too much Mg. Calcium imbalances will severely effect the soil compaction and restrict air and water movement through the soil limiting microbial activity. Liquid calcium is excellent in making soil calcium more available and is often recommended at 2 gal/acre with equal amounts of blackstrap molasses for phosphorus release.

MAGNESIUM (Mg) – Also shown in pounds per acre. Mg has a very close relationship with Ca and should be managed by balancing base saturation and reducing deficiencies. Often it is high Mg that is driving pH up and needs to be pushed out to lower pH by replacing it with Ca or other cations. Mg levels should be 12% base saturation on heavy soil and close to 20% on sandy soil. Mg is essential in photosynthesis and the development of many amino acid and enzyme systems. There are many good sources for supplying Mg to the soil such as dolomitic lime, Pro-Mag or Sul-Po-Mag. Liquid forms of Mg are important to a balanced program.

POTASSIUM (K) - is a major player in root development and reducing plant stress but is needed in much smaller amounts than Ca or Mg. Good microbial action is needed to release bound K into an available form. Again, manage K by base saturation and work hard at not over applying because it is a very mobile nutrient. K levels should be 3-5% base saturation. When pH is above 6.5 the availability becomes increasingly limited and building levels of K in the soil without organic sources becomes very hard. Sources of potassium include compost, greensand, potassium sulfate, and kelp

SODIUM (Na) - This is a needed nutrient but can be easily over done creating toxicities. Levels should not exceed 40-50 pounds per acre but ideally should not exceed 3% base saturation. High levels of Na in the soil will severely restrict the activity of beneficial bacteria which are important in keeping pathogens in check. Watch the overuse of high salt fertilizers, top dressings, composts or other common sources of Na.

BASE SATURATION PERCENTAGE -
The percent of cations on the soil colloid.

This is where management of the soil begins because it represents "balance." Manage to

60-70% Ca (**higher in alkaline soils - see below**)
10-20% Mg (higher with low CEC soils (sandy)
3-5% K
2% Na
3% Other Bases (trace nutrients), and
10% Exchangeable Hydrogen.

Remember that base saturation always adds up to 100% so if one nutrient is high, another can be exchanged for it. If these numbers are in their "ideal" percentages pH will always be between 6.0 to 6.5. Low exchangeable H may reflect low available nitrogen.

BORON (B)- Try to maintain 1.2 ppm. Boron is a very soluble nutrient and is needed in most soils on a small but frequent basis. Do not over apply because it can be very toxic but if deficient nitrogen uptake will be limited as well as many other plant/soil functions. Boron is the "gate keeper" for calcium and other minerals uptake. [Humus is the boron storehouse. Maintain organic matter above 4% to store boron until needed.
More at http://www.nutri-tech.com.au/blog/?p=595]

IRON (Fe)– Over used in most programs because of its ability to affect photosynthesis and provide a greening effect. There is a critical Fe:Mn relationship and should always be at least 1.5:1. Ideal soil levels are 100-150 ppm, but most soils can easily tolerate higher levels.

MANGANESE (Mn) – Managed to a minimum level of 25 –40 ppm. Mn will mobilize Fe in the soil and can be a good replacement for it when Fe is high. Mn like most micro-nutrients play subtle but important roles in the metabolism of both plant and soil micro-organism and when deficient can create significant plant stress which can encourage disease.

COPPER (Cu) – Managed to a minimum of 3.5 ppm. Copper is a major player in disease suppression if levels in the soil are maintained at 5-10 ppm. Cu is a major ingredient in many popular fungicides and can be very helpful in this role if available in the soil.

ZINC (Zn) – Managed at 2 times copper, with a minimum 7 ppm with an optimum of 5-10ppm. Zn can play a major role in disease suppression if found in ample amounts in the soil and biology is strong enough to create mobility.

NITROGEN (N) is an essential plant nutrient that does not show up on many soil tests because it is so volatile. Nitrogen makes up 80% of the air we breathe, and air should be a major source of N in the garden. Electrical storms convert some N to forms that plants can use. N-fixing bacteria on the roots of legumes, and some algae also make the conversion. Soil organic matter contains 5-6% N, much in the form of protein, which needs to be broken down by soil microorganisms to become available to the plant. High organic matter in the soil makes for more efficient utilization of any fertilizer N added. Ammonia nitrogen (NH_4) breaks down into nitrate nitrogen (NO_3), the form most readily utilized by plants. Excess nitrate contributes to soil acidity, which can lead to leaching of nitrates, and override microbial production of N. Excess soluble N can lead to quick, falsely stimulated growth, pleasing to the eye, but low in nutritional value and low brix. Sources of less soluble, longer lasting organic N include seed meals (e.g. soy or cottonseed), fish meal or liquid, tankage (waste from slaughtered animals), composted chicken manure, and green manure crops. Fish liquids are excellent for building soil microbial levels. N in fresh manure is basically in the ammonium form and very volatile.

Additional information:

Mycorrhiza and phosphate availability (Jerry Brunetti)

Endomycorrhiza work their way into vascular system of roots and extend the roots. They split insoluble Calcium phosphate so the Ca and Phosphate (makes ATP) can enter the plant. The mychorrhiza/rysosphere is the digestive system of the plants.

Enhancing Mycorrhiza

1. Limit Tillage
2. Avoid Fallowing (always have a cover crop)
3. Plant Winter Cover Crop
4. Diverse Crop Rotations
5. Plant "VAM-Friendly" Crops
6. Tolerate Weeds (Cover Crop)
7. Avoid excessive soluble phosphate

Additional mineral info
http://www.spectrumanalytic.com/support/basics/

The Ideal Soil: A Handbook for the New Agriculture, by Michael Astera, explains in detail how to plan an appropriate mix of mineral amendments, using calculations based on a standard soil test, such as that from Logan Labs. See www.soilminerals.com . Proper mineral balance is an essential first step in restoring soil fertility.

If all this seems too complicated for your new little vegetable garden, you might try using a complete organic fertilizer such as one of the **B.L.O.O.M mixes**, following their instructions. Other suggestions **here**.

For more information and active links see **http://tinyurl.com/GardenMaxNutr / 'Soil Mineral Balancing'**

Balancing Base Saturation.

New ideas from Michael Kraidy,
mike@ofarmer.com - http://ofarmer.com/

In alkaline soil, with low hydrogen, higher levels of calcium are needed to maintain magnesium and potassium in desirable ranges

Examples: In a sandy soil with a CEC of less than say 6, you would like to have 5% potassium, 18% magnesium and only 62% calcium along with 10% H. If there is no acidity or H, you have to increase calcium to 72%.

These numbers are ok for a CEC of 7 and below.

On a CEC of 8 to 15 or so, in an alkaline soil, I would go with 3-4% K, 13-14% Mg and 81-82% Ca, because H is 0%.

If you have soil with a CEC of 16 and above, on alkaline soils, you would have much better results pushing the numbers to:
1-3% K, 10% Mg, 85% Ca (assuming no H).

The differences are subtle but very critical. Why? Magnesium makes the soil bind up, will make for poor drainage. We don't need as much K either. We need the extra Ca to make structure and air space in the soil.

These numbers will also vary by which lab you use and which type methods they are using. These percentages would also vary on some crops, but not by much.

If the pH is between 6.0 and 6.4 or so, I would use calcium carbonate and gypsum, 6.4 and above, I would propose gypsum.

Other considerations:

When (K + Na) is high (>10% CEC) Mn uptake is blocked, as is zinc. Need to back off on K and wash out Na.

For more information see
http://tinyurl.com/GardenMaxNutr

SAMPLE SOIL TEST ⟶

Sample Location			Plot # 6
Sample ID			Strawbry
Lab Number			125
Sample Depth in inches			6
Total Exchange Capacity (M. E.)			17.95
pH of Soil Sample			7.20
Organic Matter, Percent			12.91
ANIONS	**SULFUR:**	p.p.m.	43
	Mehlich III Phosphorous:	as (P_2O_5) lbs / acre	1049
EXCHANGEABLE CATIONS	**CALCIUM:** lbs / acre	Desired Value	4883
		Value Found	5450
		Deficit	
	MAGNESIUM: lbs / acre	Desired Value	517
		Value Found	720
		Deficit	
	POTASSIUM: lbs / acre	Desired Value	560
		Value Found	321
		Deficit	-239
	SODIUM:	lbs / acre	74
BASE SATURATION %	Calcium (60 to 70%)		75.89
	Magnesium (10 to 20%)		16.71
	Potassium (2 to 5%)		2.29
	Sodium (.5 to 3%)		0.90
	Other Bases (Variable)		4.20
	Exchangable Hydrogen (10 to 15%)		0.00
TRACE ELEMENTS	Boron (p.p.m.)		2.48
	Iron (p.p.m.)		181
	Manganese (p.p.m.)		31
	Copper (p.p.m.)		13.23
	Zinc (p.p.m.)		34.31
	Aluminum (p.p.m.)		148