Correcting Soil Problems in Berries – Preplant

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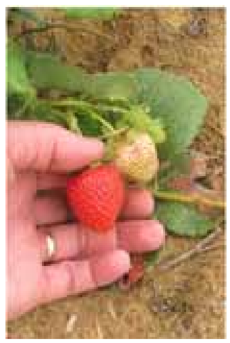
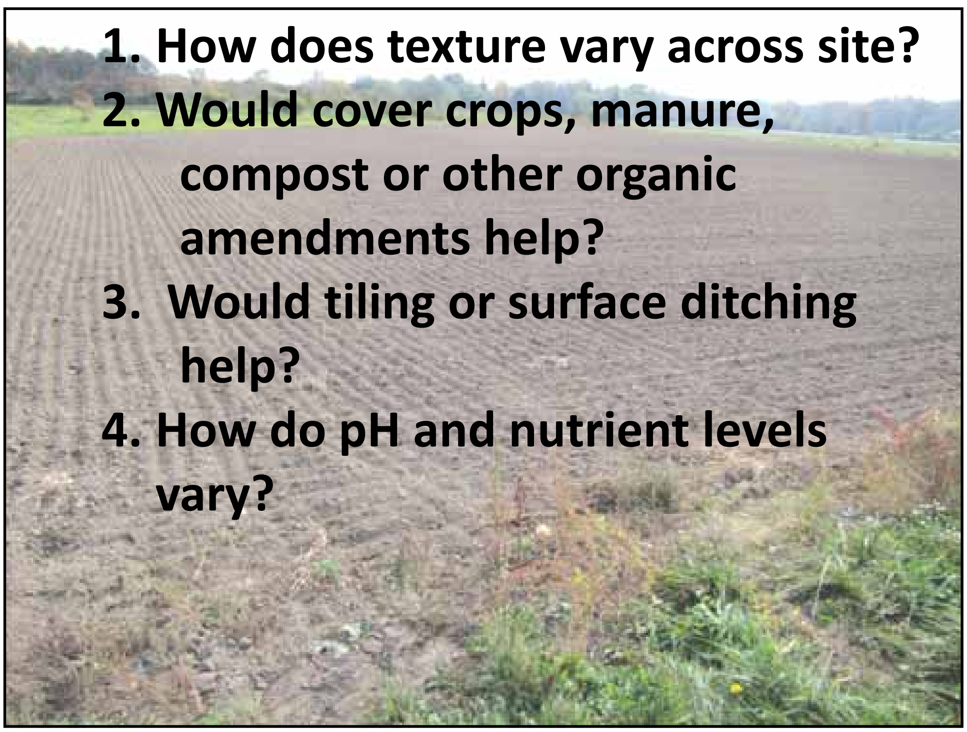


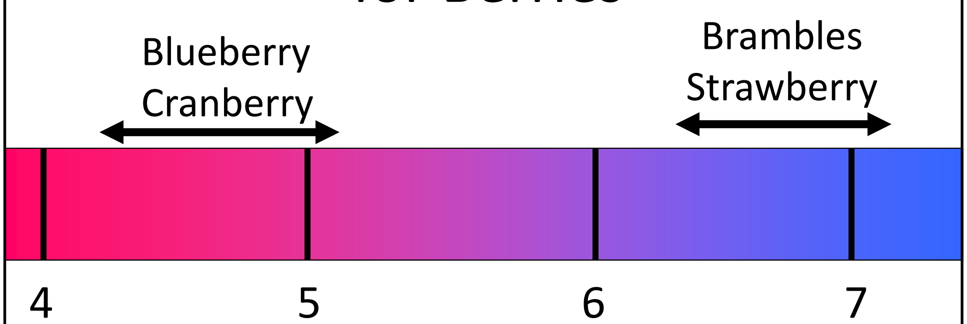


1. **How does texture vary across site?**
2. **Would cover crops, manure, compost or other organic amendments help?**
3. **Would tiling or surface ditching help?**
4. **How do pH and nutrient levels vary?**

Soil Analysis Laboratories

1. Many private and university labs to choose from.
2. Best to work with just one lab.
3. Use the interpretation/recommendations from that lab; methods vary from lab to lab.
    - nutrient extraction
    - pH and lime requirements

Optimum pH Range for Berries



Lime $CaCO_3$

↓

Ca^{+2} + HCO_3^- + OH^-

H^+ → H_2O

General Benefits of Liming

Reduces available aluminum and manganese.
Supplies calcium and possibly magnesium
Increased availability of phosphorus
Increases microbial activity associated with:
- N_2 fixation
- nitrification
- OM decomposition – N mineralization

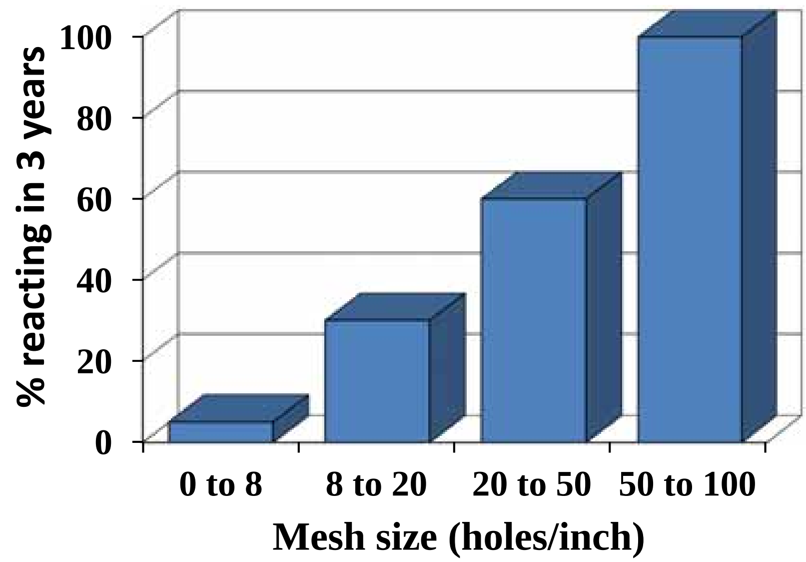
Choose lime based on:

1. Neutralizing value (calcium carbonate equivalent)
2. Reaction rate (mesh size)
3. Need for magnesium
4. Cost, ease of use, availability

Neutralizing Value of Liming Materials

Material	NV
Calcium carbonate	100
Dolomitic lime	95-108
Calcitic lime	95-100
Hydrated lime	120-135
Marl	50-90
Gypsum - $CaSO_4$	0

Relationship between particle size and rate of reaction of lime.



Pelletized or "Pell-lime"

Finely ground (smaller than 100 mesh) calcitic or dolomitic lime formed into 4-20 mesh size pellets using binders.

Pell-lime generally reacts about as quickly and neutralizes the same amount of acidity as an ag-lime with similar neutralizing value.

Easier to apply and handle.

Wind-blown losses may be less.

Much more expensive than most ag-lime.

Lowering Soil pH

-not usually desired except on blueberry sites

Iron chlorosis in blueberry, pH >5.5

Acidifying Agents

Sulfur is the preferred material.
Comes as prills, chips, and powder, containing 90-95% S.

Iron sulfate reacts quickly in soils, but is more expensive than S because 6 times as much is required for the same pH reduction. It also may result in salt stress.

Aluminum sulfate also reacts quickly, but requires high rates and may result in aluminum toxicity.

Acidifying N fertilizers (e.g. ammonium sulfate) help maintain soil pH, but result in excessive N if used to adjust pH.

1 lb S provides the same acidity as 2.8 lb $(NH_4)_2SO_4$
500 lb S is equivalent to 1,400 lb $(NH_4)_2SO_4$ or 294 lb N!

Sulfur

In moist, warm, aerated soils, bacteria oxidize S to sulfuric acid.

$$2S + 2H_2O + 3O_2 = 2H_2SO_4$$

Reaction may require a year; apply a year before planting.
Incorporate for quickest reaction.

Sulfur can be broadcasted over site or banded in planting rows.

Sulfur required (lb/acre) to reduce pH to 4.5

Current pH	Soil Type		
	Sand	**Loam**	**Clay**
5.0	175	530	800
5.5	350	1,050	1,600
6.0	530	1,540	2,310
6.5	660	2,020	3,030

Cautions:

If more than 500 lb is needed, split the application.

S can produce hydrogen sulfide in poorly drained soils, which is toxic to roots.

Pre-plant Phosphorus

Incorporate prior to planting at rates indicated by soil test results.
Choose materials based on cost per unit of P_2O_5 and % availability.

Fertilizer	Total P_2O_5 %	% Available
Superphosphate	21	96-100
Concentrated superphosphate	45	96-99
Rock phosphate	34	3-8

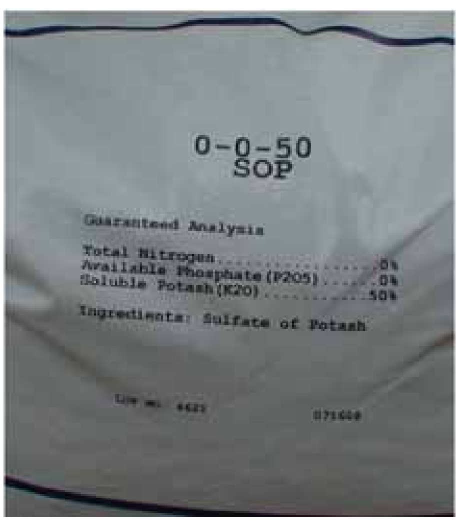
Pre-plant Potassium

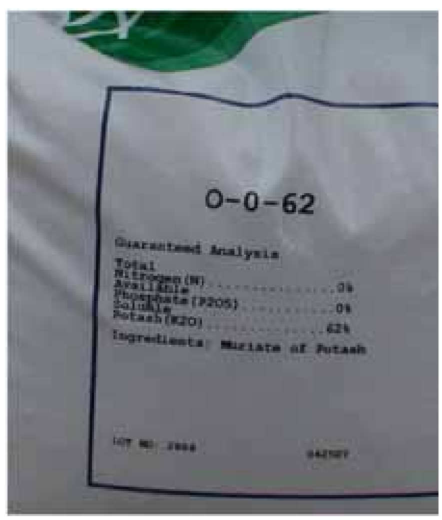
Incorporate prior to planting at rates based on soil test results.

Choose materials based on:

1. cost per unit of K_2O
2. need for other nutrients
3. potential hazard from chlorine

Fertilizer	**% K_2O**	**Cost**
Potassium chloride	60-62	$
Potassium sulfate	50-54	$$
Potassium-magnesium sulfate	22 (11% Mg)	$$$





Pre-plant Magnesium and Calcium

Incorporate prior to planting based on soil test results.
Choose materials based on:

1. cost per unit of nutrient
2. need for pH adjustment
3. need for other nutrients

Fertilizer	**% Mg**	**% Ca**	**% K**
Magnesium sulfate	10		
Calcium sulfate (gypsum)		22	
Potassium-magnesium sulfate	11		22
Calcitic lime	<5	>30	
Dolomitic lime	>5	<30	

A case for gypsum?

Gypsum ($CaSO_4$) supplies Ca but does not alter pH. It is known to improve flocculation of clay and water infiltration/drainage of saline or sodic soils.

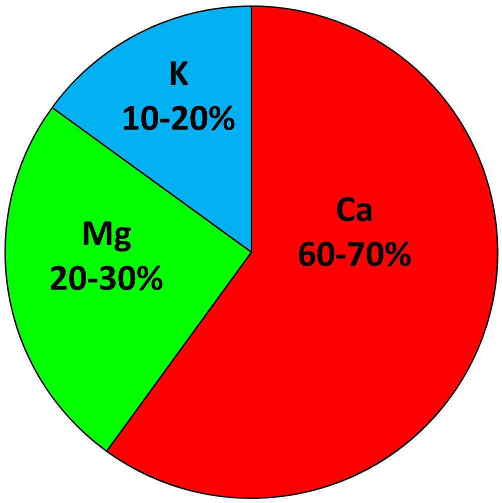
Gypsum reduced raspberry root rot caused *by Phytophthora spp.* in NY (Maloney et al., 2005) and to some extent in WA trials (Pinkerton et al., 2009).

Gypsum reduced *Phytophthora diseases of avocado* (Messenger et al., 2000) and soybean (Sugimoto et al., 2010), apparently due to the inhibitory effect of high Ca concentrations on fungal growth and infection of plant tissues.

<u>Recommendation</u>:
Incorporate 3-6 tons gypsum prior to planting raspberries on sites with a history of Phytophthora root rot.
How about red stele (P. fragariae) of strawberries?

Ca, Mg, K Ratios are important

Desired ranges for % of Bases



Salt Stress

Excessive soil salt tends to be a problem of arid regions, much less common in humid areas (eastern US states).

But, growers can create salt problems by using fertilizers inappropriately, or by using high-salt irrigation water.

Berry crops are among the least tolerant of high soil salt.

Soil salt levels based on saturated paste extract potentially causing yield reductions in fruit crops.*	
Crop	**Soil EC (dS/m)****
Olives	2.7
Grapefruit	1.8
Apple/pear/peach	1.7
Apricots	1.6
Grapes	1.5
Blackberries	1.5
Raspberries/strawberries	1.0
Blueberries	??

*Western Fertilizer Handbook (1990)
**1 dS/m = 1 mmho/cm

Salt index values for some common N fertilizers			
Fertilizer	% N	Salt index*	Salt index per unit N
Ammonium nitrate	33	105	300
Ammonium sulfate	21	69	328
Calcium nitrate	12	53	442
Di-ammonium phosphate	18	29	161
Mono-ammonium phosphate	11	27	245
Natural organic	13	3.5	70
UAN 28%	28	71	222
Urea	46	75	162

* Salt index is the increase in osmotic pressure resulting addition of fertilizer to a solution, relative to affect of the same amount of $NaNO_3$ (SI = 100).

After: Kamburova and Kirilov, 2008

Salt index values for some P and K fertilizers			
Fertilizer	% nutrient	Salt index	Salt index per unit nutrient
P_2O_5			
Superphosphate	20	8	39
Concentrated superphosphate	45	10	22
Mono-ammonium phosphate	11	27	245
Di-ammonium phosphate	18	29	161
K_2O			
Potassium chloride	63	114	181
Potassium sulfate	54	46	85

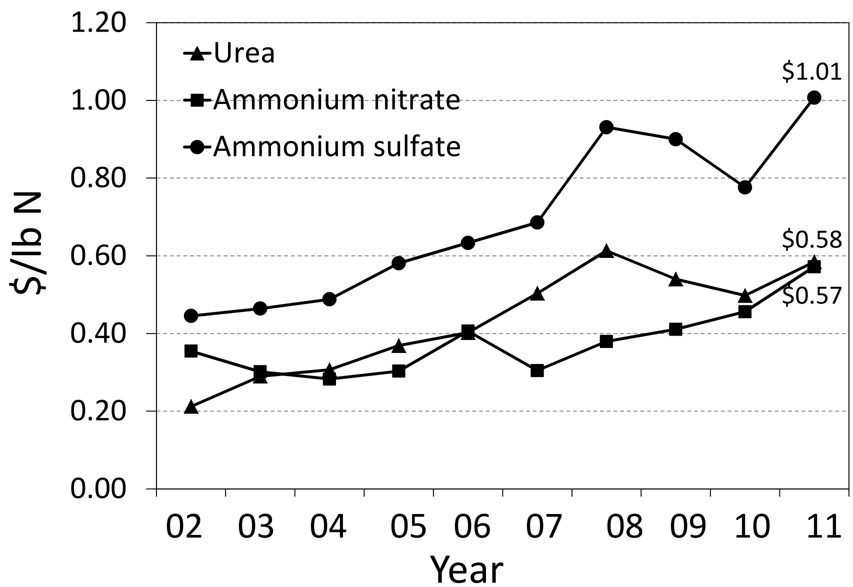
Nutrient content of some common organic sources*			
Material	N	P_2O_5	K_2O
Bone meal (steamed)	1-2	18-34	
Compost	1-3.5	0.5-1.0	1-2
Cotton seed meal	6	2.5	1.7
Dried blood	12	1.5	0.6
Fish emulsion	5	2	2
Fish meal	14	4	1
Kelp	1	0.5	4-13
Marl		2	4.5
Nitrate of soda	16		
Rock phosphate		3	
Soybean meal	7	2	2
Wood ash		1-2	3-7

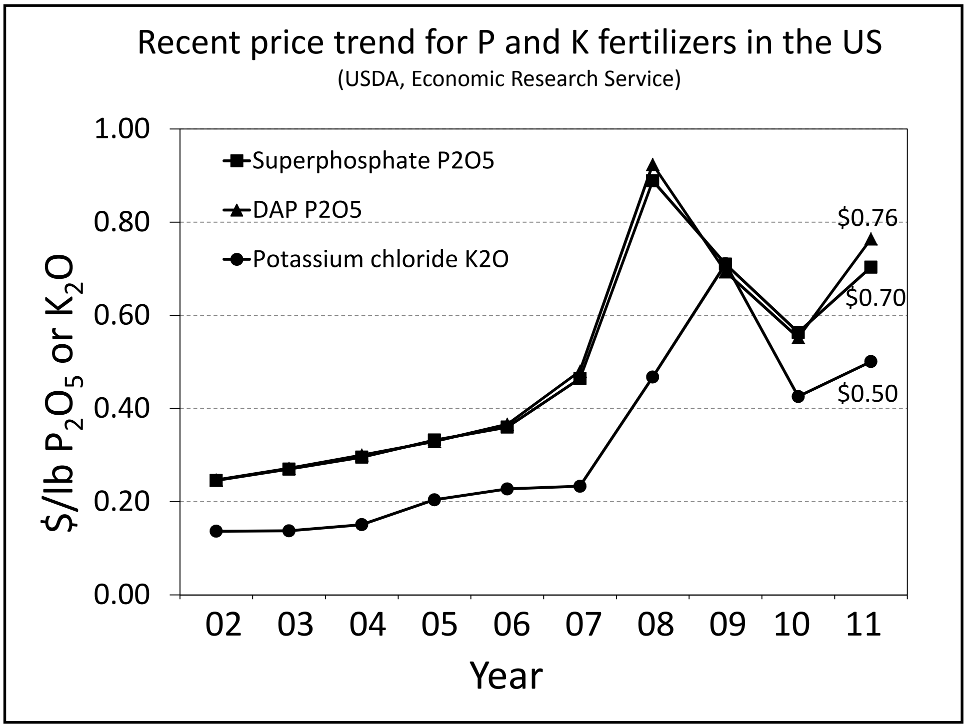
* Check with your certifier for allowable types

Pre-plant Manure and Compost Use

Average nitrogen fertilizer price trends in the US

(USDA, Economic Research Service)




Recent price trend for P and K fertilizers in the US
(USDA, Economic Research Service)
$/lb P_2O_5 or K_2O
1.00
0.80
0.60
0.40
0.20
0.00
Superphosphate P2O5
DAP P2O5
Potassium chloride K2O
$0.76
$0.70
$0.50
02
03
04
05
06
07
08
09
10
11
Year

Pre-plant manure and compost – general considerations

Often beneficial, particularly on sandier soils, heavily farmed sites.

Analyze before applying to avoid:

1. Excessive total salts.
2. Excessive P
3. N tie-up or excess
4. Specific element toxicities (heavy metals, B, Na, Cl)

Apply and incorporate raw manure in the fall before spring planting

Avoid manure or compost with salt levels > 10 dS/m.
Apply materials with moderate salt levels in the fall to allow salts to leach.

Manure nutrient content (lb/ton)

	NH_4-N	Total N	P_2O_5	K_2O
Swine, no bedding	6	10	9	8
Beef, no bedding	7	21	14	23
Dairy, no bedding	4	9	4	10
Dairy compost	<1	12	12	26
Poultry, w litter	36	56	45	34
Poultry compost	1	17	39	23
Turkey w litter	13	20	16	13

From: Rosen and Bierman. Univ. Minn. Ext. Bul. M1192.

Manure Use – Avoid Excessive Soil P

(Michigan Manure GAAMP's)

Know soil and manure P levels.

If soil tests indicate P is needed, apply enough manure to supply 100 to 200 lb P_2O_5/acre.

If Bray P_1 soil test is 75 to 150 ppm, apply enough manure to replace crop removal.

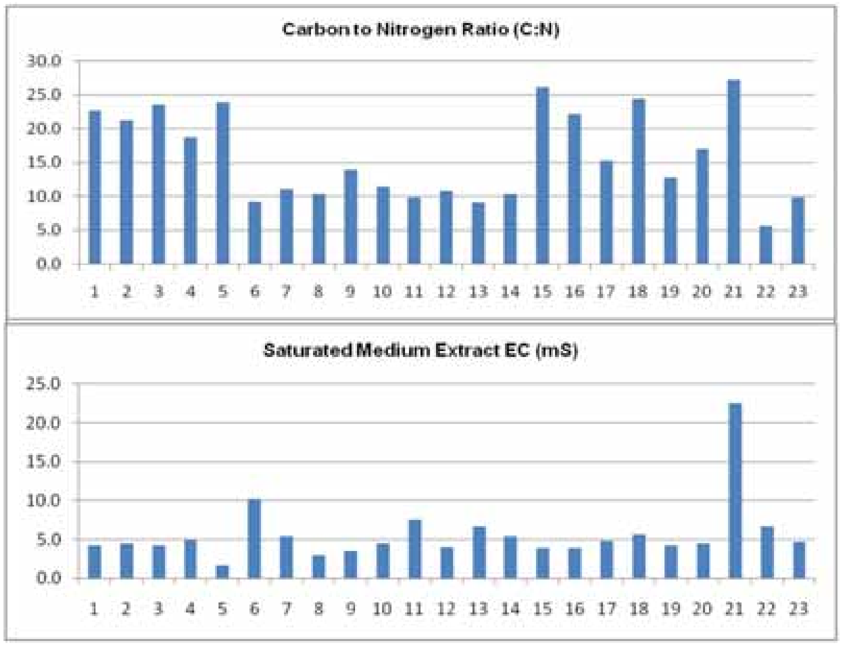
If the Bray P_1 soil test is above 150 ppm, do not apply manure.

Do not apply or stockpile manure within 150 ft of surface water.

Analyses of *compost* 20 *Massachusetts farms in 1996.*

PARAMETER	AVERAGE	RANGE
Water %	51.3	28 - 73
pH	7.1	5.4 - 7.9
Soluble Salts (dS/m)	2.8	0.4 - 19.1
Organic Matter	35.2	16.7 - 90.7
C:N Ratio	16.9	11.0 - 41.0
Total N (lb/yard^3)	8.0	3.2 - 18.7
Nitrate (lb/yard^3)	0.19	0 - 1.23
Ammonium (lb/yard^3)	0.06	0 - 0.66

Variation in C:N and salt levels of Michigan composts (J. Biernbaum)



Effect of C:N ratio on N availability

	C:N ratio	
Sawdust	500:1	**Reduces available N**
Bark	120:1	
Straw	80:1	
30:1		
Compost	25:1	**Increases available N**
Fresh grass	20:1	
Chicken manure	6:1	

Learn from your mistakes:

In an effort to provide adequate nutrition for a new planting of organic raspberries under high tunnels, we incorporated up to 10 tons of a fortified dairy compost in the rows before planting.

Injury to newly planted high tunnel raspberries from compost incorporated before planting at 10 tons/acre.

Compost Analysis								
	EC		N	P	K	Ca	Mg	Na
pH	(dS m^{-1})	C:N ratio	(%)					
6.9	14.05	7.9:1	2.92	2.43	1.83	7.45	.69	.35

Summary – Pre-plant Considerations

Understand how soil texture, pH, nutrient content, and drainage vary across site.

Understand the properties of amendments and fertilizers before applications.

Adjust pH well before planting

Build soil P, K, Ca, and Mg based on recommendations from soil tests.