Implement soil improvements for garden and turf areas

AHCSOL303

Overview

By the end of this topic, you should be able to:

- Prepare and collect soil samples for testing
- Determine physical characteristics of sample
- Determine chemical characteristics of sample
- Prepare soils for planting or replanting

Why test soil/media?

- There are many benefits to testing soil/media, including to determine:
  - The most cost effective method of improving soil/media
  - The most time efficient method of improving soil/media
  - To determine the suitability of soil/media for particular plants

- Refer to your supervisor to determine the reasons for testing soil/media

Types of soil/media

- There are a range of soil/media types:

Soil/Media	Definition
Clay soils	Heavy and difficult to work, but hold moisture and nutrients well. Prone to water logging. Holds together well and feels sticky. Neutral or slightly alkaline.
Loam-based compost	A less free-draining type of media, which is more prone to water-logging. Neutral or slightly alkaline.
Peat-based compost	Media which tends to be well-aerated and less prone to water-logging. Generally acidic.
Sandy soils	Drains easily, but dries quickly and nutrients are easily washed through the soil. Breaks up easily and has a gritty feel. Generally acidic.
Silty soils	Relatively light and rise to the soil surface. When dry, they can form a crust on the topsoil which may stop seedling emergence. Has a soapy or silky feel.

Preparing for soil/media collection

- To prepare for soil/media collection, you should familiarise yourself with the following:
  - Task requirements
    - Determine the reasons for testing the soil
    - Workplace records will identify the area from which soil/media samples are to be collected
  - Workplace information
    - Identify underground services for the site (e.g. from site plans, supervisor or contacting Dial Before You Dig)
  - Work area
    - Identify any WHS hazards and assess risks (e.g. underground services, manual handling injuries)

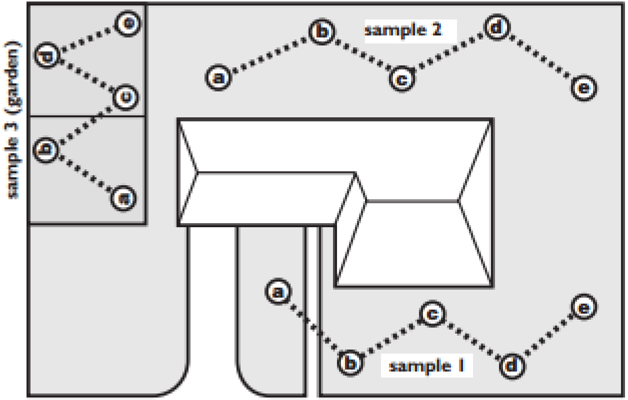
Preparing for soil/media collection

- To prepare for soil/media collection, organise the required PPE, tools and equipment:
  - PPE may include: Gloves, wide brimmed hat, work boots
  - Safety equipment may include: Barricades and signage
  - Tools and equipment may include: Soil probe, Soil auger, Soil core sampler, Shovel, Trowel, pH testing kit, jars, plastic bags, labels

- Ensure they are appropriately selected, prepared and used for the task, following manufacturer recommendations

Preparing for soil/media collection

- When taking samples, you should complete the following:
  - Ensure that tools to be used are clean
    - Even a small amount of fertiliser residue on tools can contaminate a soil sample
  - Clear away any weeds and loose organic material to uncover the soil surface
  - Take multiple soil samples at each selected site
    - Ensure that samples are only collected in paper bags if they are lined with plastic
  - Take random samples from the designated area, according to recognised sampling techniques
    - Sample garden and turf areas separately
    - Sample problem areas separately



Make a composite sample by collecting small cores from at least five locations.

Preparing for soil/media collection

- When taking samples, you should complete the following:
  - Ensure that an appropriate sample size is taken (e.g. 1-2 cups of soil per sample)
  - Ensure the sampling depth is appropriate for the area:

Sampling depth	Area
12-17cm	Gardens and unestablished lawns
10cm	Established turf
5cm	Golf course putting greens and tees

  - Label the sample appropriately:
    - Include the date and location of sample (i.e. address, GPS coordinates), depth of sample
    - The soil sample will be assigned a number and entered into the laboratory register

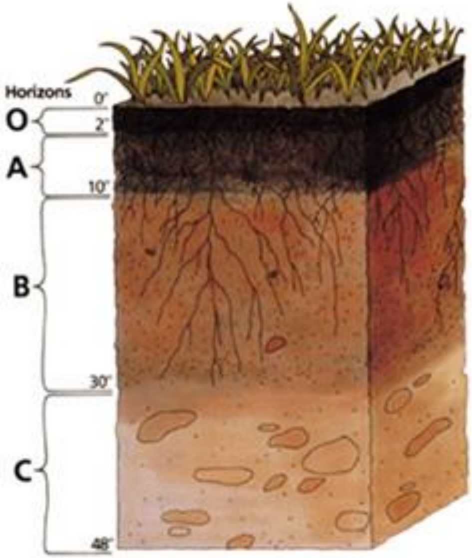
Physical characteristics of soil/media

- When testing for the physical characteristics of soil/media, the following may be considered:
  - Soil profile characteristics
  - Texture
  - Structure
  - Ability of soil to drain or retain water
  - Soil colour and the presence of organic matter
  - Depth of topsoil

- These characteristics will help establish whether improvements are needed

Physical characteristics of soil/media

- It is important to understand what exists beneath the surface when taking soil samples
  - The vertical section of soil from the ground surface downwards to where the soil meets the underlying rock is known as the **soil profile**
- The horizons (labelled) represent the following:
  - **Organic (O):** Litter (i.e. dead plants and animal parts)
  - **Surface (A):** Topsoil or mineral horizon
  - **Subsoil (B):** Chemical products of weathering accumulated in the soil
  - **Substratum (C):** Parent material from which soil has formed



Physical characteristics of soil/media

- There are a range of tests that can be conducted to determine the physical characteristics of soil/media, including **soil texture**:

Test	Results	Improvements
Soil texture is an estimate of the relative amounts of sand, silt and clay particles in soil. Soil texture affects the movement and availability of air, nutrients and water in soil. To test soil texture, moisten a small amount and roll it between your hands to try to make a 'sausage' shape.	• **Clay:** Keeps its shape and feels sticky • **Sandy:** Disintegrates and has a gritty feel • **Silt:** Does a bit of both, has a soapy or silky feel	Most people are not lucky enough to start out with the ideal loamy soil desired for a vegetable garden. Soil amendments and additives that can be used to improve the texture of soil: • Animal manure • Leaves • Straw and hay • Plant manures and cover crops • Seaweed

Source: https://www.rodalesorganiclife.com/garden/10-easy-soil-tests; http://www.completegardenguide.com/soil_texture.html
http://soilquality.org.au/factsheets/soil-texture

Physical characteristics of soil/media

- There are a range of tests that can be conducted to determine the physical characteristics of soil/media, including **soil structure**:

Test	Results	Improvements
Break apart a soil profile sample to determine whether it is cloddy, powdery or granular. Open, porous soils allow the free movement of water and oxygen.	Ideally the soil aggregates should hold their shape under slight pressure. Aggregates that break apart only with difficulty mean the soil is too hard.	Increasing soil organic matter content helps create and stabilise soil structure. Organic matter is integral in the capacity of a soil to maximise water storage through its effect on creating and stabilising soil pores and its absorption capacity.

Activity: Research and conduct a jar test

Source: https://www.rodalesorganiclife.com/garden/10-easy-soil-tests
http://soilquality.org.au/factsheets/water-availability

Physical characteristics of soil/media

- There are a range of tests that can be conducted to determine the physical characteristics of soil/media, including **water infiltration**:

Test	Results	Improvements
• Take an empty can with the bottom removed and push it into the soil until 5cm remains above the surface • Fill the can with water, marking the water height and time how long it takes for the water to be absorbed into the soil • Repeat this until the rate of absorption slows	• **Sand:** >30mm/hr • **Sandy loam:** 20-30mm/hr • **Loam:** 10-20mm/hr • **Clay loam:** 5-10mm/hr • **Clay:** 1-5mm/hr Slow water infiltration can be a sign of compacted soil, which inhibits root growth and water availability	Options to increase water infiltration rates: • Reducing tillage operations • Increasing the amount of organic materials added to the soil • Decreasing compaction by avoiding the use of machinery, especially when soils are wet • Use a rotary hoe to shatter the crust

Source: https://www.rodalesorganiclife.com/garden/10-easy-soil-tests
http://farmercommunity.incitecpivotfertilisers.com.au/Latest%20News/Horticulture/Measuring%20water%20infiltration

Physical characteristics of soil/media

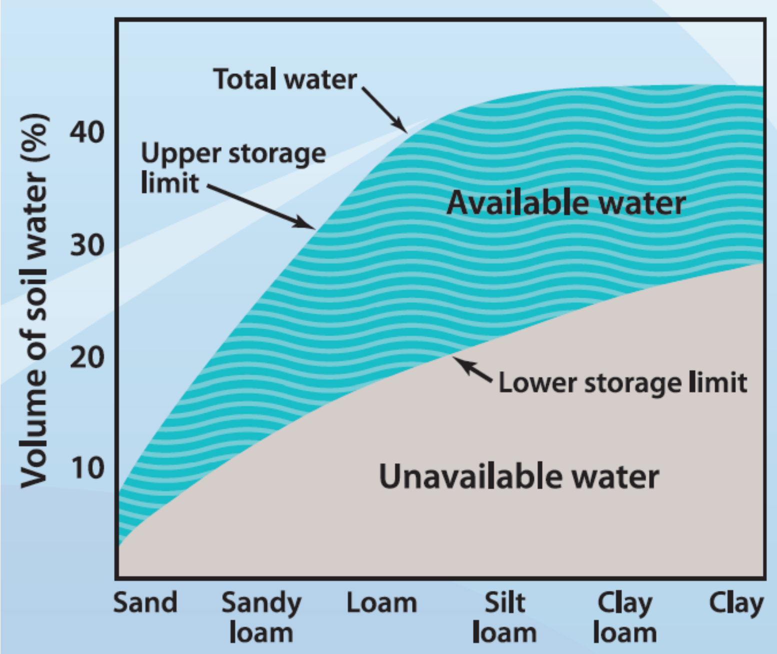
- There are a range of tests that can be conducted to determine the physical characteristics of soil/media, including **water availability**:

Test	Results	Improvements
Wait for a soaking rain and record how long until plants start to show signs of thirst	• If plants require more frequent watering than typical for your region, your soil is probably the culprit • Porous soil can better resist evaporation and adequately supply plants between waterings	• Claying sandy soils • Improving soil structure and removing barriers to plant growth to increase the area/depth of soil which plant roots may utilise for exploration • Deep ripping compacted subsoils • Liming to ameliorate soil acidity • Increase organic matter to improve water infiltration

Source: https://www.rodalesorganiclife.com/garden/10-easy-soil-tests; http://soilquality.org.au/factsheets/water-availability

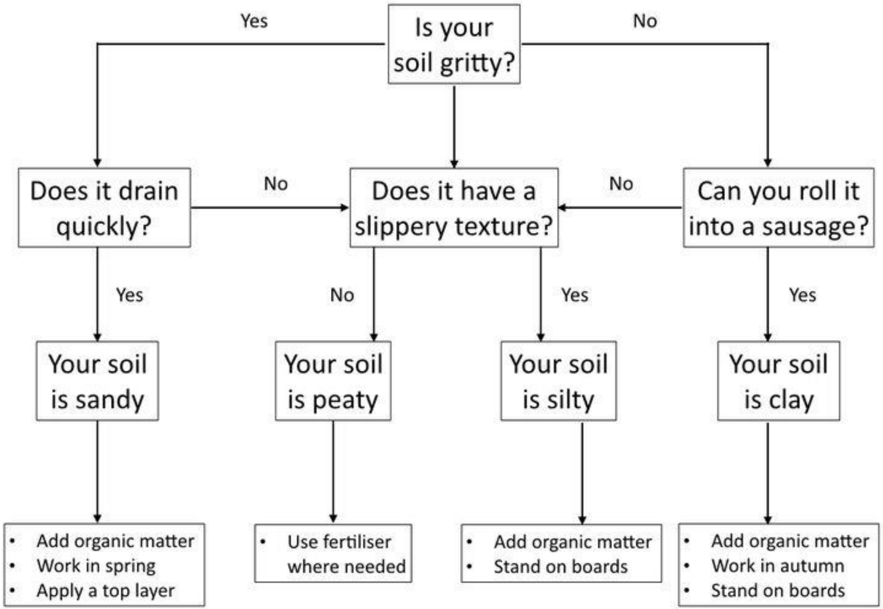
Physical characteristics of soil/media

- Refer to the graph shown to identify the relative amounts of water available and unavailable for plant growth in soils with textures from sand to clay



Physical characteristics of soil/media

- To identify soil types, you may refer to a reference chart for guidance
- An example reference chart that is shown to the right



Source: https://s-media-cache-ak0.pinimg.com/736x/78/a9/a9/78a9a98acc6313102bb95a9ec21a6f6c.jpg

Physical characteristics of soil/media

- There are a range of tests that can be conducted to determine the physical characteristics of soil/media, including **soil colour**:

Test	Results	Improvements
Observe soil colour. Colour can be a useful indicator of some of the general properties of a soil, as well as some of the chemical processes that are occurring beneath the surface.	• **Black:** High levels of organic matter. Waterlogging, low pH, high denitrification. • **White/pale/bleached:** Leaching of iron and manganese particles. Low water availability. • **Red:** Good drainage. Iron is oxidised more readily due to higher oxygen content. High phosphorous, low water availability. • **Yellow to yellow-brown:** Poorer drainage than red soils. Low water availability, compaction. • **Brown:** Moderate organic matter and iron oxides. Low to moderate water availability. • **Gleyed/grey/green:** Very poor drainage or waterlogging.	Address needs as required by soil colour (e.g. improving drainage of waterlogged soils)

Source: https://www.qld.gov.au/environment/land/soil/soil-properties/colour/

Physical characteristics of soil/media

- There are a range of tests that can be conducted to determine the physical characteristics of soil/media, including **topsoil depth**:

Test	Results	Improvements
• Take a sample of the soil profile • In dissected landscapes, you should check the depth of the topsoil on the crests, upper slopes, lower slopes and drainage depressions. • In level landscapes, you should check the topsoil depth every 100-150m, or when there are subtle changes in the landscape	*Recommended depths of topsoil* • 100-150mm: To create lawns from turf or seed • 150-200mm: Most general gardening planting • 150-200mm: Beans and zucchini • 200-300mm: Maintaining lawns and conserving soil moisture between sparse rain in South East Queensland • 300-400mm: Root vegetables	• If possible, increase soil depth using available topsoil already on site • Import quality new soil

Source: http://www.rolawn.co.uk/calculating-topsoil-requirements; http://www.qtpa.com.au/provisioning/combat-common-turf-grass-problems-with-improved-soil-depth/?COLLCC=2442405694

Chemical characteristics of soil/media

- When testing for the chemical characteristics of soil/media, the following may be considered:
  - pH
  - Salinity
  - Fertility

- These characteristics will help establish:
  - The suitability of the soil for particular plants
  - Whether fertiliser or other amendments are needed

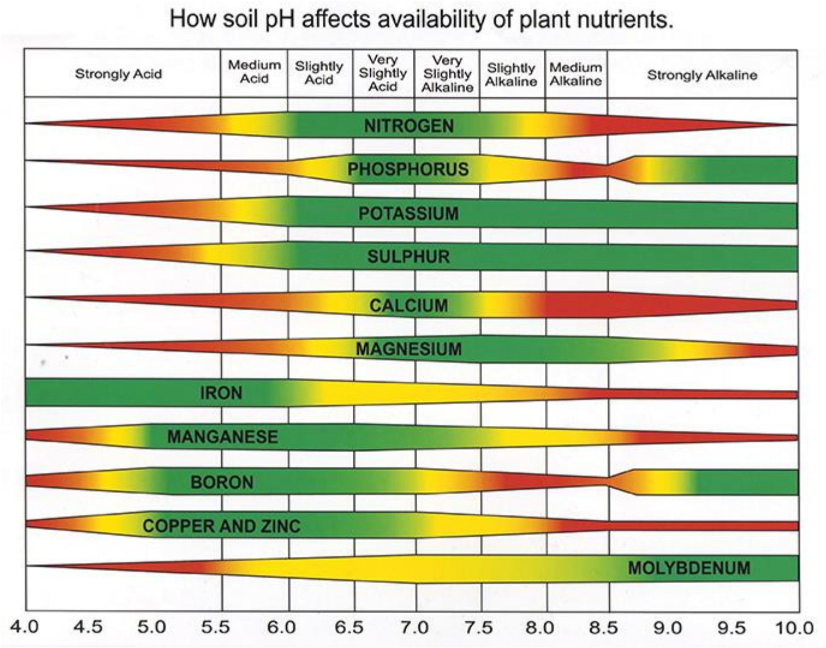
Chemical characteristics of soil/media

- Soil pH is a measure of the acidity or alkalinity in soils
  - You can test soil/media pH yourself using an over-the-counter kit or meter

1 Most acidic — 7 Neutral — 14 Most alkaline

- Soil pH affects plant nutrition
  - Having the correct soil pH is important for healthy plant growth
  - Soil pH affects the amount of a particular nutrient that can be taken up by plant roots

Chemical characteristics of soil/media



Chemical characteristics of soil/media

- Factors affecting pH include:

Acidic soils (less than 5.5 pH)	Alkaline soils (greater than 7.5 pH)
• Aluminium toxicity • Manganese toxicity • Calcium deficiency • Magnesium deficiency • Low levels of essential plant nutrients (e.g. phosphorus and molybdenum)	• Sodium toxicity (pH greater than 9) • Zinc deficiency • Copper deficiency • Boron deficiency • Manganese deficiency

Chemical characteristics of soil/media

- You can lower or raise soil pH using a range of products

Lower soil pH	Raise soil pH

• **Acidic fertiliser** (e.g. containing ammonium sufate, or sulphur-coated urea)
• **Elemental sulphur** (Flowers of sulphur), needs to be broken down by soil bacteria to be available for plant uptake
  • Apply at 35g/m^2 on soils with sandy structure
  • Apply at 100g/m^2 on clay soils
• **Manure** (i.e. cows, horses and sheep)
	• **Agricultural lime** (Calcium carbonate), a finely ground limestone which is untreated
	• **Hydrated/slaked lime** (Calcium hydroxide), which is more soluble and faster acting than agricultural lime
	• **Dolomite** (Calcium magnesium carbonate), which contains more magnesium than agricultural lime
	• **Quick lime** (Calcium oxide), but not for garden use
	• **Manure** (i.e. from poultry)

Chemical characteristics of soil/media

- Refer to a plant pH preference list

- An example list is shown to the right

pH 4.0-6.0	pH 5.0-6.5	pH 6.0-7.5	pH 5.0-7.5	pH 6.0-8.0
Potato	Apple	Apricot	Banana	Avocado
	Blackberry	Cherry	Rhubarb	Asparagus
	Cranberry	Grapevine	Strawberry	Ginger
	Gooseberry	Grapefruit	Raspberry	Leek
	Mango	Hazelnut	Carrot	Mint
	Melon	Hop	Cauliflower	Paprika
	Pineapple	Lemon	Sweet corn	Water cress
	Pomegranate	Lychee	Cucumber	
	Watermelon	Mulberry	Garlic	
	Basil	Nectarine	Lentil	
	Chicory	Peach	Parsley	
	Fennel	Plum	Pepper	
	Olive	Quince	Pumpkin	
	Peanut	Artichoke	Shallot	
	Sweet potato	Bean	Spearmint	
	Rice	Beetroot	Thyme	
	Rosemary	Broccoli	Tomato	
	Sage	Brussels sprouts	Turnip	
	Soybean	Cabbage		
		Calabrese		
		Celery		
		Chinese		
		Cabbage		
		Chives		
		Lettuce		
		Millet		
		Mushroom		
		Mustard		
		Onion		
		Pea		
		Peppermint		
		Radish		
		Spinach		

Chemical characteristics of soil/media

- Soil salinity is the salt content in the soil
  - Salinity from irrigation can occur over time wherever irrigation occurs, since almost all water (even natural rainfall) contains some dissolved salts
  - When the plants use the water, the salts are left behind in the soil and eventually begin to accumulate
  - Since soil salinity makes it more difficult for plants to absorb soil moisture, these salts must be leached out of the plant root zone by applying additional water
- Proper irrigation and drainage management can prevent salt accumulation by providing adequate drainage water to leach added salts from the soil

Chemical characteristics of soil/media

- Salinity is tested in the following way using an EC 1:5 test:
  - Take a soil sample and leave it to dry
  - Crush the dried sample so there are no large clods of soil
  - Add soil to water in a testing container
  - Shake the container to make sure the salts dissolve
  - Allow the solution to settle and place the salinity meter in the solution (but not in the soil at the bottom of the container)
  - Read and record the display once it has stabilised
  - Convert the salinity meter readings to soil salinity (EC_e) by multiplying the value of the Conversion Factor (which is based on the texture of the soil sample)

Chemical characteristics of soil/media

- To accurately test soil fertility, send your samples to a laboratory
  - This will enable you to determine the appropriate amounts of fertilisers to be added to your garden or turf
- Major and trace nutrients that may be tested for include:

Major	Trace
Nitrogen (N) Phosphorus (P) Potassium (K) Sulfur (S) Calcium (Ca) Magnesium (Mg)	Copper (Cu) Zinc (Zn) Boron (B) Manganese (Mn) Iron (Fe) Chlorine (Cl) Molybdenum (Mo) Sodium (Na) Cobalt (Co) Vanadium (V) Silicon (Si)

Chemical characteristics of soil/media

- Fertility is determined by whether there is an appropriate balance of nutrients in the soil. Major nutrients found in soil include:

Nutrient	Characteristics

Nitrogen (N)	• Essential for green growth – affects plant colour and lusciousness
	• Affects growth of roots and shoots
	• Provides strength against disease and weather (heat, cold and drought)
	• May be lost from soil:
	    • By leaching through the soil profile
	    • By removing grass clippings
	    • Into the air as ammonia gas (volatilisation) or nitrate gas (denitrification)

Phosphorus (P)	• Essential for root development • Affects the maturation of plants (i.e. avoids stunted growth) • Affects the branching of turf • Deficiency is more prevalent in sandy soils
Potassium (K)	• Essential for flower development • Essential for fruit development • Affects the ability of plants to withstand wear, drought, disease and stress

- Early signs of nutrient issues can be observed through effects on plants. For example:

Nutrient	Toxicity	Deficiency	Treating deficiency
Nitrogen	• Increased disease susceptibility • Reduced root system • Leaves dry and fall off • Fruit and flowers are inhibited or deformed	• General chlorosis of older leaves (i.e. entire leaf changing from green to yellow) • Plant is stunted and wilts in normal weather • Slow and thin turf growth	• Ammonium fertiliser (e.g. ammonium nitrate, urea, ammonium sulphate, ammonium phosphate) • Bone meal • Poultry manure • Fish emulsion

Chemical characteristics of soil/media

- Early signs of nutrient issues can be observed through effects on plants. For example:

Nutrient	Toxicity	Deficiency	Treating deficiency
Phosphorus	• Weeds increase in high-phosphorus soils	• Plants have small, thin stems • Reduced flowers • Failure to produce fruits • Older leaves shed easily • Older leaves turn dark green, purple and then a reddish purple	• Rock phosphate • Fish emulsion • Poultry manure

Chemical characteristics of soil/media

- Early signs of nutrient issues can be observed through effects on plants. For example:

Nutrient	Toxicity	Deficiency	Treating deficiency
Potassium	• May result in burning of turf	• Deformed, stunted leaves • Weak stems • Fruits drop prematurely • Poorly developed roots • Older leaves become a lighter green colour with scorched edges • Young leaves show interveinal chlorosis (i.e. yellowing between veins)	• Potassium fertiliser (e.g. potassium chloride, potassium nitrate, potassium sulfate, monopotassium phosphate) • Potash • Banana peel

Chemical characteristics of soil/media

- Things to consider when selecting a fertiliser to address nutrient issues:
  - The plant species
    - Grass plants require fertiliser with high nitrogen content
    - Rooting plants require phosphatic fertiliser with some added sulphur
    - Fruiting plants require compound fertiliser with potassium
  - The type of soil/media
    - If the soil does not readily absorb water, you should apply a liquid fertiliser that has a wetting agent or a water storage crystal or gel
  - The form of the fertiliser
    - Granular fertilisers do not act as quickly as fertilisers in soluble form
  - Percentage of nutrients within the fertiliser:
    - Low-analysis: Lower percentage of nutrients
    - High-analysis: Higher percentage of nutrients
  - Salt index
    - The measure of salt concentration the fertiliser induces in the soil

Chemical characteristics of soil/media

- The chemical characteristics of soil/media will determine its suitability for particular plants.
- For example:

Plant	Soil type	Acidic soils	Alkaline soils	Neutral soils
Camellia	Clay and silt	✓		✓
Hydrangea	Clay and silt	✓		✓
Rosemary	Sandy	✓	✓	✓
Sage	Sandy	✓	✓	✓
Thyme	Sandy		✓	✓
Weigela	Clay and silt	✓	✓	✓

Source: http://www.thompson-morgan.com/plants-for-soil-types

Preparing soils

- Soil/media affects plants in a range of different ways:
  - If a soil has a hard B horizon, roots may have limited depth
  - Large changes in pH at a certain depth may restrict root growth
  - High salinity levels at depth will restrict root growth and/or performance

- To prepare soils for planting or replanting:
  - Improve the physical and chemical characteristics of the garden or lawn area as required
  - Incorporate additional soil, as needed to establish final levels
  - Finish soil level and consolidate as per planting plants and enterprise procedures

Preparing soils

- Common ameliorants/additives:
  - Lime
  - Gypsum
  - Blood and bone / organic matter
  - Epsom salt

Activity: Research what each of the listed ameliorants/additives addresses

- Other tips include:
  - Adding iron sulphate (or rusty nails) to change colour of hydrangea flowers
  - Adding wood ashes to increase pH
  - Adding home-composted leaf and vegetable refuse or coffee grounds to lower pH