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Bed Preparation and Fertilization Recommendations for Bedding Plants in the Landscape

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For healthy, aesthetic plants, the soil must serve as a reservoir for water, oxygen, and nutrients. While this sounds very straightforward, providing these three essentials can be quite challenging. The first step in evaluating a soil for bedding plants is to examine water retention and aeration characteristics. Both water and oxygen are required for plant growth, the challenge is maintaining a proper balance between the two.

Soil Texture

Soil consists of solid particles (sand, silt and clay) and pores (spaces for air and water). Coarse-textured soils (sandy) have good drainage and plenty of oxygen but retain little water. The opposite is true for fine-textured soils (clay) where drainage and aeration are poor, but water is plentiful. The texture will determine whether maintaining water or oxygen will be your biggest problem. In clay soils, providing enough aeration will be your biggest concern. On the other hand, maintaining enough water will be your biggest challenge for sandy soils.

Soil Amendments

Both of these problems can be improved by amending the soil. Properly amended clay soils will have adequate drainage to supply both water and oxygen. The best amendments for clay soils are pine bark humus (< 1/2" in diameter), composted leaf mold, or small pea gravel (< 3/8"). Be careful when selecting leaf mold, and make certain that the material is fully composted and not merely "aged." Decomposing materials will compete with plants for nutrients, especially nitrogen and sulfur, resulting in nutrient deficiencies and poor plant growth.

Peat moss, sand, hardwood bark, sawdust, wood chips and pine straw are not recommended for clay soils. Addition of these materials will not adequately improve the physical properties of a clay soil. Amendments to clay soils must be incorporated to at least 25% by volume to be effective. For example, to result in approximately 8 inches of amended soil, a minimum of 2 inches of the amendment should be incorporated into the top 6 inches of soil. This also helps raise the bed which will not only improve drainage but will also make bedding plants look more attractive. Incorporating up to 50% by volume will probably improve plant growth. Incorporating over 50% may have a negative effect on plant growth, while incorporating less than 25% by volume is a waste of time and material.

Amendments such as pine bark humus, composted leaf mold, or peat moss will improve water retention in sandy soils. Similar to clay soils, these amendments need to be added at a minimum of 25% by volume and a maximum of 50%.

Water Infiltration and Irrigation Calculations

Infiltration is the rate of water movement into the soil. Typical infiltration rates for four soil types are listed in Table 1. This table provides a rough idea of the rate you can use for your irrigation system before water begins to run off instead of being absorbed by the soil. These rates should not be exceeded as the extra water drains off and is wasted. Clay soils have infiltration rates that are 4 to 20 times slower than sands. Of course, this will change after amendment, but a sandy soil will always have a higher rate of infiltration compared to clay.

A second important issue concerning irrigation is how long it takes for the water to drain from the soil, allowing oxygen to return. Without adequate drainage between irrigations, there will be little oxygen in the soil. A clay soil will take longer to drain and re-aerate than a sandy soil. Bedding plants grown in a clay soil that has been properly watered may not have to be watered more than once a week. This will vary with time of year, sun or shade, plant growth, and other environmental factors. However, bedding plants grown in a sandy soil may have to be watered 2 to 3 times a week. Subsoil compaction or the presence of a hard pan beneath the bed can also affect water drainage and soil aeration. It may be necessary to deep till beds to break up the subsoil and increase drainage rate.

Table 1. Typical infiltration rates for 4 common soil types.

Soil type	Infiltration rate (inches/hour)
Sands	> 0.8
Sandy & silty soils	0.4 to 0.8
Loams	0.2 to 0.4
Clay soils	0.04 to 0.2

Bedding Plant Nutrition

Compared to woody plants, bedding plants have very limited root systems so it is critical that nutrients (excluding nitrogen) be distributed uniformly throughout the soil. This requires planning prior to bed preparation to determine what nutrients are needed and in what quantity.

A soil test is the only way to determine if phosphorus, potassium, calcium, or magnesium must be added or if a pH adjustment is needed. Without a soil test, any application of fertilizer could be detrimental to the landscape. Overapplication or application of unneeded materials could result in salt injury to plants, cause nutrient imbalances unsuitable for plant growth, and is environmentally unsound. Contact your county extension agent for soil sampling boxes and proper sampling procedures. Soil samples should be taken after amendments to improve aeration and/or drainage have been incorporated into the beds. If test results indicate nutrient or pH adjustments are needed, follow the application recommendations given below.

Phosphorus and **calcium** move very slowly through the soil profile so to be most effective they should be incorporated into the top 6 to 10 inches. These elements can be surface applied but the nutrients will not be as readily available to the plants and will be less effective. It is impossible to tell how much calcium and phosphorus are required without a soil test. However, because most North Carolina soils are low in phosphorus, it is usually safe to add 1 to 2 lbs of P_2O_5 per 1000 ft^2. For soil incorporation of phosphorus, triple superphosphate (0-46-0) is recommended. For 1 to 2 lbs of P_2O_5, incorporate 2 to 4 lbs of triple superphosphate per 1000 ft^2 of bed area. Diammonium phosphate (18-46-0 or 16-48-0) is the most soluble phosphorus source and should be used if phosphorus is applied to the surface. For 1 to 2 lbs P_2O_5, apply 2 to 4 lbs of diammonium phosphate per 1000 ft^2 of bed area. This will also supply 0.4 to 0.8 lbs of nitrogen per 1000 ft^2.

Guessing at the amount of calcium to apply without a soil test is inadvisable, for two reasons. First, it is possible to get too much calcium in the soil which can lead to potassium and magnesium deficiency, and second, many sources of calcium

such as calcitic and dolomitic limestone raise soil pH. A high pH can cause many other problems such as making some nutrients unavailable to plants. If calcium is low but a pH change is undesirable, gypsum ($CaSO_4 \cdot 2H_2O$) can be incorporated into the soil prior to planting. A soil test is the best way to make fertilizer applications most cost-efficient.

Magnesium may be deficient, especially in low pH soils. If magnesium levels and soil pH are low, dolomitic limestone can be used to raise the pH and supply the needed magnesium. To add magnesium without affecting the pH, Epsom salts ($MgSO_4 \cdot 7H_2O$) can be applied, either as a soil incorporation or as a soil drench. A soil incorporation of granular Epsom salts is the method of choice for application during bed preparation, while a soil drench with an Epsom salt solution is used if magnesium is needed and plants are already in place. If magnesium is needed, the general rate for Epsom salts is 10 lbs per 1000 ft^2 of bed area for dry application or 4 lbs per 100 gallons of water for a soil drench applied at 250 gallons per 1000 ft^2 of bed area (1 quart per square foot of bed area).

The soil **pH** for bedding plants should be between 5.5 and 6.5. An approximate pH can be determined on site by using a portable pH meter. Mix one volume of soil with two volumes of distilled water, stir, allow to stand for 30 minutes, then read the pH. As with soil testing for fertilizer needs, amendments to improve aeration and/or drainage should be applied prior to testing soil pH. Table 2 presents some approximate amounts of ground limestone needed to increase the pH of five soil types. These values are only representative and should not be taken as recommendations. Limestone should be incorporated into the upper 7 inches of the bed for effective pH adjustment. If the pH must be lowered, elemental sulfur can be incorporated into the soil (Table 3). If only a small decrease in pH is required, acid-forming fertilizers such as ammonium nitrate can be used as a nitrogen source (Table 4).

Table 2. Approximate amount of ground limestone needed to increase the pH of the upper 7 inches of 5 soil types to 6.5.

	pH Range			
	4.5 to 4.9	5.0 to 5.4	5.5 to 5.9	6.0 to 6.4
Soil texture (upper 7 inches)	Lime to apply (lbs/1000 square feet)			
Sand	115	92	69	23
Loamy sand	138	115	92	46
Sandy loam	184	138	115	69
Clay loam and loam	230	184	138	92
Clay and silty clay	270	230	184	92

Lime recommendations are based on using a ground limestone with a neutralizing value of 90%.

Table 3. Approximate amount of ground sulfur needed to decrease the pH of the soil to 6.5.

	pH Range			
	7.0 to 7.5	7.6 to 8.0	8.1 to 8.5	8.6 to 9.0
Soil texture	Sulfur to apply (lb/1000 square feet)			
Sandy soils	9–13	22–34	34–45	45–68
Clay soils	18–22	34–45	34–45	---

Sulfur recommendations are based on using a ground sulfur material containing 95% S.

Potassium can be surface applied, if needed. If soil test results are not available, then a rule of thumb is to apply 1 to 3 lbs K_2O per 1000 ft^2. However, it is possible to over apply potassium which can lead to deficiencies of other nutrients, particularly magnesium. To apply 1 to 3 lbs K_2O, use 1.7 to 5 lbs of muriate of potash (potassium chloride), 2.3 to 6.8 lbs of potassium nitrate, or 2.1 to 6.3 lbs of potassium sulfate per 1000 ft^2. Muriate of potash has a salt index of 114 which is very high and should be used with caution.

Both potassium nitrate and potassium sulfate have a lower salt index, indicating that they are less likely to increase soil salt levels. The potassium nitrate at this rate will also supply 0.3 to 0.9 lbs N per 1000 ft^2.

Nitrogen is the nutrient that most frequently limits plant growth, and is often the only nutritional element that accelerates the growth of ornamental plants. Unfortunately, nitrogen is also the most difficult nutrient to manage. Unlike other nutrients, it is not possible to accurately determine from a soil test how much nitrogen is required. The challenge is to maintain adequate nitrogen levels to meet the plant requirements without damaging the plants. Surface application is not only the most cost effective method of nitrogen application but it is also the most efficient in getting the nutrient into the plant.

Nitrogen can be supplied with two different approaches and both work very well. Nitrogen can be applied in a ① water soluble form which includes liquid feed and granular fertilizers (Table 4) or ② slow release forms. If using a water soluble fertilizer, apply it every 4 to 8 weeks throughout the bedding plant season, applying a total of no more than 4 to 6 lbs N per 1000 ft^2 during the growing season. If using liquid feed, apply every 1 to 4 weeks, using 1 quart per ft^2 of bed area. With slow release fertilizers, applications should be divided into two applications. The first application should be incorporated into the bed just before planting and the second should be broadcast over the bed midway through the growing season. If using a slow release fertilizer as a nitrogen source that contains P and K as well, additional application of P and K may not be needed. The seasonal total application of slow release fertilizer should not exceed 4 to 6 lbs N per 1000 ft^2 of bed area.

In summary, preparing and managing landscape beds for bedding plant use can be broken down into the following steps:

❶ Determine the soil texture.

❷ Determine the amendment needs and add amendments, if needed for drainage and aeration.

❸ Take a soil test to determine soil nutrient and pH needs after adding drainage and aeration amendments.

❹ Incorporate recommended fertilizer and/or liming material.

❺ Manage water and nitrogen during the growing season.

Table 4. Suggested nitrogen sources, application methods, intervals between applications and application rates for bedding plants in the landscape.

		Applied as a dry material broadcast uniformly over the bed surface Weeks between applications (number of applications per season)			Applied as a liquid feed using 1 quart per square foot of bed area at each application Weeks between applications (number of applications per season)		
		4 wks (5 apps.)	6 wks (3 apps.)	8 wks (2 apps.)	1 wk (18 apps.)	2 wks (9 apps.)	4 wks (5 apps.)
Nitrogen source	Effect on soil pH	lbs/1000 sq.ft. to apply at each app.			lbs/100 gallons of solution		
Ammonium nitrate (33.5-0-0)	moderately acidic	2 lbs 6 oz	4 lbs	6 lbs	4.5 oz	9 oz	1 lb
Ammonium sulfate (20-0-0)	very acidic	4 lbs	6 lbs 11 oz	10 lbs	7 oz	14 oz	1 lb 10 oz
Calcium nitrate (15.5-0-0)	moderately basic	5 lbs 3 oz	8 lbs 10 oz	12 lbs 14 oz	9 oz	1 lb 2 oz	2 lbs 1 oz
Potassium nitrate (13-0-44)	slightly basic	6 lbs 2 oz	10 lbs 4 oz	15 lbs 6 oz	11 oz	1 lb 6 oz	2 lbs 7 oz

Nitrogen recommendations are based on delivering a seasonal total of approximately 4 lbs N/1000 sq. ft. of bed area.