

Table 1. Nitrogen requirement for vegetable crops (lb/1000 ft<sup>2</sup>)<sup>a</sup> based on seasonal nitrogen uptake (adapted from Gaskell et al. 2007).

Low: 3 lb/1000 ft <sup>2</sup>	Med: 4 lb/1000 ft <sup>2</sup>	High: 5 lb/1000 ft <sup>2</sup>
Baby greens	Carrot	Broccoli
Bean	Corn, sweet	Cabbage
Cucumber	Garlic	Cauliflower
Radish	Lettuce	Celery
Spinach	Melon	Potato
Squash	Onion	
	Pepper	
	Tomato	

<sup>a</sup>Multiply values by 44 to approximate the conversion of lb/1000 ft<sup>2</sup> to lb/acre.

impractical for gardeners who may grow different crops in a single planting bed. Gardeners in this situation can use the information in Table 1, which is grouped by crop based on its nitrogen requirement. For companion planting, fertilize at the rate designated for the crop with the highest nutrient demand. This rate will provide sufficient nutrients for both crops.

### Soil Nutrients in the Environment

Soil and water are intimately connected in the environment. Water transports nutrients and agricultural chemicals in solution, as well as sediments, all of which can degrade the water quality of lakes, streams, rivers, and estuaries. Nitrogen and phosphorus are essential elements for plant growth and yield, but when they are present in water at high levels, they become an environmental hazard, especially in terms of drinking water, aquatic organisms, and aquatic recreation. Water bodies that have excess levels of these nutrients experience increased growth of aquatic plants, as well as an increase in other photosynthetic organisms (especially algae and cyanobacteria, a photosynthetic blue-green algae). Fish and other aquatic organisms suffer because decomposing plants reduce the oxygen availability in water, a process known as eutrophication (Figure 3).

When water containing chemicals and sediment infiltrates the soil, some of these materials are adsorbed



Figure 3. Eutrophication of water bodies can lead to cyanobacteria and algae blooms (a rapid increase in the population of algae). Photo by Gene Williams, Snohomish County Surface Water Management.

and thus reduced. Soil microorganisms and plant roots also help reduce nutrient and chemical loads. However, poorly managed soils can contribute to an excessive nutrient load in rivers and streams. Additionally, soils on sloping terrain are subject to erosion, allowing soil and nutrients to move into nearby streams, lakes, and rivers. Soils in wetter environments can lose nutrients, especially nitrogen, through leaching (loss of water-soluble plant nutrients from the soil due to rain and/or irrigation). Groundwater contamination reduces drinking water and irrigation water quality, and because ground water and surface water are often linked, leaching can also increase eutrophication of surface water.

Selecting the right fertilizers requires attention to soil nutrient excesses, as well as nutrient deficiencies. For example, repeatedly using manures or other high phosphorus organic fertilizers may lead to excessive levels of soil phosphorus. A soil test will indicate whether there is excess phosphorus in the soil. If so, fertility planning should include the reduction or elimination of high phosphorus fertilizers.

Nitrogen can also be lost from the soil system in the form of ammonia or nitrous oxide gas. Not only could these losses be financially unproductive, but nitrous oxide is also a greenhouse gas and contributes to global warming. Ammonia losses occur when ammonia-rich fertilizers, such as fresh cow manure, are left on the soil surface. Turning (incorporating) these materials back into the soil immediately will reduce ammonia loss. Nitrous oxide losses occur when abundant nitrogen is available and soils become waterlogged.

### Organic Soil Amendments as Nutrient Sources and Soil Builders

#### Cover Crops

Cover crops can improve soil quality and/or compete with weeds. When incorporated into the soil as a green manure, cover crops may increase soil organic matter content and soil tilth. In wet climates, such as western Washington or Oregon, winter cover crops reduce nutrient loss by taking up excess nutrients from the soil before winter rains wash (leach) them away. The