

New Lawns and Turf

Nitrogen Recommendations

An initial nitrogen (N) application of 0.5 lb. N/1000 sq. ft. (22 lb./acre) is recommended at the time of establishment for a new home lawn or commercial turfgrass area. If the grass is established from seed, incorporate N fertilizer into the surface $\frac{1}{2}$ to 1 inch of soil. Either mix it into the soil along with the seed or till it in just before planting. If the grass is established from sod, N fertilizer should be applied over the sod the day after it is laid and watered in lightly. Sod is watered heavily immediately after it is laid, so it is important to delay fertilization or the N will be leached below the root zone.

An additional 0.5 lb. N/1000 sq. ft. (22 lb./acre) should be applied 2 weeks after seedling emergence or sodding and watered in. After this, the rates and timing of N fertilization are based on the cultural practices that are used, and recommendations for established lawns and turf in **Tables 13 and 14** should be followed.

Phosphorus and Potassium Recommendations

Phosphorus (P) and potassium (K) fertilizer recommendations for a new lawn or turf are given in **Tables 11 and 12**. After preparing the site and testing the soil, broadcast the recommended amounts of P and K and incorporate the fertilizer into the top 4 to 6 inches of soil.

Phosphorus and K applications before planting are very important, because both elements are relatively immobile in most soils. Topdress applications following establishment will move very slowly through the soil, so it will be difficult to make substantial changes in P and K fertility levels after the grass is planted. Soil preparation before seeding or sodding offers an opportunity to make basic P and K applications by placing these nutrients in the plant root zone. Establishment of turf is usually quicker with adequate P in the root zone. Current law allows application of P fertilizer to turf during the establishment year. Soil tests for P and K are especially important before planting, because they permit an accurate assessment of fertilizer needs.

Potassium will leach through coarse-textured soils, so sands, loamy sands, and artificially prepared sandy mixtures such as those used in constructing golf course greens should receive no more than 2 lb. K_2O /1000 sq. ft. (85 lb./acre) prior to seeding or sodding. If the K soil test is low and the recommendation calls for a higher rate, apply the remainder as part of the regular fertilization program after establishment. On sandy mixes and sandy soils, K fertilizer should be surface applied at no more than 1 lb. K_2O per 1000 square feet per application.

Table 11. Phosphorus recommendations for a new lawn or turfgrass area before seeding or sodding

Phosphorus (P) Soil test level		Amount of phosphate (P ₂ O ₅) to apply*
----- ppm -----		lb. P ₂ O ₅ /1000 sq.ft.
Bray-P1	Olsen-P	
0-10	0-7	5
11-25	8-18	2
over 25	over 18	1

*Multiply by 44 to convert the rates in lb./1000 sq. ft. to lb./acre.

Table 12. Potassium recommendations for a new lawn or turfgrass area before seeding or sodding.

Potassium (K) Soil test level	Amount of potash (K ₂ O) to apply*
----- ppm -----	lb. K ₂ O/1000 sq.ft.
0-50	6**
51-100	4**
101-150	2
over 150	0

*Multiply by 44 to convert the rates in lb./1000 sq. ft. to lb./acre.

**On sandy soils incorporate only 2 lb. K₂O/1000 sq. ft. prior to seeding or sodding and fertilize regularly with fertilizer containing potassium after establishment.

Established Lawns and Turf Nitrogen Recommendations

Nitrogen (N) fertilizer recommendations for established lawn and turfgrass areas are based on the organic matter content of the soil and the management practices that are followed in maintaining the turf (Table 13). Nitrogen is gradually released from decomposing organic matter during the growing season, so less fertilizer N is required as soil organic matter levels increase. A well-watered lawn grows more vigorously and requires more N than one that is not watered and goes dormant in mid-summer. Removal of grass clippings also increases N needs. Clippings left on the lawn gradually decompose over a 3- to 4-week period and the nutrients in them are recycled, reducing the need for fertilizer by about 1 lb. N/1000 sq. ft. per year.

When using fertilizers containing quickly available forms of N, no more than 1 lb. N/1000 sq. ft. should be applied at any one time. Higher rates can burn the grass. They are also inefficient and pose

a potential pollution problem, because not all of the N can be immediately utilized and it may leach through the soil and out of the plant root zone. Fertilizers containing slow-release forms of N can be applied at a rate of up to 2 lb. N/1000 sq. ft. and the number of applications reduced. When using slow-release fertilizers, be sure to follow manufacturers' recommendations as in some cases only a small portion of the N is in the slow-release form.

Late summer and fall are the best times of the year to fertilize lawns. This is contrary to the traditional springtime application of lawn fertilizer, but applying the majority of the fertilizer in the late summer or fall produces healthier lawns by improving the balance between root and shoot growth. Early spring applications of N can stimulate shoot growth that depletes stored energy reserves in plant roots. When summer stress periods occur, the plants are weaker and less able to survive. Late summer and fall fertilization lengthens the period that the turf remains green in the fall, results in earlier green-up in the spring without stimulating excessive shoot growth, results in higher stored energy reserves during the spring and summer, and reduces the incidence of some of the summer diseases.

The optimum timing of N fertilizer applications is shown in **Table 14**. The potential for fertilizer burn is greater at high temperatures and if the grass is wet at the time of application. Fertilization with quick-release nutrients should be avoided at temperatures greater than 85° F. Use a mechanical spreader for uniform application. For the drop type spreaders, apply the fertilizer in two directions. In most situations, turf should be watered immediately following fertilizer application to wash the fertilizer off the leaves and into the soil. For fertilizer containing an herbicide, follow label instructions for watering. Fall applications should be made when soil temperatures are still warm enough (above 40° F at the 2-inch depth) for N absorption by roots and when shoot growth has stopped, usually from early September to mid-October.

Never apply fertilizer to frozen ground because surface runoff can contribute to water pollution problems. Immediately clean up any fertilizer that spills over onto sidewalks or streets during application or it will be washed into storm sewers and contribute to environmental problems.

Phosphorus Recommendations

Application of Phosphorus (P) fertilizer to established turf in Minnesota is regulated by state law. Unless a soil test indicates a need, P fertilizer cannot be applied to established turf. Phosphorus recommendations for established lawn and turf are based on P soil test levels and are presented in **Table 15**.

For low-testing soils requiring P, the best time to apply P fertilizer is following core aeration of the turf for thatch control in late summer or early autumn. In this way, immobile P is applied or washed into the bottom of the holes made by the coring machine and placed in the vicinity of plant roots. Phosphorus moves very little in soil and becomes bound to soil particles.

If soils test above 25 ppm Bray P or 18 ppm Olsen P, a fertilizer grade without P should be used (middle number on the bag should be 0).

Potassium Recommendations

Potassium (K) recommendations for established lawn and turf are based on K soil test levels and the management practices that are followed in maintaining the turf (**Table 16**). Recommendations are also modified for sandy soils, where K moves readily, compared to finer-textured soils where K is relatively immobile.

As with N, regular irrigation increases K requirements by increasing growth and the removal of grass clippings increases K requirements by removing K that could be reused in future growth. No more than 1 lb. K_2O /1000 sq. ft. should be applied at any one time. Higher rates can burn the grass, especially when applied as a complete fertilizer that also contains N.

If the soil is a sand or loamy sand, the recommended annual rate of K_2O should be divided into split applications to prevent K deficiency due to leaching beyond the root zone. Regular K_2O applications can be made in combination with N according to the schedule for N fertilization in **Table 14**. On finer-textured soils such as loams, silt loams, and clay loams, K does not move readily through the soil and the most effective method of application is to fertilize following soil coring as described above for P.

Table 13. Annual nitrogen recommendations for an established lawn or turfgrass area

Maintenance Practices	Soil organic matter level ¹		
	Low	Medium to high	Organic soil
	Amount of nitrogen (N) to apply ^{2,3} ----- lb. N/1000 sq. ft. -----		
Regular irrigation			
Clippings removed	4.0	3.0	2.00
Clippings not removed	3.0	2.0	1.00
No irrigation			
Clippings removed	2.0	1.0	0.50
Clippings not removed	1.0	0.5	0.25

¹Low organic matter = less than 3.1%, medium to high = 3.1 to 19%, organic soil = greater than 19% organic matter.

²Multiply by 44 to convert the rates in lb./1000 sq. ft. to lb./acre.

³Apply no more than 1 lb. of quick-release N/1000 sq. ft. in a single application.

Table 14. Timing of annual nitrogen fertilizer applications to established lawn or turfgrass; apply no more than 1 lb. of quick-release nitrogen/1000 sq. ft. in a single application

Number of Applications Required	Optimum timing of applications
1	early Sept.
2	mid- to late Aug.// mid-Oct.
3	May or June // mid- to late Aug. // mid-Oct.
4	May or June // Aug. // Sept. // mid-Oct.

Table 15. Annual phosphorus recommendations for an established lawn or turfgrass area

Phosphorus (P) Soil test level		Amount of phosphate (P ₂ O ₅) to apply*
----- ppm -----		lb. P ₂ O ₅ /1000 sq.ft.
Bray-P1	Olsen-P	
0-10	0-7	1.0
11-25	8-18	0.5
over 25	over 18	0.0

*Multiply by 44 to convert the rates in lb./1000 sq. ft. to lb./acre.

Table 16. Annual potassium recommendations for established lawn and turfgrass

Potassium (K) Soil test level	Maintenance practices			
	Regular irrigation		No irrigation	
	Clippings Removed	Clippings Not removed	Clippings Removed	Clippings Not removed
	Amount of potash (K ₂ O) to apply ^{1,2,3}			
----- ppm -----	----- lb. K ₂ O/1000 sq. ft. -----			
0-50	4	3	3	2.0
51-100	3	2	2	1.0
101-150	2	1	1	0.5
over 150	0	0	0	0.0

¹Multiply by 44 to convert the rate from lb./1000 sq ft to lb./acre.

²Apply no more than 1 lb. K₂O/1000 sq. ft. in a single application.

³On sandy soils the recommended rate should be divided into split applications made on a regular basis.

Cultured Sod Production

Basic P and K fertilizer recommendations and management practices for cultured sod production are similar to those given for other turf-grass areas in the preceding two sections and **Tables 11, 12, 15, and 16**. *Note: cultured sod production is exempt from the phosphorus law because it is considered to be an agricultural crop.* The only other difference is that maximum sod production, under high levels of management, will require higher levels of N fertilization following establishment. Suggested N fertilizer management for cultured sod seeded in late summer or early fall is presented in **Table 17**.

Table 17. Nitrogen fertilizer recommendations for cultured sod seeded in late summer or early fall

Timing of application	Soil organic matter level ¹		
	Low	Medium to high	Organic soil ²
	Amount of nitrogen (N) to apply ³		
	----- lb. N/A -----		
seeding	20	20	20
first mowing	30	25	20
early-mid October	30	25	20
late May	30	25	20
June	30	25	20
August	20	20	20

¹Low organic matter = less than 3.1%, medium to high = 3.1 to 19%, organic soil = greater than 19% organic matter.

²Lower rates of N may be used on organic soils not previously used for sod or crop production

³Irrigated fields may require 1 to 2 additional applications between May and August to sustain growth.

Secondary Macronutrients for Commercial Turfgrass and Cultured Sod Production

Calcium Recommendations

Calcium (Ca) deficiency due to low soil Ca is rare, but may occur on acid, sandy soils. Calcium is generally not deficient in Minnesota soils when soil pH is 5.5 or above. If soil pH is less than 5.5, use lime to add Ca at the rates recommended in **Table 1**.

Magnesium Recommendations

Magnesium (Mg) deficiency may occur on acid, sandy soils or be induced by high rates of potassium fertilizer on sandy soils that are already low in Mg. Recommended rates of Mg based on a soil test are given in **Table 18**. If soil pH is low and liming is recommended, the use of dolomitic limestone will supply Mg.

Sulfur Recommendations

Sulfur (S) deficiency is most common on sandy soils that are low in organic matter. Sulfur recommendations based on a soil test are given in **Table 19**. The S soil test is only accurate for low or medium organic matter soils (less than 4.6% organic matter).

Table 18. Magnesium recommendations for new and established turfgrass

Magnesium (Mg) Soil test level	Amount of magnesium (Mg) to apply*
----- ppm -----	lb. Mg/1000 sq.ft.
0-50	1
over 50	0

*Multiply by 44 to convert the rates in lb./1000 sq. ft. to lb./acre.

Table 19. Sulfur recommendations for new and established turfgrass

Sulfur (S) Soil test level ¹	Amount of Sulfur (S) to apply ²
----- ppm -----	lb. S/1000 sq.ft.
0-6	0.5
over 6	0.0

¹The sulfur soil test is reliable only for low or medium organic matter soils (less than 4.6% organic matter)

²Multiply by 44 to convert the rates in lb./1000 sq. ft. to lb./acre.

Micronutrients for Commercial Turfgrass and Cultured Sod Production

Boron Recommendations

Response by turfgrass to boron (B) has not been reported in Minnesota; therefore, none is recommended. Excessive applications of boron can be toxic to turfgrass, causing dieback of the shoots.

Copper Recommendations

Response by turfgrass to copper (Cu) on mineral soils has not been reported in Minnesota; therefore, none is recommended.

Copper deficiency, characterized by shoot dieback, is most likely on organic soils and Cu recommendations based on a soil test are given in **Table 20**. The Cu soil test is reliable only for organic soils. Copper can be applied to the soil or directly to plants as a foliar spray. Applications of Cu are suggested on a trial basis only.

Iron Recommendations

Soil test results for iron (Fe) are not reliable for predicting Fe fertilizer needs. Iron availability is related more to soil pH than it is to soil test Fe levels. If soil pH is greater than 7.2 and chlorosis is observed, a short term “greening” response in turfgrass may be obtained with foliar Fe applications. Apply 0.2 oz. Fe/1000 sq. ft. (0.55 lb. Fe/acre) as a foliar spray.

Manganese Recommendations

Soil test results for manganese (Mn) are not reliable for predicting Mn fertilizer needs. As with iron, Mn availability is related more to soil pH than it is to soil test Mn levels. Deficiencies, characterized by shoot yellowing, are possible on mineral soils with a pH greater than 7.2 and organic soils with a pH greater than 5.8. If Mn deficiency is suspected, apply 0.1 to 0.2 oz. Mn/1000 sq. ft. (0.25 to 0.55 lb. Mn/acre) as a foliar spray.

Zinc Recommendations

Zinc (Zn) deficiency can occur on alkaline soils and sandy soils low in organic matter. High levels of phosphorus coupled with low levels of soil Zn may induce Zn deficiency. Zinc recommendations based on a soil test are given in **Table 21**. Zinc can be applied to the soil or as a foliar spray.

Table 20. Copper recommendations for both new and established turfgrass areas (for organic soils only)¹

Copper (Cu) Soil test level	Application method	
	Soil Broadcast	Foliar Spray ²
-- ppm --	Amount of Cu to apply/1000 sq. ft. ³	
	-- lb. Cu --	-- oz. Cu --
0-2.5	0.1-0.3	0.4
over 2.5	0.0	0.0

¹Applications are suggested on a trial basis only.

²Apply foliar sprays at the recommended rate 2 to 3 times per year.

³Multiply by 44 to convert the rate from lb./1000 sq. ft. to lb./acre; multiply by 2.7 to convert from oz./1000 sq. ft. to lb./acre.

Table 21. Zinc recommendations for both new and established turfgrass areas

Zinc (Zn) Soil test level	Application method	
	Soil Broadcast	Foliar Spray
-- ppm --	Amount of Zn to apply/1000 sq. ft.*	
	-- lb. Zn --	-- oz. Zn --
0-1.0	0.2-0.3	0.4-0.8
over 1.0	0.0	0.0

*Multiply by 44 to convert the rate from lb./1000 sq. ft. to lb./acre; multiply by 2.7 to convert from oz./1000 sq. ft. to lb./acre.

Vegetable and Flower Gardens

Nitrogen Recommendations

Nitrogen (N) fertilizer recommendations for vegetable and flower gardens are based on the organic matter content of the soil and the crops that are grown. Basic N recommendations are given in **Table 22**. Nitrogen fertilizer should be applied in the spring, prior to planting annual vegetables and flowers, or at the time growth begins for most established perennials. Fall applied N can be lost through leaching. Nitrogen fertilizer can be either surface applied or incorporated into the soil. An additional 0.15 lb. N/100 sq. ft. may be needed as a sidedress application 3 to 4 weeks after planting for sweet corn, vine crops, tomatoes, potatoes, and cole crops.

Split applications of N are recommended on sandy soils to reduce leaching losses. Divide the basic and sidedress recommendations in half and apply twice as often. Do not exceed the total recommended rates. Another option is to use slow-release N fertilizers or natural organic N sources.

Phosphorus and Potassium Recommendations

Phosphorus (P) and potassium (K) fertilizer recommendations for vegetable and flower gardens are given in **Tables 23 and 24**.

Phosphorus and potassium can be applied in either fall or spring. For annual plantings and new perennial plantings, broadcast the recommended amounts of P_2O_5 and K_2O and incorporate the fertilizer into the top 4 to 6 inches of soil. For established perennials, topdress fertilizer around the plants and work it lightly into the soil to avoid disturbing plant roots.

Applications of P and K before planting are very important in new perennial plantings, because both elements are relatively immobile in most soils. Topdress applications following establishment will move very slowly through the soil, so it will be difficult to make substantial changes in P and K fertility levels in the plant root zone after planting. Soil tests for P and K are especially important before planting perennials, because they permit an accurate assessment of fertilizer needs.

Table 22. Nitrogen recommendations for vegetable and flower gardens

Soil organic matter level ¹	Amount of nitrogen (N) to apply ²
	lb. N/100 sq. ft.
Low	0.20
Medium to high	0.15
Organic soils	0.10

¹Low organic matter = less than 3.1%, medium to high = 3.1 to 19%, organic soil = greater than 19% organic matter.

²An additional 0.15 lb. N/100 sq. ft. may be needed as a sidedress application 3-4 weeks after planting for sweet corn, vine crops, tomatoes, potatoes, and cole crops.

Table 23. Phosphorus recommendations for vegetable and flower gardens

Phosphorus (P) Soil test level		Amount of phosphate (P ₂ O ₅) to apply
----- ppm -----		lb. P ₂ O ₅ /100 sq.ft.
<u>Bray-P1</u>	<u>Olsen-P</u>	
0-5	0-3	0.4
6-10	4-7	0.3
11-15	8-11	0.2
16-25	12-18	0.1
over 25	over 18	0.0

Table 24. Potassium recommendations for vegetable and flower gardens

Potassium (K) Soil test level	Amount of potash (K ₂ O) to apply
----- ppm -----	lb. K ₂ O/100 sq.ft.
0-50	0.4
51-100	0.3
101-150	0.2
151-200	0.1
over 200	0.0

Trees, Shrubs, and Fruits

Nitrogen Recommendations

Nitrogen (N) fertilizer recommendations for landscape trees and shrubs, fruit trees, and small fruits are based on the organic matter content of the soil, the age of the planting (new vs. established), and the level of maintenance or degree of desired growth.

Landscape Trees and Shrubs: Landscape plants typically go through three stages of nitrogen need: 1) newly planted stage, 2) young, rapid growth stage, and 3) mature, maintenance stage. Nitrogen needs should be adjusted to account for the stage of growth.

Growth Stage 1 - Newly planted: Most transplanted trees or shrubs lose roots during the transplanting process. High rates of quick release N applied at this time will not be used efficiently and may push canopy growth at the expense of root growth. This low N stage typically lasts for a full year after planting.

During the newly planted phase, quick-release N levels should not exceed 0.1 lb. N/100 sq. ft. per year. The N rate can be adjusted downward by soil organic matter level according to the low maintenance recommendations in **Table 25**. As an alternative, a higher rate of a slow-release fertilizer, up to 0.2 lb. N/100 sq. ft. per year, can be used.

Slow-release and natural organic fertilizers can be incorporated into the backfill soil. Quick-release fertilizers should be broadcast after planting and then watered in. Do not mix quick-release forms with the soil used to backfill the planting hole, because direct contact with fertilizer will burn the roots.

Growth Stage 2 - Rapid growth of young trees and shrubs: On young landscape trees and shrubs where rapid growth is desirable, use the high maintenance rate given in **Table 25**. During the rapid growth phase, the N rate should be 0.1 to 0.2 lb. N/100 sq. ft. per year and should be applied in the spring or early summer. A low maintenance level should be used in situations that restrict growth (e.g., slow growing and dwarf species, dry or compacted soils, and when the plant has a restricted root zone).

For trees in lawn areas, do not exceed 0.1 lb. N/100 sq. ft. per application unless a slow-release or natural fertilizer is used. Higher rates will burn the grass.

Growth Stage 3 - Maintaining maturing trees and shrubs: As trees and shrubs mature and growth rate naturally slows down, the need for N drops. The low maintenance level in **Table 25** should be used for established trees and shrubs. The purpose of this low maintenance level is to maintain landscape plants in a healthy condition without excessive vegetative growth.

Trees and shrubs planted in lawn areas will likely receive adequate N from lawn fertilizations. In non-lawn areas a rate of 0.4 lb. N/100 sq. ft., once every 4 to 5 years may be used in place of annual applications, except on sandy soils.

Established landscape trees and shrubs may be fertilized in early spring or late fall. Do not make late fall applications after the ground is frozen as it will be lost in runoff.

On sandy soils, late fall applications should not be made because the N will leach beyond the root zone before growth resumes in the spring. Split applications of N are recommended in the spring to reduce leaching losses. Divide the recommendations in half and apply twice as often. Do not exceed the total N rate recommended. Another option is to use slow-release or natural organic N sources.

Since feeder roots of trees extend beyond the dripline of the branches, broadcast nitrogen fertilizer uniformly in a broad band around the dripline (i.e., under the tree canopy and about 4 feet beyond the tree's dripline). A thorough watering is necessary to move broadcast N fertilizer into the tree or shrub root zone. Alternative application methods, as discussed below for P and K fertilization, may be required to place adequate N in the tree or shrub root zone.

Using ammonium sulfate or urea as the N source will help maintain low soil pH for plants like blueberry, azalea, and rhododendron that prefer acid conditions. Do not apply them at rates that exceed the recommendations for supplying N. See the section on Soil pH Modification - Soil Acidification for more information on lowering soil pH.

Tree Fruits: For newly planted fruit trees, follow recommendations for landscape plants in Growth Stage 1. For young nonfruiting trees, follow recommendations for Growth Stage 2.

On established fruit trees use only the low maintenance rate given in **Table 25**. Higher rates of N will stimulate excessive vegetative growth at the expense of fruit production, may also reduce winter-hardiness, and will predispose apples and pears to fireblight. When growing fruit trees in a lawn area, avoid fertilizing the lawn more than once a year to prevent excessive growth of the fruit tree.

Table 25. Nitrogen recommendations for tree fruits, landscape trees, and shrubs

Soil organic matter level ³	Maintenance level	
	Low ¹	High ²
	Amount of nitrogen (N) to apply -- lb. N/100 sq. ft. --	
Low	0.10	0.20
Medium to high	0.07	0.15
Organic soils	0.05	0.10

¹Use the low maintenance level:

- a) for newly planted fruit trees and landscape plants
- b) to maintain health of mature trees and shrubs where rapid growth is not desirable
- c) for established fruit trees
- d) for young trees and shrubs under restricted growing conditions

²Use the high maintenance level on young nonfruiting trees and young landscape plants when rapid growth is desired.

³Low organic matter = less than 3.1%, medium to high = 3.1 to 19%, organic soil = greater than 19% organic matter.

Apply fertilizer in the early spring after the ground thaws. Broadcast the N fertilizer in a wide band around the dripline and four inches beyond and water it in.

Small Fruits: Nitrogen recommendations for small fruits are given in **Table 26**. For June-bearing strawberries, N should be topdressed when the bed is renovated after harvest. On everbearing/day-neutral varieties, the fertilizer application should be split in monthly applications from May to August. Typical annual application rate is 0.5–0.8 lb. N/100 linear feet of row.

Other small fruits like raspberries, grapes, and blueberries should be sidedressed when growth begins in the spring. Typical application rates on established grapes and raspberries are 0.5 to 1 lb. N/100 linear feet of row. Use higher rates to stimulate shoot growth. Use the lower rate if shoot growth is excessive. On blueberries, a standard N rate is 1/4 cup of ammonium sulfate per young plant and 2 cups ammonium sulfate per mature plant.

Table 26. Nitrogen recommendations for small fruits

Soil organic matter level*	Amount of nitrogen (N) to apply
	lb. N/100 sq. ft.
Low	0.20
Medium to high	0.15
Organic soils	0.10

*Low organic matter = less than 3.1%, medium to high = 3.1 to 19%, organic soil = greater than 19% organic matter.

On sandy soils, split applications of N are recommended to reduce leaching losses. Divide the recommendations in half and apply twice as often. Do not exceed the total recommended rates. Another option is to use slow-release N fertilizers or natural organic N sources.

Phosphorus and Potassium Recommendations

Phosphorus (P) and potassium (K) fertilizer recommendations for small fruits, tree fruits, and landscape trees and shrubs are given in **Tables 27 and 28**. Preplant P and K applications are very important in new plantings, because both elements are relatively immobile in most soils. Topdress applications following establishment will move very slowly through the soil, so it will be difficult to make substantial changes in P and K fertility levels in the plant root zone after planting. Soil tests for P and K are especially important before planting, because they permit an accurate assessment of fertilizer needs.

Table 27. Phosphorus recommendations for fruits, trees, and shrubs

Phosphorus (P) Soil test level		Amount of phosphate (P ₂ O ₅) to apply
----- ppm -----		lb. P ₂ O ₅ /100 sq.ft.
Bray-P1	Olsen-P	
0-5	0-3	0.20
6-10	4-7	0.10
11-25	8-18	0.05
over 25	over 18	0.00

Table 28. Potassium recommendations for fruits, trees, and shrubs

Potassium (K) Soil test level	Amount of potash (K ₂ O) to apply
----- ppm -----	lb. K ₂ O/100 sq.ft.
0-50	0.20
51-100	0.10
101-150	0.05
over 150	0.00

For new plantings where the entire area can be cultivated, such as strawberry and raspberry beds, hedges, and groups of trees or shrubs, broadcast the recommended amounts of P_2O_5 and K_2O and incorporate the fertilizer into the top 4 to 6 inches of soil. Where cultivation of the entire area is not feasible, as when planting individual fruit trees and ornamental trees or shrubs in lawns, quick release P and K fertilizer can be incorporated into the bottom of the planting hole if the hole is dug deep enough to allow fertilizer placement well below plant roots. Dig the hole $1\frac{1}{2}$ ft. deeper than the roots will be set, mix the fertilizer thoroughly with enough soil to fill the bottom 1 ft. of the hole, add a 6 inch layer of unfertilized soil as a buffer zone, and plant the tree above this using only unfertilized soil as backfill. Fertilizer may also be incorporated adjacent to the planting hole (see **Figure 3**). If slow-release fertilizers are used, $\frac{1}{2}$ to $\frac{3}{4}$ of the recommended fertilizer can be mixed in the planting hole. Do not exceed recommended rates for the area fertilized.

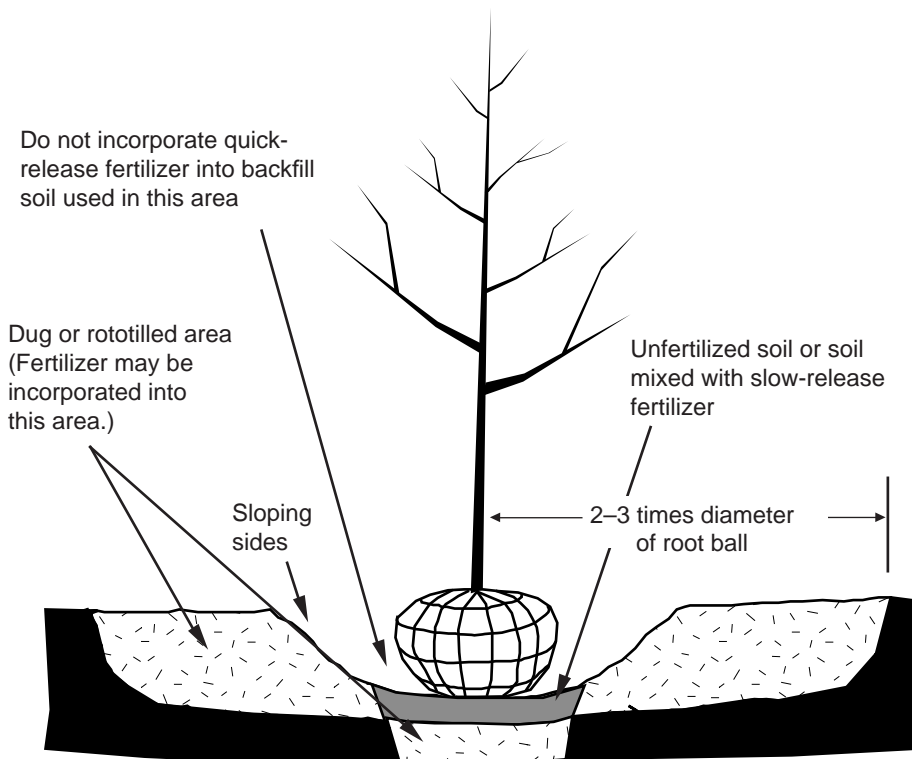


Figure 3. Fertilizing new plantings.

On established plantings, P and K can be applied in either the fall or spring. Spread fertilizer uniformly around the plants and if possible work it lightly into the soil to avoid disturbing plant roots. Deep placement of fertilizer is required to efficiently fertilize established trees with P and K. It may also be necessary for supplying adequate N to the roots of trees growing in lawn or turf. One effective method of deep placement is to drill a series of evenly spaced holes under the trees with a soil auger. The holes should be $\frac{1}{2}$ to 2 inches in diameter, 12 to 18 inches deep, and spaced 2 feet apart. The area covered should extend 2 feet beyond

the tree canopy, but no hole should be within 3 feet of the trunk to prevent damaging the root collar. The recommended amount of fertilizer for the entire area is divided equally among the holes and mixed with the soil used to refill them.

Correcting Iron Chlorosis

In cases where the soil pH is above the optimum range for the growth of a particular plant species, interveinal chlorosis or yellowing between veins may occur on their foliage. Azaleas, pin oaks, as well as other species that prefer acid soils may exhibit this symptom. The chlorosis is an indication of poor iron availability in the soil. The soil contains enough iron, but the plant is not able to take up and use the iron effectively.

The long-term solution to solving this problem is to lower soil pH according to the section on soil acidification on page 5 (preferably before planting).

A short-term solution is to apply a foliar iron chelate to the leaves or soil. Chelates are a chemical compound that keeps the iron available over a wide pH range. Various chelate products are available at garden stores. Follow label directions for appropriate rates to apply. Foliar applications have to be repeated several times during the growing season. Soil applications need to be made on a yearly basis. However, higher rates are needed compared to foliar applications leading to increased cost.

The chlorotic tree can also be injected with iron chelates. This technique can correct the problem for a few years, but repeated injections may be necessary leading to some damage of the tree trunk. The best means to avoid or minimize iron chlorosis problems is to plant species tolerant of high soil pH conditions (see appendix).