

Conservation and Nutrient Management Practices for Field Production of Nursery Stock
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Site Development and Layout Considerations

When arranging a site for a field nursery you should consider natural features of the land as well as length, width, and turning radius required for sprayers, tractors, and wagons. Take care to ensure that rows follow the proper contour to reduce soil loss during crop production. Plan for grass waterways and field edge buffer strips to reduce erosion and sedimentation. Grass strips can effectively slow runoff and trap sediment, thereby reducing soil losses by 30 to 50 percent compared to bare soil. A grass barrier will slow runoff water in front of it, allowing silt to settle out in the crop area before it reaches the grass strip. Buffer strips should be established next to surface water or in fields parallel to rows of planted trees. Strips should be minimally 12 feet (3.7 m) wide to meet conservation standards; however, the first 3 to 4 feet (1.0-1.2 m) does most of the filtering. As slope increases, the number of strips needed increases and the distance between them decreases. Best grasses for buffer strips and grass waterways tend to be sod-forming types, such as fescue since they produce a tight mat to slow runoff and catch sediment. Before planting, prepare these areas as you would other planting areas and incorporate nutrients recommended by soil tests. Mow grass strips at least during the first year to keep the grass from seeding and to encourage a thicker stand. To keep grass waterways and buffer strips vigorous, avoid frequent traffic over them, lift implements above the ground before crossing, and mow and fertilize regularly.

The most effective Best Management Practice for protecting water quality in all watersheds has been identified as maintenance or development of 50 ft (15-m) riparian buffers along all natural conveyances including streams, rivers and estuaries. Existing buffers between fields and public surface water, should be preserved as field nurseries are planned and planted. Fact sheets on field border strips, waterways, grading, contours, terraces and riparian buffers are available at USDA Natural Resources Conservation Service-Conservation Practices-National Handbook of Conservation Practices (<http://www.ftw.nrcs.usda.gov/technical/references>).

Soil Fertility Practices

Conduct soil tests to determine soil fertility. The number of soil tests required per field will vary with the size and uniformity of the field. Take at least one soil test for each change in field texture, color, and drainage characteristics. The soil pH and nutrient content may vary considerably, thus requiring varied amendment practices. It is important to take soil tests well in advance of any cultivation, because it takes time to conduct the tests, evaluate the results, and plan the most economical and effective

program for crop production. Certain practices such as adding lime and phosphate should be completed before planting so that these materials can be thoroughly mixed with the top 6 to 8 inches (15 to 20 cm) of soil during normal soil preparation practices. Soil test results will indicate if other soil nutrients are required as pre-plant adjustments. In clay loam soils, where phosphorus (P) and potash (potassium, K) tend to remain high once adequate levels are established, nitrogen may be the only required yearly addition. Currently, ammonium nitrate (33-0-0) and urea (46-0-0) are the most popular soluble fertilizers. In some regions, yearly P application is also warranted. In those instances, diammonium phosphate (18-46-0) is often used as a nitrogen and phosphorus source. If new land for field production of nursery stock has had animal manure applied over a number of years, soil analyses should be conducted to determine if zinc or copper might be present in concentrations that will create nutrient disorders. If high zinc or copper levels are present, growing nursery stock may be difficult. High levels of zinc or copper compete with absorption of iron and create iron deficiencies. Lime application to the upper limits based upon soil tests may reduce the availability of copper and zinc, and also iron. Foliar application of chelated iron may be one alternative to relieve the iron deficiency problems, however one to two applications per year may be required. If possible, growers should avoid planting nursery crops in fields with high zinc and copper levels. Since nursery crops are perennial crops, nutrient disorders are magnified over several years. Any planting in these fields should be considered experimental, possibly growing several species of nursery crops to determine tolerance levels of various crops and develop management strategies to improve the productivity of the field. Best management practices for fertilizer applications focus on water quality and nutrient runoff as well as maximizing growth of nursery stock. During field preparation, incorporate fertilizer at 50 pounds of nitrogen per acre (56.1 Kg/ha); this practice reduces runoff potential and usually meets the nitrogen requirements of new plants during the first year. Other nutrients as recommended by soil tests should be incorporated before planting. In subsequent years, surface application of nitrogen is based on an amount of nitrogen per plant rather than pounds of nitrogen per acre (Kg/ha). Place fertilizer within the root zone as a side dress at the rate of 0.25 to 0.5 ounces (7.1 to 14.2 g) of nitrogen per plant rather than previous recommendations of 100 to 200 pounds of nitrogen per acre (112.2 to 224.4 Kg/ha). Doing so maximizes growth with a minimum amount of fertilizer. If supplemental fertilizer is required the first year for fall-transplanted plants, each plant should receive 0.25 to 0.5 ounce (7.1 to 14.2 g) of nitrogen before bud break. The second year each plant should receive 0.5 to 1.0 ounce distributed in split applications: the first two-thirds of the total amount should be applied before bud break, and the second application should be applied by mid-June. The third and following years each plant should receive 1.0 to 2.0 ounces (28.4 to 56.8 g) in split applications as described for the second year. Slower growing cultivars or species should be fertilized at the lower application rates, whereas vigorous plants will have increased growth if the higher application rate is used. Rates greater than those recommended have not proven to be warranted and, in fact, have reduced growth and can contribute to nutrient runoff and water quality impacts. Recently, slow-release fertilizers developed specifically for field use have been introduced. Although they are more expensive, one application will last the entire growing season.

Soil Amendments and Cover Crops

Balled and burlap tree growers lose soil due to the nature of the business because soil is sold when trees are harvested and sold. Preventing further loss of soil and rebuilding soil in fields is very important. Perennial field grown nursery crops require three to seven years for cropping cycles. Therefore, nursery professionals need to implement growing practices which maintain and improve soil quality characteristics during un-cropped, fallow periods, as well as during field preparation for planting and even during the production cycle. The term “soil quality” is the fitness of a specific kind of soil to function within its surroundings, support plant and animal productivity, maintain or enhance water and air quality and support human health and habitation. Soil quality information is available from the Natural Resources Conservation Service on line: <http://www.statlab.iastate.edu/survey/SQI/> . The health and productiveness of soil is a concern for field nurseries. Loss of soil and nutrients from fields may be the largest concern for nurseries. Environmental conditions such as wind and rain storms are responsible for major losses, however farming practices such as frequent tillage results in loose soil that blows and washes away and in soil compaction which reduces water penetration and moisture holding characteristics but increases formation of washes and gullies. Frequent tilling can also reduce soil microbial activity which contributes to soil and nutrient loss from fields. Most soils benefit from the addition of organic matter. In addition to improving soil structure, water retention and drainage, aeration, and the quality of nursery stock grown, digging is usually easier in mineral soils that have been amended with organic matter. Also, some nursery species develop a more fibrous root system as the amount of organic matter is increased. Unfortunately, costs may prohibit transporting significant quantities of bark, yard waste compost, or other organic amendments to any but the most intensively cultivated sites like seed beds or transplant production beds. Animal wastes such as cattle manure or poultry litter can be applied to fields, but only in light applications of 1/4 to 1/2 inch (0.64 to 1.2 cm) over surface areas, or more efficiently, incorporated into the soil after application. If wastes are incorporated, 75 to 100 percent of the nitrogen in the waste may be available the first year. Rate of application should be based on nutrient analysis of animal wastes. Particular attention should be given to the metal content of animal wastes. Zinc and copper levels may be high enough to raise these elements to toxic levels if repeated applications are made year after year. Foliar tissue analysis of newest fully expanded leaves collected early in the growing season can provide valuable information about the efficiency of the animal waste application and determine if any supplement is required. Growers should check to see if composts from municipal yard wastes are affordable organic source for amending fields. Application rates of stabilized composted wastes can be 50 to 200 tons per acre (121 to 486 metric tons/ha) if the composted yard wastes has only 0.2 to 0.5 percent nitrogen content, therefore nutrient loss is of less concern. The 50 tons per acre (121 metric tons / ha) application rate represents approximately 1/2-inch (1.3 cm) coverage over a 1-acre area (0.4047 ha), while the 200 tons per acre (486 metric tons) would be approximately a 2-inch (5 cm) depth. An alternative to applying organic materials over the entire field is to incorporate the organic matter in planting rows only. If rows in the field are spaced 12 feet apart (3.6 m) and the root zone area of plants is considered to be 2 feet (0.6 m) on each side of the stem, a 4-foot (1.2 m) strip would receive the organic

matter, thus reducing the amount of organic matter applied in the field by two-thirds. Conservation efforts are needed to reduce soil and nutrient loss from wind erosion and stormwater movement off site. Soil stabilization and erosion control best management practices include: planting across slopes and contoured layout of fields, use of cover crops for fallowing land, use of vegetation in aisles, row ends, drive roads, field border strips, grassed waterways, sediment dams in waterways, bio-swale collectors, wetlands and irrigation practices that do not increase erosive washes or the need for tilling due to weed germination stimulation. Most practices to reduce soil loss involve planting and maintaining vegetation cover in fields as well as growing nursery crops. Growing cover crops may be one of the most important management tools to improve soil quality. Use of cover crops on soil that would otherwise be barren during the first year of production or the last year of production can significantly reduce soil loss. Cover crop rotation should also be considered. Planting hybrid sudan grass in large fallow areas during summer months followed by planting dwarf barley as a winter cover crop can reduce sediment and nutrient loss. Grasses and small grains can also be used in a double cropping system. Small grains can be sown in the fall then killed with herbicide or disc in before they produce seed in the spring. Sorghum-sudan hybrids and even corn are commonly used as the summer cover crops. Sudan grass is mowed at least twice to prevent seed formation, then plowed or disc under in the fall. Covering the surface of the ground has a direct effect on reducing soil loss, and numerous other benefits when cover crops are used during field production. However, increases in the organic matter of soils may not be one of the benefits as most nurseries would assume. One of the most important physical property improvements is increased size of soil aggregate fractions in the 1-2 mm size range. An increase in the larger aggregates facilitates water infiltration and retention and provides a better biological habitat and a better rooting environment. Direct links can be demonstrated between the number of resident fungivores and macropredators with cover cropping practices. Fungivores regulate the rate of nutrient mobilization while macropredators density has been correlated with pest control. Arthropods and earthworms also appear to be stimulated by cover cropping. Deposition of green manure cover crops on soil surfaces has been shown to support high populations of mites which are bio-control agents.

Results of the studies have indicated that regular incorporation of organic residue is needed and that these improvements can be lost quickly under conditions of frequent tillage. Vegetative filter strips between the production site and surface waters are considered best management practices to reduce off site movement of soil and nutrients. To be effective, filter strips should have no less than 70% surface cover and be at least 12 feet (3.6 m)wide. Cool season grasses used as filter strips are most effective during critical erosion periods in fall, winter and spring when rain is frequent and possibly excessive storm run-off events. Use of filter strips reduce turbidity and collect sediment and nutrients by trapping and binding of fertilizer to the vegetative matter in the filter strip. Field nurseries often are located on land with gentle slopes where sediment loss potential is high, particularly if vegetation is sparse. The use of stormwater ponds and wetlands as natural filters can be used to provide even greater retention of sediment and nutrients than can be accomplished with filter strips. However, depending on surface cover, slope and environmental factors, such sediment retention basins require cleaning

possibility as often as every 2 years. Selection of best management practices reduce soil and nutrient losses from field nurseries. Fertilizing and irrigation practices can have great direct and in-direct effects on soil and nutrient losses. Cover crops as well as nursery crops require plant nutrients, therefore under fertilizing can reduce growth and coverage, increasing soil loss. Over application of fertilizer can result in environmental impacts. To implement an appropriate fertility program, soil testing is mandatory.

Field Preparation

Whether or not you decide to use a green manure program, it will be necessary to mix in previous crop stubble, fertilizer, lime, and soil amendments. Tall weeds should be mowed before seed dispersal then disc into the soil. This will permit more effective soil mixing during plowing and minimize the problem of long, coarse stems becoming entwined in equipment. A chisel plow will efficiently mix materials in the soil profile, ensuring an even distribution of materials and rapid root development during the growing season. Roto-tilling equipment can also prove effective but generally does not mix the soil as deeply as a chisel plow. Avoid the use of a mold board plow, because it tends to deposit a layer of material beneath the soil rather than distributing it evenly throughout the soil. For best results, chisel plow twice. If erosion is not a problem, plow first across the field in one direction then plow at right angles to the first path. Terraces and contours should not be destroyed during chisel plowing.

Irrigation

Design your irrigation system as you plan your field layout and planting strategy. The main irrigation trunk lines will need to be buried in the field, usually along roads, with the valves located at convenient intervals. Remember to plan for a method of draining irrigation lines to avoid damage caused by winter freezing. Also, leave space for a traveling gun to move across a field if you think you will be using this type of irrigation system. Irrigating field crops requires a water supply, the type of irrigation determines the quality of water required for irrigation. Some new growers already have hose reel irrigation equipment. This equipment can be used to irrigate field grown nursery crops, however, if the system is shared with other agricultural crops, nursery crops should receive priority for irrigation since delayed irrigation may result in woody nursery crops that have already stopped growing and possibly loss of terminal leaders. Since the value per acre of field grown nursery stock is higher than other agronomic crops, not irrigating crops in time can cause an expensive loss. Hose reel or gun types of irrigation are designed to apply large volumes of water. To keep nursery stock growing, 1 to 2 applications of an inch (2.54 cm) of irrigation per week may be required. Adequate water supply is, of course, essential.

If water quantity is limited, consider drip irrigation or microirrigation because it uses water more efficiently. Drip irrigation is a low volume, low pressure system and does not cause irrigation water run off from fields as can occur with large irrigation guns. With drip irrigation, water is applied directly to the soil surface gradually over extended periods of time (for example, 1.0, 2.0 or 5.0 gallons (3.8, 7.6 or 19 ml) per hour), which

results in less water lost to evaporation or run off. Because drip irrigation applies water only to the root zone of the nursery crop, roots tend to concentrate within the zone wet by the drip irrigation. Also, a large benefit is that weeds are not germinated by water distributed over large areas as with overhead irrigation. Widely distributed water increases weed pressure. Less weed competition can increase the effectiveness and reduce costs of pre-emergent herbicides and directed post-emergence herbicides management programs, which also reduces the need for frequent tilling. Since drip irrigation is in place, it can be used regularly to keep plants growing rather than waiting until they stop growing. On new field stock, it may make the difference between few or moderate versus large losses of new liners. Drip irrigation does require very clean water free of sediment and minerals. Well water generally requires only minimal filtration for drip irrigation. Public water supplies if available may prove to be affordable and are also a clean water source requiring only minimal filtration. Surface water from rivers or ponds generally require sand media filters to avoid plugging small drip orifices. If fertilizer is applied with drip irrigation, the amount of fertilizer applied to a crop can be reduced while increasing growth due to improved efficiency in fertilizer application.

Advantages of drip irrigation include reduced water consumption and fertilizer costs as well as reduced potential of environmental impacts of erosion and nutrient runoff. An additional advantage of drip irrigation is the concentration of more roots in the root ball when the crop is shipped to market and potentially better plant survival. A disadvantage to some nursery crops might be that with drip irrigation, the protection of frost-freeze water application over flowers and flower buds is not possible.

Fertigation

Fertigation is the process of applying water soluble fertilizers to plants through a drip or trickle (low volume) irrigation system. Drip or trickle is the only irrigation system available that applies fertilizer solutions efficiently enough to be used in field nurseries. While it is possible to inject fertilizer into overhead systems, fertilizing areas other than crop root zones and potential nutrient runoff make fertilizing through overhead systems impractical. Because drip irrigation systems depend upon tiny openings for the delivery of water to plants, totally soluble fertilizers must be used as well as fertilizers that will not precipitate to form solids in the irrigation lines. Otherwise lines will become clogged. All irrigation systems through which any chemical is applied must be equipped with proper backflow prevention and is required by law in most states..

Injectors: Almost any system that can inject a solution into a water line can be used to inject fertilizer into a drip irrigation line. However, the injectors that have become most popular are those that are operated by water pressure rather than electronically. For smaller systems, a Venturi-type system can be used which draws fertilizer solution from a tank by differential pressure. The most common of these is the "hozon." Nurseries larger than 0.5 acres will probably be better served by systems that use water to drive a piston pump or hydraulics to draw fertilizer solution from a tank because of their far greater capacity and dependability.

Fertilizers: Little research is available as a guide in determining how much or how often fertilizer should be applied to woody field grown nursery crops. Soil tests should be conducted and nutrients including minor elements, calcium, magnesium, phosphorous and potassium is best applied during field preparation when tilling the soil for planting. By doing this, the only fertilizer needed is nitrogen. In areas where soils or special needs of the crop dictate application of additional nutrients, they may be injected if soluble formulations are available. Nitrogen and potassium can usually be applied at the same time while phosphorous solutions should be applied alone, following the application of other nutrients, then lines should be flushed thoroughly, leaving no fertilizer solution in the irrigation lines.

Ammonium nitrate and urea have both been used successfully for fertigation. Both are highly soluble in room temperature water. Calcium nitrate has been used when calcium needed to be applied via fertigation. Potassium nitrate and nitrate of soda potash have been used when sources of potassium were required. Phosphoric acid has been used as a source of phosphorous. Chelated micronutrient fertilizer solutions are available when minor elements are needed. With all of these fertilizers, it is important that they be fully dissolved before injection begins. Any non dissolved fertilizer should be removed by filtration or decanting so it can not enter and block irrigation lines. If you have problems dissolving fertilizers, check with your fertilizer dealer to be sure you have the right grade. Some fertilizers will normally have non-dissolving materials or coatings that must be removed before you can safely use them for fertigation. The injection point should always be located before filtration so that any impurities can be filtered out before they enter the system.

Calculating fertilizer needs: Each grower will need to determine their own rates and time of fertilizer application. Our research has shown good results by beginning to fertigate about two weeks before first bud break in the spring and continuing to fertigate weekly for at least eight weeks. In areas with longer growing seasons, fertigating for twelve weeks or longer may provide good results. However, do not fertigate with nitrogen within six weeks of the expected first fall frost or plants may fail to adequately winter acclimate or go dormant.

The amount of fertilizer to use when fertigating is determined by applying one-half what would be applied top-dressed with granular fertilizers. Less fertilizer can be used produce more growth due to increased efficiency of fertigation compared to application of granular fertilizers spread on the soil surface.

For example: If the planting density is 1200 plants per acre and the rate of granular fertilizer would normally be 0.5 oz. of nitrogen per plant, the fertigation rate would use half this (0.25 oz N/plant). Further calculations are as follows:

1. The number of plants per acre multiplied by the amount of fertilizer needed equals the amount of fertilizer needed per acre.

$$1200 \text{ plants/acre} \times 0.5 \text{ oz. (14.2 grams) N/plant} = 600 \text{ oz. (21 grams) N per acre.}$$

2. One-half of 600 oz (21 g). is 300 oz. (10.5 grams) of Nitrogen ($600/2 = 300$). If the source of nitrogen is ammonium nitrate (34-0-0), approximately 900 ounces (31.7 g) of ammonium nitrate per acre (300 oz [10.5 g] of N divided by .34N in ammonium nitrate equals 882 oz [31 g]) is required.
Since there are 16 oz./pound (454 g/ pound), that's about 56 pounds (25.4Kg) of ammonium nitrate ($900/16=56$) are required to fertigate 1200 plants.
3. Fifty-six pounds (25.4 Kg) of ammonium nitrate is to be applied over a period of eight weeks. Therefore, 1/8 is applied each week. To determine how much to apply, divide the total by the number of times fertilizer is to be applied. Therefore 56 pounds (25.4Kg) divided by 8 applications equals 7 pounds (3.6Kg) per fertigation event. Consequently, dissolve 7 pounds (3.6 Kg) of ammonium nitrate in water then inject this nitrogen stock solution through the irrigation system.

Fertigation Procedures:

1. Fully charge the irrigation system. When the system is fully charged, water should be coming out of the emitter farthest from the injection point. Record the amount of time required from when the irrigation is turned on until water is flowing from the farthest emitter, then add a couple of minutes safety margin. Using this figure each time you fertigate can save time walking to the end of the system each time you fertigate.
2. Begin injection. The length of time required to inject the fertilizer should be at least as long as it took to fully charge the system.
3. After all fertilizer solution is injected, run the system for at least as long as it took to charge the irrigation system so you are sure all fertilizer solution has been flushed from the system. This is a good time to walk the system to make sure emitters are not clogged.