# FIELD PRODUCTION MANAGEMENT PRACTICES

## Introduction

Interest in planting field-grown nursery stock has increased as agricultural producers have considered new ways of diversifying. Although many nursery operators are familiar with field production of certain agricultural crops, they may have less experience with nursery stock. Some aspects of growing shade trees in the field are similar to producing row crops, but many characteristics, such as procuring line-out stock, spacing, weed management, and managing a crop for more than one year, are quite different. New nursery operators must also initially plan a marketing strategy, which includes identifying clientele, thereby making it possible to determine what plant species or cultivars to grow, market size of plants grown, field layout and spacing, and equipment required. If nursery stock is to be sold within a local area, marketing may be limited to retail garden centers, which prefer small and very well-formed trees and shrubs, or to landscapers, who usually need larger plant material and in some cases may prefer specific leader, canopy height, and branch structures when they select shade trees at the nursery. Shipping nursery stock to other geographic locations requires special handling during harvest and transportation. The more specific the marketing strategy, the easier it will be to determine which plants to grow and to design the planting plan.

# Site Selection

No single factor influences the ultimate success of a field nursery more than native soil. Field grown nursery crops are grown in the ground with cycles of production lasting three to eight years. Therefore, one should know the history of the field, such as; previous crops grown, types of pesticides used, and previous applications of animal wastes. Investigate crop records and previous land use to determine if further inquiries are warranted, particularly with regards to environmental issues and plant quarantines.

Because some soil will be sold with the field-grown nursery stock, consideration should be given to whether a field soil will form a root ball with enough soil cohesion to remain around the roots. Generally, root balls with sandy soil fall apart during handling unless baskets are used. Soils should be relatively free of rocks to facilitate digging and planting, as well as deep enough to allow digging a root ball. The *American Standards for Nursery Stock* (ANSI 60.1) establishes standard diameters for harvesting root balls according to the size of the plant.

Soil drainage is another factor that must be considered when selecting a site. Avoid soils that have poor internal drainage or are subject to flooding. Fields being considered for nursery stock production should have a minimum of 8-10 inches depth that is well drained and three feet is preferred. A soil probe can be used to detect a shallow water table. Mottled yellow, gray, or blue soil or a sour-smelling soil indicates poor drainage and a high water table at some time during the year. Soils with mottled characteristics are often saturated during winter months. These soils are not suitable for production of most perennial nursery stock.

Slope is another important consideration. Many major field nurseries are located in flat, non-flooding river bottoms. These bottom lands are generally close to irrigation water, flat enough to allow easy working with equipment, and relatively rock free. However, properly located upland soils with these same characteristics can make excellent nursery sites, as long as the slope is not too great, topsoil too thin, or erosion too severe. Locating a field nursery near rivers and streams also bears a responsibility to protect the watershed from erosion sediment and nutrient contamination.

*Grass waterways or filter strips at the edge of fields reduce erosion and sedimentation.*

Some field nurseries are not irrigated, but in choosing land for field production, the potential to irrigate crops should be a major consideration. Nursery liners are expensive. Mortality during the first year after planting can be considerably higher in non-irrigated field nurseries compared to nursery fields with irrigation. Therefore, most nursery operators conclude that the costs to install irrigation are quickly recovered.

**# 128** **A soil probe or auger should be used to determine drainage characteristics of the field soil.**

# Site Development and Layout

When arranging a site for a field nursery, natural features of the land should be considered as well as length, width, and turning radius required for sprayers, tractors, and wagons. Take care to ensure that rows follow the proper contour. Plant grass waterways and field edge filter strips to reduce erosion and sedimentation. Grass strips can effectively slow runoff and trap sediment, thereby reducing soil losses by 30-50% compared to bare soil. A grass filter strip will slow runoff water velocity, allowing silt to settle before it reaches a water containment structure. Filter strips should be established next to surface water or at field perimeters parallel to rows of plants following contour of land. Strips should be a minimum of 20 feet wide to meet conservation standards; however, the first three to four feet does most of the filtering. As slope increases, the number of strips needed increases and the distance between them decreases. Best grasses for filter strips and grass waterways tend to be sod-forming types, such as fescue or spreading rhizome grasses like Bermuda grass because 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 filter strips vigorous, avoid excessive traffic over them, lift implements before crossing, mow, and fertilize regularly.

One of the most effective BMPs for protecting water quality in watersheds has been identified as maintenance or development of 50-foot- wide riparian buffer strips along all natural water conveyances including streams, rivers and estuaries. Existing buffers between fields and public surface water should be preserved as field nurseries are planned and planted. To learn more about riparian buffers, visit the following website: http://www.nrcs.usda.gov/feature/buffers/.

*Vegetation between rows of plants is used to reduce soil and nutrient loss from erosion.*

**# 129** **Grass waterways and filter strips should be used to reduce erosion and trap sediments.**

# *Soil Amendments, Cover Crops, and Vegetative Zones*

Field nurseries lose soil because some soil goes with the plants when they are harvested and sold. Preventing further loss of soil and rebuilding soil in fields is very important. Nursery professionals need to implement production practices to prevent loss of soil and to maintain and improve soil quality during non-cropped fallow periods, as well as during field preparation for planting, and during the production cycle. Environmental conditions such as wind and rainstorms are responsible for major losses of soil; however, practices such as frequent tillage increase formation of gullies and result in loose soil that blows and washes away. Excessive tilling can also increase soil compaction, reduce water penetration and decrease moisture-holding characteristics of soils. Frequent tilling can reduce soil microbial activity as well, which contributes to soil and nutrient loss from fields.

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: contoured layout of fields; use of cover crops on fallow land; use of vegetation in aisles, on row ends, and in drive roads; field border strips and grassed waterways; sediment catch basins in waterways; bio-swale (sediment) collectors; and wetlands.

## *Soil Amendments*

Most soils benefit from the addition of organic matter. Organic amendments improve soil structure, water retention, drainage, and aeration. Thus, organic amendments may improve the quality of the root system. Digging is usually easier in mineral soils that have been amended with organic matter. Some species develop a more fibrous root system as the amount of soil organic matter increases.

Nursery operators may want to check to see if composts from municipal yard waste facilities are an affordable organic source for amending fields. Application rates of stabilized composted wastes can be 50-200 tons per acre because composted yard wastes may have 0.2-0.5% nitrogen content and nutrient loss is of less concern. The 50 tons per acre application rate represents approximately half-inch coverage over a one-acre area, while the 200 tons per acre would be approximately a two-inch depth. Unfortunately, costs may prohibit transporting significant quantities of bark, yard waste compost, or other organic amendments. An alternative to applying organic materials over the entire field is to incorporate the organic material in planting rows only.

If animal wastes have been applied to fields in previous years, soil analyses are needed to form guidelines regarding the use of these fields for nursery production. Some nutrient levels may become toxic if repeated applications are made year after year. High levels of zinc and copper can reduce fibrous root development and this may cause difficulty when harvesting root balls that should remain intact during digging.

## *Cover Crops*

Using cover crops may be the most important conservation management tool (Table 11). 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 grass in summer months followed by planting a winter cover crop can reduce sediment and nutrient loss. One of the most important soil physical property improvements resulting from cover crops 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. Arthropods and earthworms also appear to be stimulated by cover crops.

**Table 11.** A list of potential cover crops, seeding rates, weight of seed, and planting dates are provided below.

| *Species* | *Seeding Rate* | *Weight (lbs/bushel)* | *Planting Date* |
|---|---|---|---|
| Barley | 2.0 bu/A | 48 | Aug. - Oct. |
| Rye (annual) | 1.5 bu/A | 56 | Aug. - Oct. |
| Ryegrass (annual) | 2.0 bu/A | 24 | Aug. - Oct. |
| Oats | 1.5 bu/A | 32 | Aug. - Oct. |
| Buckwheat | 1.5 bu/A | 45 | Aug. - Oct. |
| Wheat | 25.0 lb/A | 60 | Aug. - Oct. |
| Crimson Clover | 20.0 lb/A | 60 | Aug. - Oct. |
| Sorghum-Sudan Hybrids | 25.0 lb/A | 50 | Apr. - May |

## *Vegetative Zones*

Vegetative filter strips or zones between the production site and surface waters are considered best management practices for reducing off site movement of soil and nutrients. Grassed contour strips slow down and direct flow of water across a slope and serve as a buffer and final biological filter to remove any excess nutrients before runoff leaves the nursery. Tall fescue, fine-leafed fescues, and Bermuda grass are effective in providing workable sod because they are vigorous and provide a great deal of biomass. To be effective, filter strips should have no less than 70% surface cover and be at least 20 feet wide. Cool season grasses used as filter strips are most effective during critical erosion periods in fall, winter, and spring when rain is frequent with possible excessive stormwater runoff. Filter strips will reduce turbidity and collect sediment and nutrients by trapping and binding of fertilizer in the vegetative matter. The use of stormwater reservoir structures 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 for runoff, slope, and environmental factors; stormwater reservoir structures may require cleaning.

**# 130** **Organic soil amendments should be used to improve soil structure, water retention, drainage and aeration.**

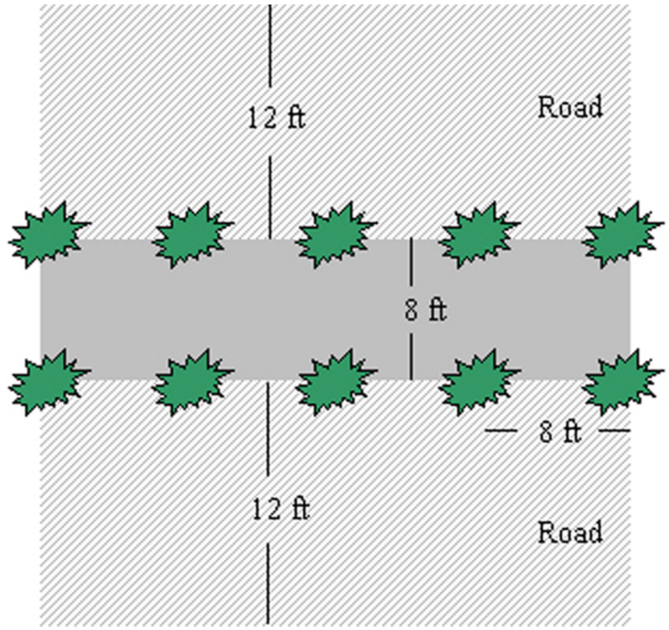
**# 131** **Cover crops should be used to minimize soil loss.**

**# 132** **Filter strips should be used to improve runoff water quality.**

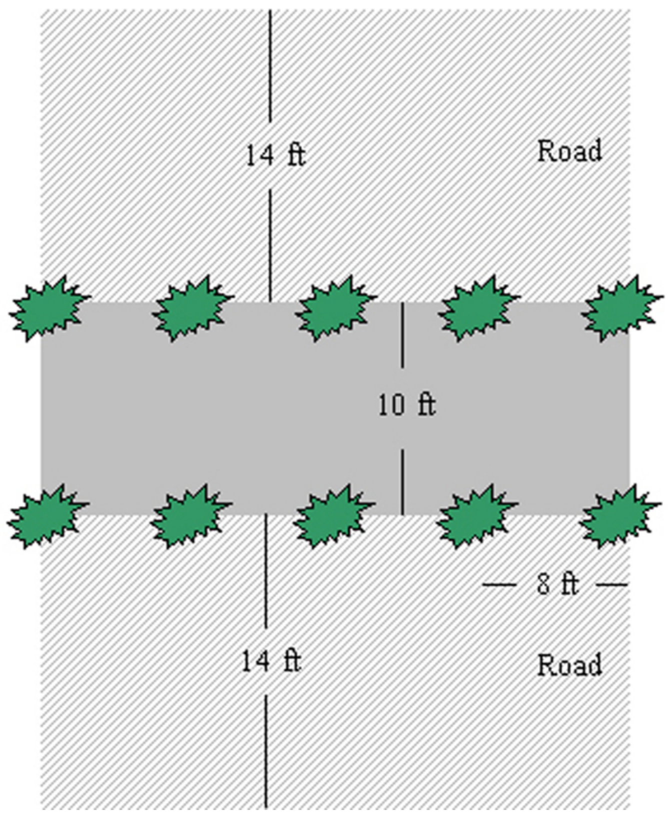
*Vegetative zones filter runoff from the production area before entering surface water.*

## Planting and Planting Density

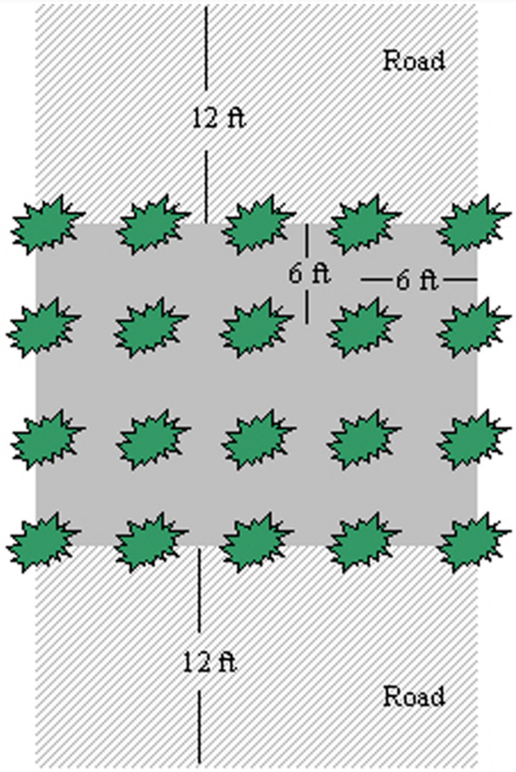
Spacing is always a concern in new fields, especially if you are uncertain about the size of plants to be marketed. Wide spacing is encouraged if the marketing strategy is uncertain, as it allows more opportunity for finding a market before the trees become overgrown. A spacing method that allows the most flexibility in planting is two rows eight feet apart and a road of 10-14 feet on each side of the two rows. Repeat this pattern across the field. This spacing allows greater room for digging activities and results in less injury to trees during harvesting. Smaller flowering crops can be spaced six feet apart in rows, and larger shade tree species should be spaced up to ten feet apart in the row. Some nurseries wish to increase planting densities in fields, and choose to plant more rows (four or six rows) of plants between roads. In choosing planting dimensions, it is important to account for space required by fertilizing, cultivating, mowing, harvesting, and spraying equipment. Each plant is considered to “own” half the space between it and the next plant or row for calculating the number of plants per acre. In reality, the canopies and roots may exceed half the distance by harvest.



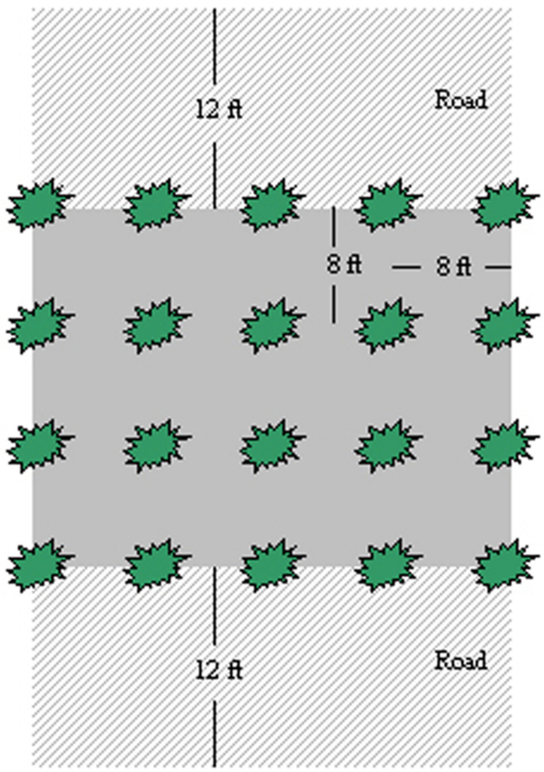

*Two rows 8 ft apart, plants 8 ft within row, 12 ft wide roads*
*8 ft x 10 ft/plant = 80 $ft^2$/plant, 43,560 $ft^2$/A/80 $ft^2$/plant = 544 plants/A*




*Two rows 10 ft apart, plants 8 ft within row, 14 ft wide roads*
*8 ft x 12 ft/plant = 96 $ft^2$/plant, 43,560 $ft^2$/A/96 $ft^2$/plant = 454 plants/A*




*Four rows 6 ft apart, plants 6 ft within row, 12 ft wide roads*
*24 ft x 30 ft/plant = 720 ft$^2$/16 plants, 45 ft$^2$/plant, 43,560 ft$^2$/A/45 ft$^2$/plant = 968 plants/A*




*Four rows 8 ft apart, plants 8 ft within row, 12 ft wide roads*
*24 ft x 36 ft/plant = 864 ft$^2$/12 plants, 72 ft$^2$/plant, 43,560 ft$^2$/A/72 ft$^2$/plant = 605 plants/A*

# Irrigation

Design your irrigation system as you plan your field layout and planting strategy. The main irrigation 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 and for conducting repairs without shutting off the entire system.

Microirrigation is a good conservation practice and a best management practice for production of field-grown crops. Microirrigation is a low volume, low-pressure system and does not result in irrigation water runoff from fields as can occur with large irrigation guns. With microirrigation, water is applied directly to the soil surface gradually over extended periods of time (for example, 0.5, 1.0, or 2.0 gallons per hour), which results in less water lost to evaporation or runoff.

Water infiltration rates vary with soil types **(Table 12).** When irrigation rates exceed the infiltration rate of a soil, water will move laterally across the soil surface. For microirrigation, this may increase the area wetted; however, if irrigation rate is excessive, runoff can occur even with microirrigation.

The rate of application should be matched to the infiltration rate of the field soil as well as to the size and capacity of the pump. Because microirrigation applies water only to the root zone of the nursery crop, roots tend to concentrate within the zone wet by the irrigation. An additional benefit is that weed growth is less because water is not distributed over large areas as with overhead irrigation. Less weed competition can increase the effectiveness and reduce costs of pre-emergence and directed post-emergence herbicide management programs. Microirrigation also reduces the need for frequent tilling because of less weed presence, thereby reducing risk of erosion from wind and storm events. On newly planted stock, irrigation may make the difference between few to large losses of liners.

Microirrigation does require very clean water free of sediment and minerals. Well and municipal water generally requires minimal filtration for microirrigation. County water supplies, if available, may prove to be affordable and are also a clean water source requiring only minimal filtration. Surface water from rivers, ponds, canals, or collection structures generally requires sand media filtration to prevent plugging and reduced water flow of microirrigation emitters.

# 133 **Microirrigation should be used whenever possible. It places water directly at the root zone; thus, concentrating roots and reducing weed germination, tilling, and erosion.**

**Table 12.** Water infiltration rate varies with soil texture.

| *Soil Texture* | *Max. Rate of Irrigation (in/hr, Bare Soil)* |
|---|---|
| Sand | 0.75 |
| Fine sand | 0.6 |
| Loamy sand | 0.5 |
| Loamy fine sand | 0.45 |
| Sandy loam | 0.4 |
| Loam | 0.35 |
| Silt loam | 0.3 |
| Clay loam | 0.25 |
| Silty clay | 0.25 |
| Clay | 0.15 |

*(Data extracted from Western Fertilizer Handbook Horticulture Edition, Interstate Publishers, Inc., Danville, IL. p 17.)*

## Soil Fertility

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. Practices such as liming and applying phosphate and potash fertilizers should be completed during soil preparation before planting so that these materials can be thoroughly mixed with the top six to eight inches of soil.

**# 134** **Soil tests should be used to determine soil fertility requirements. Take at least one soil test for each change in field texture, color, and drainage characteristics.**

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 for clay type soils. Sandy coastal plain soils may require higher rates. Incorporation of nitrogen fertilizers during field preparation reduces runoff potential and usually meets the nitrogen requirements of new plants during the first year. Other nutrients should be incorporated before planting as recommended by soil tests and in most cases will meet the needs of the crop during the entire growing cycle until harvest. In subsequent years, only nitrogen is required. The amount of nitrogen to apply can be based upon planting density (number of plants per acre) in contrast to most agricultural fertilizer rates that are based on pounds of nitrogen per acre such as 100-200 pounds of nitrogen per acre. Basing nitrogen rates on the number of plants or amount per plant saves money and provides equivalent amounts of fertilizer per plant for fields planted with 544 plants per acre compared to fields with a higher planting density such as 605 plants per acre. Fertilizer should be applied as side dress on a per plant basis.

**# 135** **Nitrogen rates should be based on the number of plants rather than the acreage. Per plant applications save money and provide equivalent amounts of fertilizer per plant when fields are planted with variable numbers of plants per acre.**

## *Dry Granular Fertilizer Application*

A rate of 0.25-1.0 ounce of nitrogen per plant may be enough to meet nitrogen requirements for crops during the second year of growth in clay soils. Vigorous growing plants and sandy soils may require higher rates. During the third and following years, rates from 1.0-2.0 ounces of nitrogen per plant may be appropriate for clay soils with higher rates for the most vigorous crops and sandy soils. For field grade soluble granular fertilizers applied as a surface application around the root zone of field grown plants, two-thirds of the total amount should be applied before bud break, and the second application should be applied by mid-June. Slower-growing cultivars or species should be fertilized at the lower application rates, whereas vigorous plants may need higher application rates. Although applying higher rates of granular soluble fertilizers may promote more growth, frequently the opposite effect occurs, especially in non-irrigated fields. Dry granular fertilizer applied in late spring or early summer may not be dissolved until late summer or fall, causing salt injury or a late flush of growth that keeps crops from acclimating during fall. This results in cold damage to a late growth flush or death to crops.

Example: 2.0 oz N/plant/year split into Feb.- March & June
2.0 oz N X 750 plants/A = 1500 oz N/A = 94 lbs N/A/yr (62 lbs N/A/Feb.- March, 32 lb N/A/June)

## *Soil Auger Controlled Release Fertilizer Application (Drill and Fill)*

An additional fertilizer application technique is to auger or punch holes at the edge of the root zone of field grown plants. Long-term Controlled-Release Fertilizers (CRF's) applied in one application will last the entire production season or longer with limited runoff potential. To use this technique, holes are drilled approximately 6-8 inches deep on both sides of the plants in the row. Then 8 oz (0.5 lb) of a CRF fertilizer such as 18-6-12 are poured into each hole. Example: 750 plants X 1 lb CRF X 0.18 N = 135 lb N/A/yr distributed in a hole on each side of the plant

## *Liquid (Solution) Fertilizer Application via Microirrigation (Fertigation)*

If fertilizer is applied with microirrigation, the amount of fertilizer applied to a crop can be reduced while growth will usually increase due to improved efficiency in fertilizer use. Injectors can be purchased to control the amount of fertilizer injected into irrigation water. However, the procedure discussed below does not require a fertilizer injector. The amount of solution fertilizer to apply is about one half of the nitrogen amount that would be applied as a surface application with granular fertilizers. Less fertilizer can be used to produce growth because of the increased efficiency of fertigation. More fertilizer is likely to get to the plant roots with solution fertilization than when granular fertilizers are spread on the soil surface. Example: 750 plants/A x 0.5 oz N/plant/yr = 375 oz N/A/yr. If using ammonium nitrate (34-0-0), then 375 oz N/A/yr/16 oz/lb = 23 lbs N/A/yr/0.34 N/fertilizer = 70 lbs fertilizer/A/yr. If fertigation five times per year, 70 lbs ammonium nitrate for five applications = 14 lbs in stock solution per irrigation.

**# 136** **Fertigation should be used when possible to improve fertilizer efficiency. The amount of nitrogen required when applied with microirrigation is about one-half of the recommended surface-applied granular fertilizer rate.**

Record the amount of time required for water to flow to the farthest emitter when the irrigation is turned on, and then add a few minutes for a safety margin. The length of time required to inject the fertilizer should be at least as long as it took to fully charge the system. 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 of the fertilizer solution has been flushed from the irrigation pipes.

# Pest Management Planning

Nursery operators can anticipate certain pest problems by knowing the crop history of a field. If a field has been in sod, for instance, expect grubs. When sod is killed, root-feeding grubs remain. These grubs will feed on the roots of liners planted into the field unless control measures are taken. Pest management is a primary cultural consideration when designing the layout of a field nursery. A nursery operator should review the requirements of specific crops in relation to the soil characteristics. For example, birch and willow can tolerate wetter soils than dogwood or pine. Plant locations and potential pesticide programs are easily changed during planning but are expensive to alter once the field has been planted. In addition to proper field nursery design, any practice that will reduce stress on the plant while promoting healthy, vigorous growth will reduce pest problems.

## *Weed and Groundcover Management Planning*

The most important weed management tasks are done before planting. Good site preparation includes controlling the difficult perennial species such as trumpet creeper, multiflora rose, mugwort, Florida betony, kudzu, and hedge bindweed before planting. Manual or mechanical control of perennial weeds can be difficult and costly once the field is planted. Controlling perennial weeds requires killing the root system, because most perennial weeds will re-grow if only the shoots are destroyed. There are three options for controlling perennial weeds: cultivation, systemic post-emergence herbicide (glyphosate), or fumigation. While cultivation can be effective against certain perennial weeds, multiple cultivations over a period of several months are often required to control the root systems. Before cultivating, determine what types of weeds exists in case this information is needed for other control options. Furthermore, some perennial weeds such as mugwort are spread by cultivation. Systemic ***post-emergence*** herbicides such as glyphosate (Roundup-Pro and many other trade names) will control many perennial weeds, but timing of the application is critical to ensure satisfactory perennial weed control.

Planting each species in separate blocks allows for more options in weed control. For example, separate hemlocks from other conifers because hemlocks are sensitive to some pre-emergence grass herbicides. Similarly, plant deciduous shrubs separated from evergreens because pre-emergence and post-emergence herbicide options are different.

Fumigation is used to eradicate infestations of weeds, soil-borne insects, nematodes, or pathogens that cannot be controlled adequately after the crop is planted. If inspection standards for noxious pests cannot be met by any other means, then fumigation may be the most practical pest control strategy particularly for valuable, pest-prone crops. Fumigants are highly toxic chemicals and kill most insects, pathogens, nematodes, and weeds. Regardless of the fumigant used, soil preparation is the key to successful sterilization. Soil should be cultivated twice to a depth of six to eight inches: once seven to ten days before fumigation and once immediately before fumigation. Tillers and rotovators are excellent for this purpose. At treatment time, the soil should be free of clods and fresh organic debris, moist enough for seed germination, and have a temperature greater than 55 F at the 6-inch depth. Because most fumigants are inactivated by high levels of un-decomposed organic material (such as roots, stumps, leaves, and grass), remove organic debris or allow it to decompose before fumigation. If the soil is not properly prepared and free of fresh organic matter, there may be insects, diseases, nematodes, or weeds present that the fumigant will not kill. Fall is an excellent time to fumigate because soils are warm and proper moisture levels are easier to attain. Rooting beds and seedbeds are used frequently during the cold winter months. If they have not been fumigated in the fall, it is very difficult to achieve the required temperature and moisture conditions needed to fumigate in the winter or early spring.

**# 137** **New production fields should be sampled for nematode populations. If nematodes are present at levels that can cause damage, select resistant crops or consider fumigation.**

## *Weed Scouting*

Scouting the fields for weeds will enable the nursery operator to determine which weeds are present and to plan appropriate management strategies. Field nurseries should be scouted at least twice a year - in late summer or early fall, and again in early summer. In late summer most summer annual, perennial, and biennial weeds are easily identified. In early summer, winter annuals, perennials, and summer annuals that escaped control procedures can be identified. Weed scouting involves assembling an inventory of the weeds in each block. This is done by simply walking each field and recording the species encountered. Then, highlight the most important species - those that are most prevalent, perennial, new to the field, on noxious weed lists, or should have been controlled by the weed management program in place. With this information, the nursery operator can better plan a weed management program that matches the needs of each crop and field.

## *Between-Row Vegetation Management*

Vegetation between rows of plants is managed to prevent encroachment of the vegetation into the plant rows, eliminate habitat for vertebrate pests (such as deer) and to provide improved access to the field. Use mowing, cultivation, sub-lethal rates of herbicides (referred to as chemical mowing), or growth regulators to slow growth but not kill vegetation between rows. The most common vegetation management practices are cultivation and mowing. Cultivation is discouraged because this leads to erosion, excessive soil displacement around the stem of plants and may actually spread perennial weeds. Mowing is conducted numerous times each year. However, the interval between mowing events can be extended by careful selection and use of plant growth regulators.

***Pre-emergence*** herbicides are applied before weeds emerge and immediately after the liner is planted. This prevents weed seeds from germinating from several weeks to months. As with any tool, each herbicide has unique characteristics that should be considered when planning a weed management program. Because pre-emergence herbicides will not control emerged weeds, they should be applied before weeds germinate. Frequency of herbicide application will depend upon the herbicides residual, but usually two or three applications are required per year. Residual weed control will increase with increasing herbicide application rate; but control decreases with increasing amounts of rainfall or irrigation, higher temperatures, and adsorption of herbicide to organic matter. The proper herbicide for each situation will be dictated by the crop species, weed species, and other label requirements.

Post-emergence herbicides are classified as systemic or contact, and as selective or nonselective. Systemic herbicides are absorbed and move throughout the plant. These are useful for controlling perennial weeds. For best control, the weeds must be actively growing so the herbicides can move throughout the plant. Contact herbicides kill only the portion of the plant that is actually contacted by the herbicide. Non-selective herbicides have the potential to kill or injure any plant they contact; whereas, selective herbicides kill some types of plants and not others. All post-emergence herbicides have a specified drying time ranging from 30 minutes to six hours for maximum effectiveness. This is the length of time that needs to pass after herbicide application before irrigation or rain to ensure that the herbicide has had adequate time to enter the plant. Although post-emergence herbicides labeled for field production remain in the soil for a relatively short length of time after application, they generally have little or no activity in the soil; therefore, multiple applications are needed for perennial weeds. The majority of herbicides used for post-emergence weed control in field production are used either for grass control or for nonselective weed control. Products that provide nonselective weed control should not be applied to the foliage or green stems of ornamental plants as severe injury or plant death may occur.

**# 138** **Perennial weeds should be controlled prior to planting.**

## *In-Row Vegetation Management*

The two basic strategies for in-row vegetation management are (1) residual, relying primarily on pre-emergence herbicides, and (2) non-residual, relying almost exclusively on non-selective post-emergence herbicides. Each strategy has its advantages and disadvantages. The residual approach will utilize more expensive herbicides but will require fewer trips through the fields. The non-residual approach is simple and inexpensive but will require many trips across the fields each season to control emerged weeds.

For the residual strategy, pre-emergence herbicides are applied in late winter to control summer annual weeds, and late summer to control winter annual weeds. Depending upon the local conditions and the weeds and pre-emergence herbicides used, an additional treatment in early spring or early fall may be required.

The non-residual strategy involves frequent applications of non-selective, post-emergence herbicides. Treat weeds when they are six to eight inches in height; this will enable the applicator to contact weeds and avoid the crop. Persistent perennial weeds are spot treated with appropriate post-emergence herbicides or removed mechanically. A common practice is to combine a pre-emergence and post-emergence herbicide to control a broad spectrum of weeds. It is common during production to treat fields every four to six weeks, but the interval between applications will vary with weed spectrum present, the mode of action of the herbicide used, and the prevailing weather conditions. Frequent field scouting should be conducted to identify the appropriate times for treatment, so a weed-free area centered on the row of nursery plants is maintained.