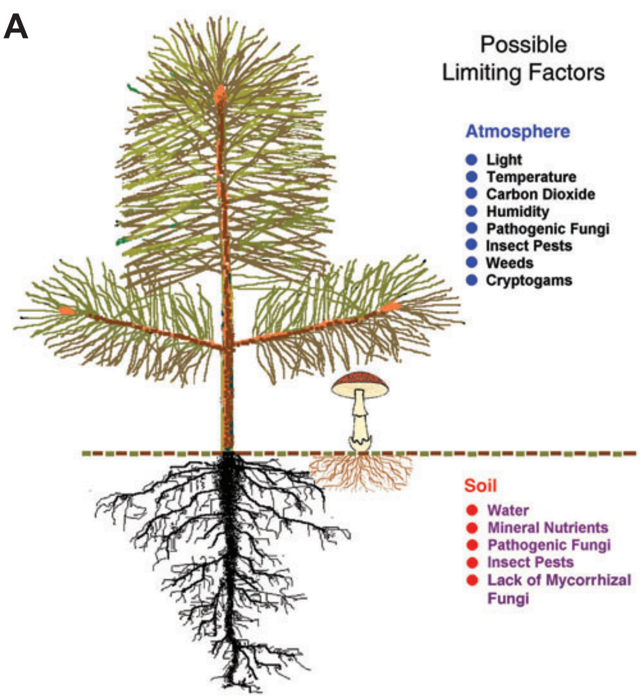
Chapter 1. Basic Concepts of Growing Native Plants

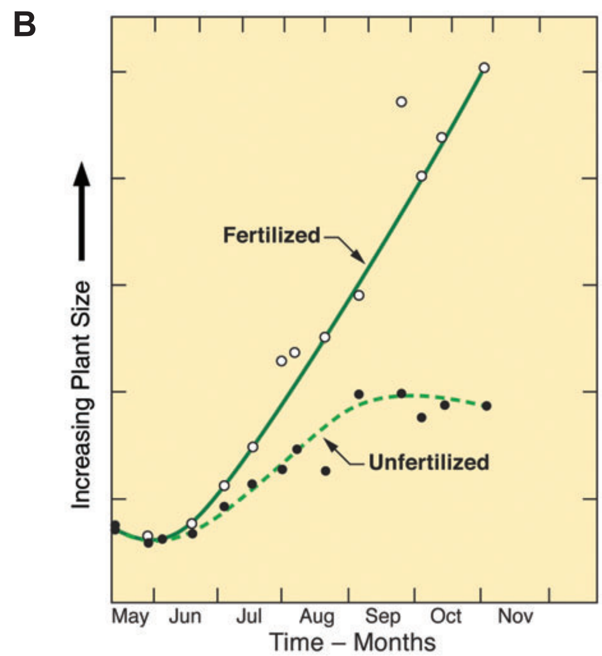
This booklet was written for the novice who wants to grow native plants and may also wonder what is involved in starting a nursery. If you think that operating your own native plant nursery as a business is your calling, then this manual, and particularly this first chapter, can help you move forward. If, however, you plan to grow native plants for fun, perhaps for use around your home or as a science fair project, this manual can still give you the basic information required for you to be successful, and all the concepts provided in this chapter are still applicable.

Much has been written about growing trees and commercial conifers in particular, and the same basic principles can be used to grow native shrubs, forbs, ferns, wildflowers, and grasses. Growing native plants involves a unique combination of science and art. Although this book explains the basic science of growing native plants, a good grower must also have skills that can be acquired only through innate ability or experience. Collectively, these special skills are what is commonly known as having a "green thumb."

1.1 Factors That Limit Growth

To grow plants well, it is important to understand what limits growth. Ecologists refer to this as the concept of limiting factors and it can be helpful to people starting a native plant nursery. It states that, although a biological process such as growth is affected by several factors, the rate of that process is controlled by the factor that is most limiting. If we apply this concept to nursery culture, we can identify those environmental factors that would be potentially limiting to plant growth and design our nursery to overcome them (Figure 1.1A). For example, water is often limiting so we supply plenty of quality water through irrigation. The concept of limiting factors is easy to demonstrate; when fertilizer was provided to spruce seedlings, their growth increased significantly compared with those plants grown without fertilizer (Figure 1.1B), indicating that the lack of fertilizer was limiting growth.





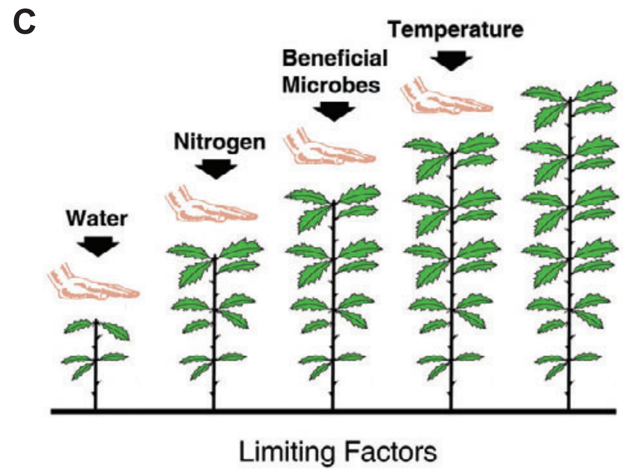


***Figure 1.1**—Many environmental factors can limit plant growth (A), and we can overcome most of those limitations in nurseries. For example, supplying fertilizers greatly increases plant growth (B). Typically, more than one factor is limiting so their effects can be sequential and cumulative. In this example (C), water is the most limiting factor but once we supply irrigation then nitrogen becomes most limiting, and so on.*

Note that plant growth is usually limited by more than one factor and that these limiting factors are sequential—as soon as you satisfy one, another one becomes limiting. Only when we overcome all the environmental factors that limit plant growth can we achieve their maximum growth (Figure 1.1C).

By managing growth-limiting factors we can develop an environment suitable for growing plants, our "propagation environment"; this is any location that has been modified for the purpose of growing plants. Propagation environments can be as simple as a garden plot where water and fertilizer are applied, or as complex as high-tech greenhouses that also modify light, temperature, humidity, and carbon dioxide levels.

1.2 Starting Your Own Nursery

If you decide to start a native plant nursery, the first question to answer is whether it should be a bareroot or container facility. Limiting factors must be considered when deciding between a bareroot or container nursery, and often, the lack of a suitable nursery soil is the critical factor. Your general climate is also critical because greenhouses used to grow seedlings in containers are best at high latitudes or elevations where extremely short growing seasons make bareroot production impractical. Under some circumstances, the most appropriate nursery includes bareroot and container capabilities.

1.2.1 Bareroot Nurseries

Bareroot nursery plants are, as their name implies, harvested and outplanted (planted at their final destination) without any soil around their roots (Figure 1.2A). They are grown in open fields in native soil (Figure 1.2B), and consequently, the quality of the soil and water is critical. The types of bareroot seedlings (stocktypes) include those grown from seeds or rooted cuttings. Sometimes these seedlings are transplanted, physically removed from their original nursery bed, and moved to a different bed for an additional 1 or 2 years' growth. In bareroot nurseries, plant growth rate is controlled by local climate because it determines the length of the growing season. Although any good garden soil can be used to produce bareroot seedlings, large, quality bareroot nursery sites are difficult to find in convenient locations, and good agricultural land is often expensive. Due to land and equipment costs, a considerable capital investment is usually required to develop a bareroot nursery of any size. However, compared to container nurseries, energy requirements and operating expenses are relatively low.

A

B

Figure 1.2*—Bareroot seedlings are stored and shipped for outplanting without soil around the root system (A). They are grown in outdoor nursery "beds" in native soil and are exposed to local weather conditions (B).*

1.2.2 Container Nurseries

Most native plants are grown in containers filled with an artificial substrate (growing medium) rather than soil (Figure 1.3A). In colder climates, plants are grown in a controlled environment, such as a greenhouse, where all growth-limiting factors can be controlled (Figure 1.3B), whereas in milder climates, container plants can be grown in outdoor growing areas. Because the volume of growing medium is relatively small, the roots bind the medium into a cohesive "plug" by the time they are harvested (Figure 1.3C). Although they are also called "containerized," "container-grown," or "plug" seedlings, we prefer the term "container plants" because it is simple and definitive.

Container nurseries can be located on land with low agricultural value that would be unsuitable for bareroot seedling production. Fully controlled greenhouses require expensive structures and environmental controls, but open growing compounds are much less costly. Because container seedlings are grown at high densities, considerably less land is required than would be needed to produce a similar number of bareroot seedlings. Container plants can have high growth rates, especially in fully controlled environments, and so many crops can be produced in one growing season.

Many things must be considered when deciding whether to start a bareroot or container nursery. It is helpful to list the various considerations side-by-side for ease of comparison (Table 1.1).

A

B

C

Figure 1.3*—Container plants are grown in artificial growing media (that is, not native soil) in some type of special propagation container (A), and raised in a propagation environment designed to minimize factors that potentially limit growth (B). By the end of the growing season, container plants are harvested with the root system and growing media forming a "plug" (C).*

Table 1.1—Many factors should be considered when deciding whether to start a bareroot or container nursery.

Factor	Container Nursery	Bareroot Nursery
Land Requirement	Less land needed	More land needed
Soil Quality	Not important because artificial growing media are used	Critical—sandy loams are preferred
Water Quantity	Lesser amounts required	Greater amounts required
Water Quality	Good water is desirable but some problems can be chemically corrected	Good water is critical
Propagation Structures	Depends on location, size, and complexity of the nursery	None
Equipment	Depends on size and complexity of the nursery	Tractors and specialized equipment for sowing and harvesting
Duration of Crop Cycle	4 to 12 months to several years depending on container size	1 to 3 years
Crop Storage and Transportation	Greater volume required	Lesser volume required
Plant Handling	Roots are protected in plug	Roots are exposed and are often treated for additional protection
Season Seedlings Can Be Outplanted	Year-round if soil moisture is good	Spring or sometimes Fall

1.3 Seeds and Other Propagules

A “propagule” is any plant part that can be used to produce another plant. These are typically either seeds (sexual propagation) or cuttings (asexual or vegetative propagation). To determine which type of propagule would be most efficient, you should become familiar with the life cycle of the plants that you wish to grow and how they reproduce in nature. For example, common snowberry produces abundant white fruits (Figure 1.4A), but the small seeds (Figure 1.4B) do not germinate reliably. Therefore, native plant nurseries usually propagate this species from another type of propagule—stem cuttings, a form of vegetative propagation (Figure 1.4C). Many native plants do not produce a reliable crop of viable seeds every season, which is another reason that growers sometimes prefer to propagate from cuttings. The rooting ability of cuttings also varies with the time of the year, so growers must collect cuttings carefully at the proper season. Some species can be propagated from either seeds or cuttings. Quaking aspen seeds are very small and don’t store well, but this species does produce root sprouts, which can be collected and used as propagules (Figure 1.4D). Some plants with branches that grow low along the ground naturally root into the soil, so each branch section with roots can be a propagule—a propagation method called layering (Figure 1.4E). Many grasses and other grass-like plants have extensive root masses that can be divided into propagules (Figure 1.4F). If the native plant you want to grow produces bulbs, the bulblets that form naturally around the perimeter are potential propagules (Figure 1.4G). Other natives, such as woodland strawberry, produce stolons, which are specialized horizontal stems that produce new shoots and roots that can be used as propagules (Figure 1.4H). Seed (sexual) propagation will be discussed in Chapter 3 and vegetative (asexual or cutting) propagation in Chapter 4.

When collecting or purchasing propagules, the sex and genetics of the resulting plants must be considered. It is important to consider where seedlings will be planted before you begin to grow them. Native plants are adapted to their local growing conditions so it is usually best to collect seeds or cuttings from plants growing near the eventual outplanting site. This is important because moving a plant from one environment to another induces stress. Often the result is poor growth or even death. In addition, collecting propagules from a variety of individual plants ensures that the genetic diversity of the resulting nursery plants represents the original population of plants (see Chapter 2 for more information). In addition, plants that reproduce sexually (through flowering) obtain a mixture of genetic characteristics in their offspring, so each new plant will appear slightly different from its parents and each other (Figure 1.5). About 15% of native plant species are, however, dioecious, which means that plants are either male or female. This is important for species that are often propagated by cuttings, such as willows and cottonwoods, because taking cuttings from a single plant means that all new plants will be the same sex and have exactly the same genetics as the source plant; so because sexual and genetic diversity are desired, it is even more important to collect a few propagules from a large population of source plants.

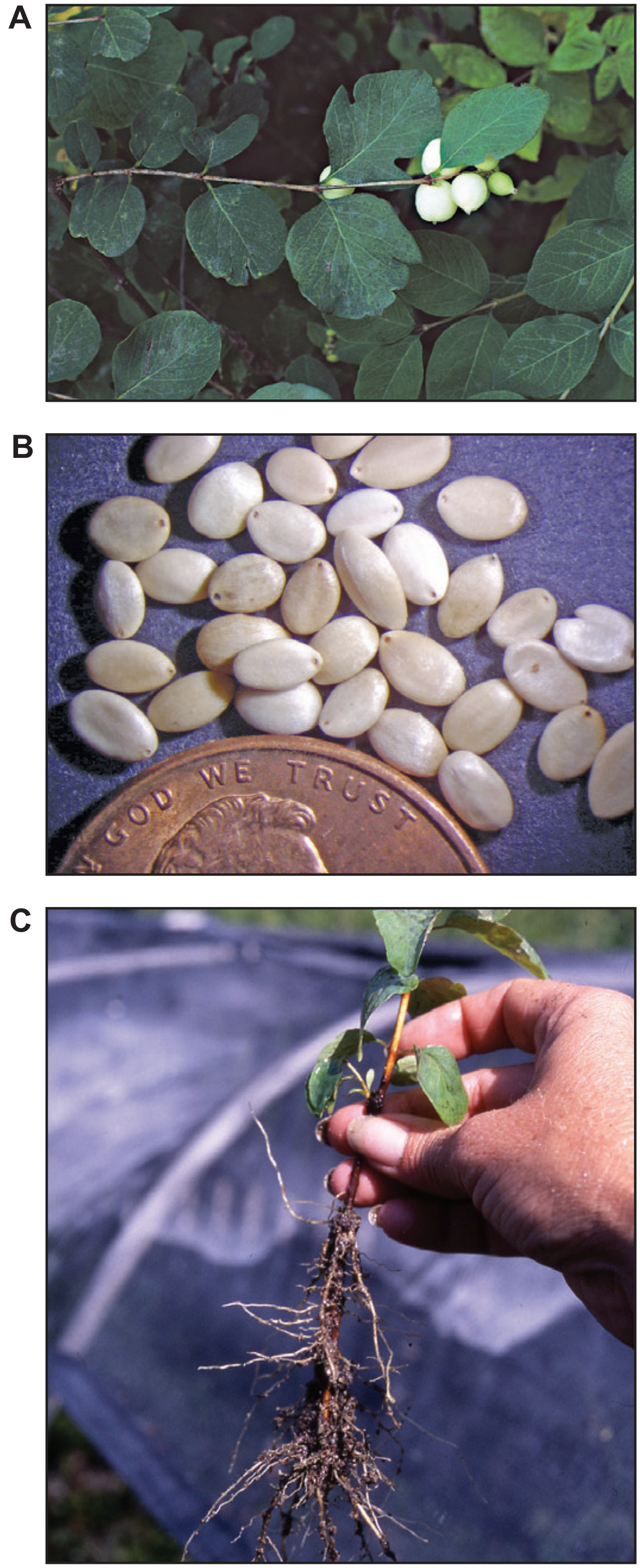
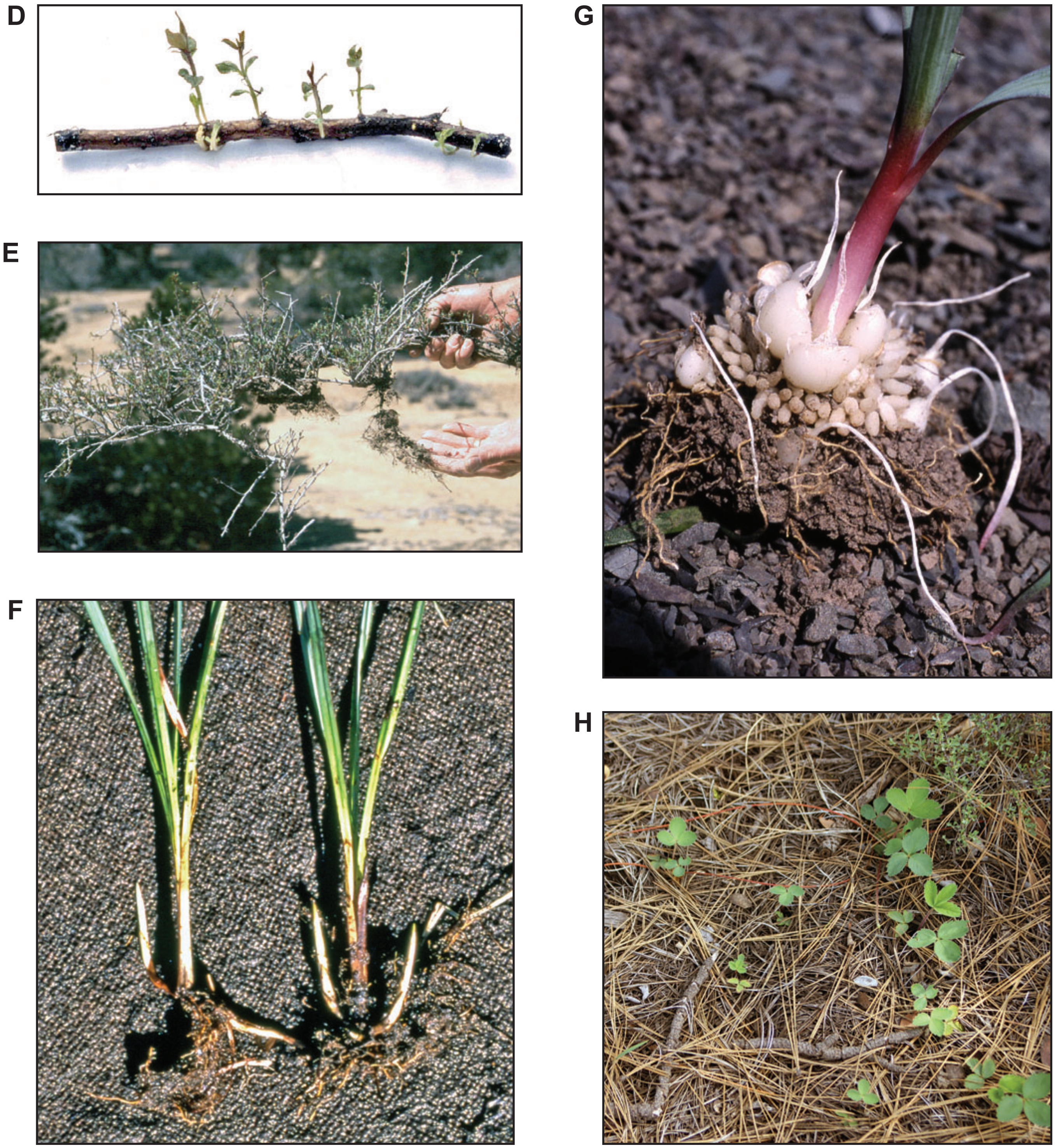


Figure 1.4—*Types of propagules used to grow native plants include fruits (A) containing seeds (B), stem cuttings (C); continued on next page.*

Figure 1.4—*(Continued) Types of propagules used to grow native plants include root sprouts (D), layers (E), divisions (F), bulblets (G), and stolons (H).*



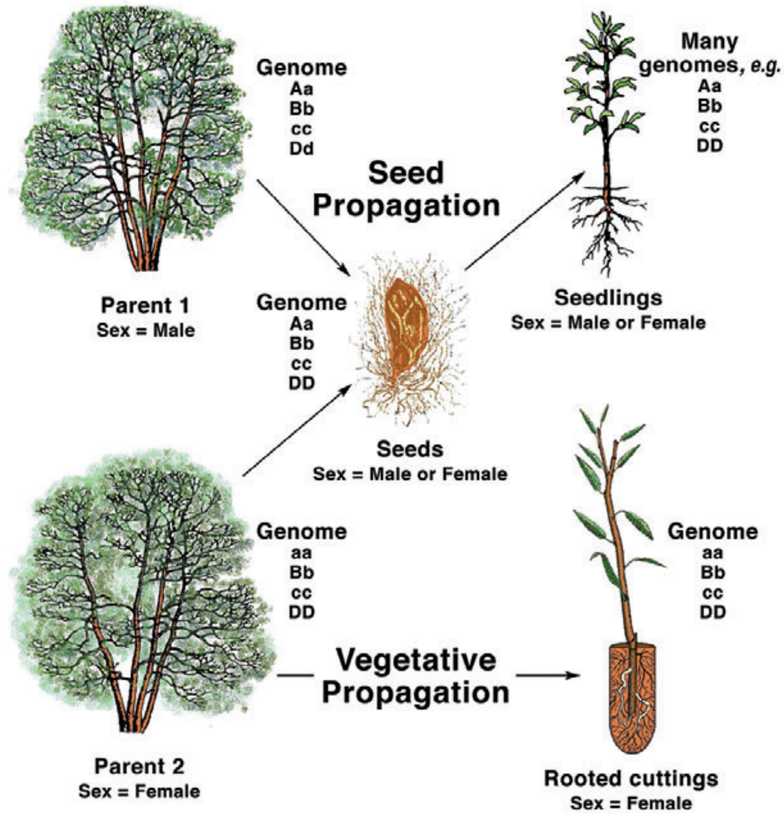


Figure 1.5*—Plants propagated from seeds may look different from their parents and their siblings because they contain a mixture of the genetic characteristics of each parent. Conversely, vegetative cutting propagation produces exact duplicates of the parent plant (“clones”).*

1.4 Crop Scheduling

Once the best propagation technique has been identified, then the grower must do some planning and consider several different factors (Figure 1.6). Species characteristics, genetic variability, and availability of propagules were discussed in the previous section, and now we’ll cover crop scheduling. The final cost of producing a crop depends on all these factors but especially the choice of propagation method—plants propagated from seeds are always less expensive to produce than those from cuttings.

Native plant growth and development, whether in nurseries or in the wild, is controlled by two factors: genetics and environment. Genetics are predetermined but, as we discussed earlier, you can control the propagation environment and minimize the effects of growth-limiting factors. All native plants follow a typical annual growth cycle, which begins when seeds germinate or seedlings resume shoot growth in early spring and continues until the plants become dormant in the fall. For nursery planning purposes, plant growth and development during the year can be divided into three

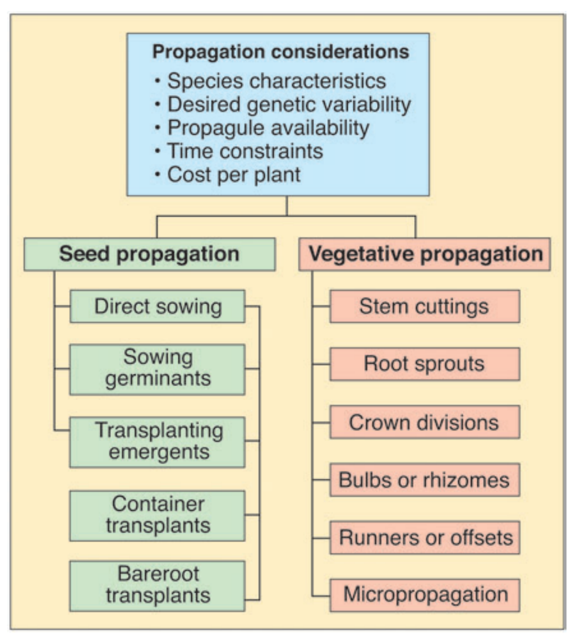


Figure 1.6*—A successful native plant nursery is based on proper planning and many factors must be considered.*

consecutive growth phases: establishment, rapid growth, and hardening. Because cultural objectives are different for each phase, the growing environment and perhaps even the type of propagation structure may be different. The amount of time required for each of these growth phases varies depending on species, the propagule collection location (that is, the "seed source"), type of propagation environment, and cultural practices. Nursery managers use growth data from previous crops to estimate the duration of each phase and total length of the crop cycle.

1.4.1 Seedling Growth Phases

1.4.1.1 Establishment—In the case of seed propagation, the establishment phase begins when seeds are sown, continues through seed germination and emergence, and generally ends when the young seedlings develop true leaves. For vegetative propagation, the phase begins when the cuttings are struck into the container and ends when cuttings have rooted.

1.4.1.2 Rapid Growth—The rapid growth phase is so-named because it is during this period that young nursery plants increase rapidly in size; in general, most of this increase in biomass is shoot tissue with relatively less root growth—some native plants, especially those adapted to harsh, dry sites, may do just the opposite, growing more roots than shoots . With seedlings, this phase begins after the cotyledon stage when the new shoot begins to grow at an accelerated rate and ends when plants have reached their target size.

1.4.1.3 Hardening—During the hardening phase, plants divert energy from shoot growth to stem diameter and root growth, and gradually become conditioned to withstand cold temperatures and the rigors of harvesting, shipping, and outplanting. In general, the cultural objective is to stop shoot growth, initiate development of a terminal bud in determinate species, and improve the plant's tolerance to colder temperatures.

1.4.2 Crop Production Schedules

The first and most long-term type of growing schedule is the crop production schedule, which is designed to help nursery managers visualize "the big picture." These schedules typically are designed on a month-by-month time scale, cover at least 1 year, and include all phases of nursery production from crop planning to outplanting (Figure 1.7). Many nursery customers fail to appreciate how long it really takes to grow native plants crop, so crop production schedules are particularly useful for explaining all the various steps in the nursery process and the time involved. For example, a crop production schedule will illustrate that it will be necessary to ship seeds to the nursery several months prior to sowing, especially if germination tests and presowing seed treatments are necessary. These growing schedules are also useful in illustrating how different seedling stocktypes are produced, the time required to grow them, and when they would be available for outplanting.

1.4.3 Solar Timing

Because of seasonal changes in the Temperate Zone, native plant crops are usually scheduled around the solar cycle (Figure 1.8). Both light intensity and daylength vary considerably during the year, so nursery managers plan their crops around the summer solstice to take full advantage of available sunlight. This is particularly critical for container nurseries that grow two crops per season. The first crop must be sown very early so that they can be large enough to move out of the greenhouse in time to allow plenty of sunlight for the second crop. Planning around the solar calendar also ensures that crops perceive the naturally shortening daylengths that queue them to prepare for winter.

1.5 The Right Plant for the Right Place

Although many people think that all plants of the same species are alike, they can be very different. We already discussed that plants can have different genes, which means they may have different morphology (how they look) and physiology (how they function).

The best nursery stock has the proper morphological characteristics (such as height, stem diameter, and root volume) and physiological characteristics (such as dormancy status and cold hardiness) to have maximum survival and growth for a particular outplanting site. Seedlings being grown for a very dry place need thicker stem diameters, shorter shoots, and more roots than those being grown for a very moist place. Seedlings being grown for a very mountainous site must survive colder temperatures than seedlings being grown for valley locations. Trees for urban landscapes or orchards can be quite large with a large ball of soil around the roots because they will have better care after planting. The type of tool used to plant the seedlings will also affect how the seedlings must look in the nursery. Remember, before starting your crop, it is always important to consider where the plants will be outplanted to ensure they are adapted to the environment, the conditions on the planting site, and the type of planting tool.

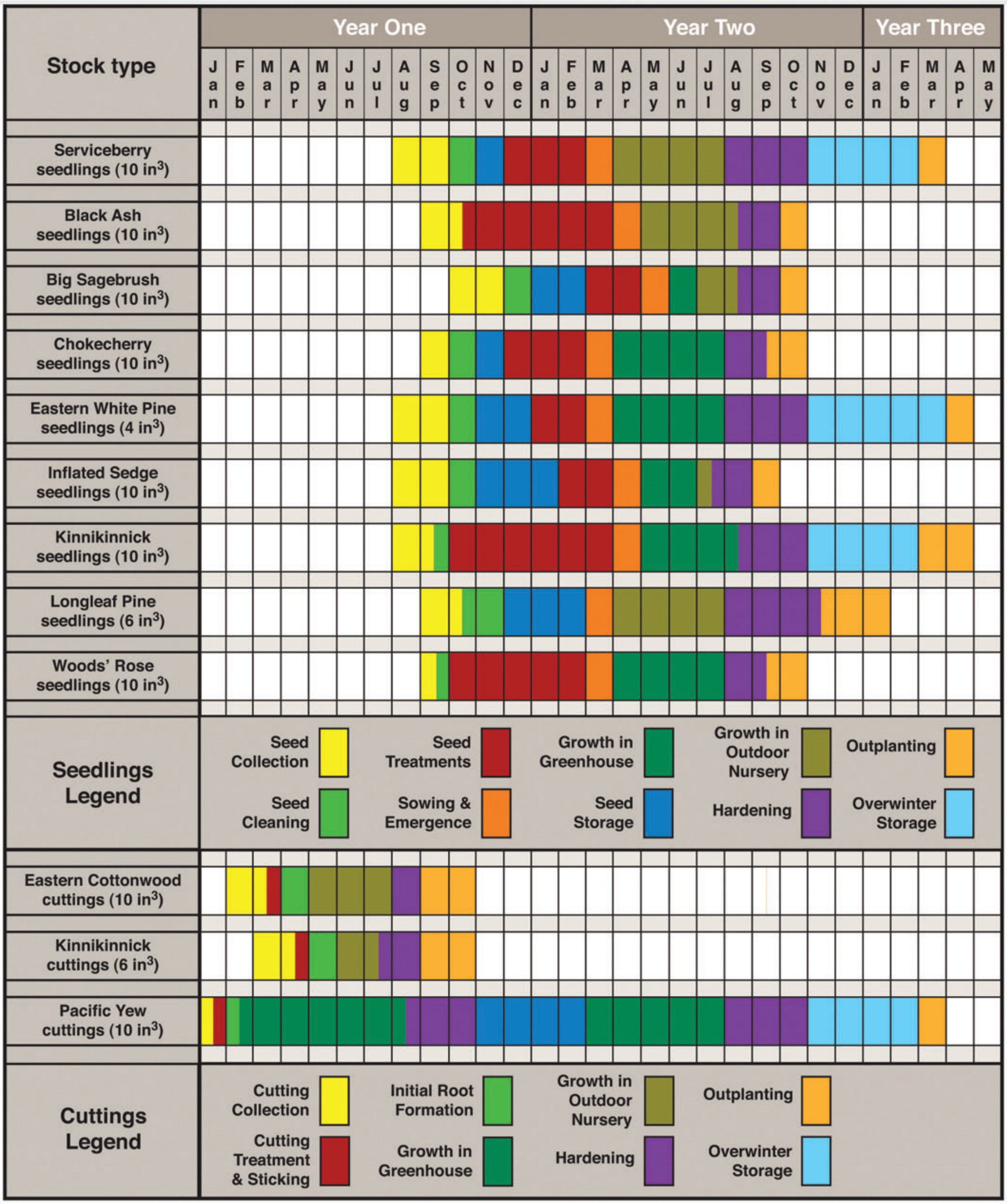


Figure 1.7*—Crop production schedules give a chronological view of the necessary steps to produce a native plant crop, and how long it takes to complete each of those steps. Schedules are useful planning aids for nursery managers as well as their customers.*

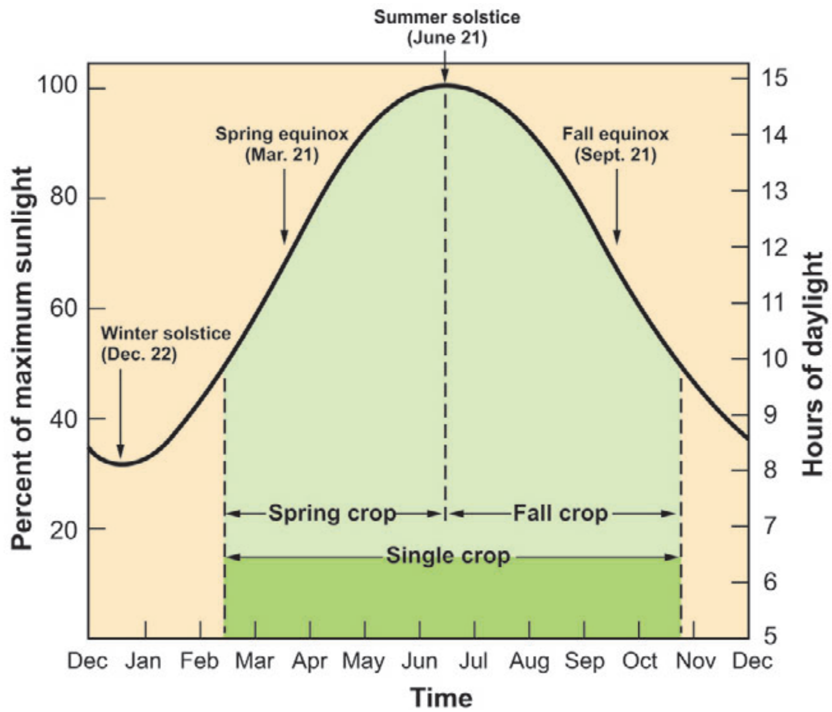


Figure 1.8*—Native plant crops should be scheduled around the annual solar cycle to take advantage of available sunlight; this is especially important for nurseries that plan to grow two crops each year.*

1.6 Additional Reading

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