Dedication

To the Penn State Extension Master Gardeners in recognition of their outstanding volunteer efforts promoting sustainable horticultural practices and environmental stewardship in Pennsylvania communities.

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Introduction to the Penn State Extension Master Gardener Program

As a volunteer for the Penn State Extension Master Gardener program, you will be representing Penn State. For this reason, it is important for you to become familiar with the history and organization of Penn State Extension and understand the responsibilities of a Master Gardener.

THE LAND-GRANT SYSTEM AND COOPERATIVE EXTENSION

Land-grant institutions constitute a uniquely American educational system. Before the latter half of the nineteenth century, when the land-grant system was created, America’s colleges and universities existed primarily to prepare wealthier citizens for the professions of medicine, law, and the ministry. As the need for higher education grew, educators and politicians proposed a different kind of university—one devoted to educating all people, particularly those seeking a vocation in the nation’s businesses, farms, and trades. The result was the land-grant institution.

A remarkable cooperation among federal and state governments, university educators, and laypeople marked the creation and growth of the land-grant system. It was established with the Morrill Act of 1862, by which Congress provided large grants of federal land for each state to sell. The states were to use these funds to create an endowment, on which interest would accrue to sustain the colleges. It soon became apparent that these monies were insufficient, and with the second Morrill Act of 1890, Congress provided for additional federal funding. The act also established funding for a second system of land-grant institutions in 16 southern states where existing land-grant colleges practiced segregation. Thus, historically black land-grant institutions joined the system.

At this time, colleges were severely hampered by the general lack of sound research in support of teaching. In 1887, Congress passed the Hatch Act to create and support experiment stations. Then in 1914, the Smith-Lever Act created Cooperative Extension as a partnership among federal, state, and county governments for its support and oversight. The Smith-Lever Act gave land-grant institutions the responsibility “to aid in diffusing among the people of the various states, useful and practical information on subjects relating to agriculture and home economics; and to encourage the application of the same.”

The land-grant idea evolved to include three central functions: resident teaching, research, and extension. Cooperative Extension is the premier organization for fulfilling the extension function of each state’s land-grant institution.

Cooperative Extension’s ultimate goal is personal development—to enable people to be self-directed, manage their resources, and handle change in primary dimensions of their lives. The means for personal development is education, which empowers
Basic Botany

CHAPTER 2
INTRODUCTION

Botany is the science of plants. A study of botany is important for understanding horticulture, the art and science of cultivating vegetables, fruits, and ornamental plants. Home horticulture is the use of these arts and sciences by the home gardener. Taxonomy is the science dealing with the naming and classification of plants and animals.

To gain a working knowledge of horticulture, it is necessary to understand the structure and function of plants, as well as the environmental factors that affect their growth. All plants have certain structures and functions in common, as discussed throughout this chapter. Much of the information presented relates to higher plants, the seed-producing flowering plants and gymnosperms that are of greatest importance to horticulture, rather than more primitive spore-producing plants such as mosses, ferns, and their relatives. All vegetable and flowering ornamental plants are angiosperms, which produce seeds inside a fruit, while conifers and their relatives are gymnosperms, which produce seeds but lack protective fruits.

Life Cycles

Plants are classified by the number of growing seasons required to complete their life cycle.

Annuals pass through their entire life cycle, from seed germination to seed production, in one growing season and then die. Examples are sunflowers and pot marigolds.

Biennials start from seed and produce vegetative structures and food-storage organs the first season. During the first winter, a hardy evergreen rosette of basal leaves persists. During the second season, the rapid elongation of the flower stalks, called bolting, occurs; flowers, fruit, and seeds develop to complete the life cycle. The plant then dies. Carrots, beets, cabbage, celery, and onions are biennials whose flowers produce seeds that develop the second year of growth. Hollyhock, Canterbury bells, foxglove, and sweet William are biennials commonly grown for their attractive flowers.

Perennial plants live for two or more years. After reaching maturity, they typically produce flowers and seeds each year. In areas of the country that experience frost, perennials are classified as herbaceous if the top dies back to the ground each winter and new stems grow from the crown each spring. They are classified as woody if the top persists, as in shrubs or trees.

CLASSIFICATION OF THE PLANT WORLD

Plants are vital to our existence. In an effort to provide a means to catalog information about the vast number of living plants, scientists have classified them into various groups based on shared characteristics that are inherited from one generation to the next (Fig. 2-1).

Individual plants are grouped into species, or groups of individuals that share close
a common or vernacular name. The first letter of the genus is capitalized, the specific epithet is lowercased, and both are either underlined or written in italics. Examples of species names are *Cucumis sativus* (cucumber), *Lathryus odoratus* (sweet pea), and *Cercis canadensis* (eastern redbud).

The Latinized species name is a universal format used worldwide and should be understood by everyone discussing a plant. Common names, on the other hand, are just that—common to a particular area, region, or country—and may not provide accurate identification of a plant in all situations.

*Nymphaea alba* (European white waterlily), for example, has 245 different common names across Europe. The Latinized species name is thus best used in discussions of plants since it is unique to this species.

Some plants may have a third Latinized name after the genus and specific epithet. Used to designate a variety, it is preceded by “var.,” which signifies a group of plants subordinate to the species. The differences between varieties within a particular species are inheritable and passed on to succeeding generations. However, the morphological differences between two varieties of a particular species are smaller than the morphological differences between two different species. Varieties of a species are usually interfertile, while different species are usually not. Examples of varieties include *Cercis canadensis* var. *alba*, which has white flowers, and *Gleditsia triacanthos* var. *inermis*, a thornless variety of common honeylocust.

Another common horticultural term is cultivar, short for cultivated variety. A cultivar is a collection of cultivated plants that are clearly distinguished by certain characteristics and when reproduced (sexually or asexually) retain their distinguishing characteristics. Cultivars do not occur in nature and must be maintained under cultivation. Cultivar names are written in a modern language, not italicized, set within single quotation marks, and with the first letter of each word capitalized.

Examples of cultivars are *Acer platanoides* ‘Crimson King’, and *Cornus florida* var. *rubra* ‘Cherokee Chief’. ‘Crimson King’ maple has purple foliage instead of green like the species, and ‘Cherokee Chief’ dogwood has flowers of a deeper red than the variety *rubra*.

Occasionally, a plant name may have “×” between the genus and species. This represents an interspecific hybrid resulting from a cross between two species within the genus. An example is *Viburnum × burkwoodii*—Burkwood viburnum that resulted from a cross between *V. carlesii* and *V. utile*. 

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**Fig. 2-2. Principal parts of a vascular plant.**
Plant Propagation

CHAPTER 3
appear, there is less chance it will spread. Seedlings in rows are easier to label and handle at transplanting time than those that have been sown in a broadcast manner. Sow the seeds thinly and uniformly in the rows by gently tapping the packet of seed while moving it along the row. Lightly cover the seeds with dry vermiculite or sifted medium if they require darkness for germination. A suitable planting depth is usually about twice the diameter of the seed.

Do not plant seeds too deeply. Extremely fine seed such as that of petunia, begonia, and snapdragon are not covered but lightly pressed into the medium or watered in with a fine-mist spray. If these seeds are broadcast, strive for a uniform stand by sowing half the seeds in one direction and then sowing the remaining seeds in the other direction.

Large seeds are frequently sown into some sort of a small container or cell pack, eliminating the need for early transplanting. Usually two or three seeds per unit are sown and then thinned later to allow the strongest seedling to grow.

**Seed Tape**

Most garden stores and seed catalogs offer indoor and outdoor seed tapes, which have precisely spaced seeds enclosed in an organic, water-soluble material. When planted, the tape dissolves and the seeds germinate normally. Seed tapes are especially convenient for tiny, hard-to-handle seeds. However, tapes are much more expensive per seed. Seed tapes allow uniform emergence of seedlings, eliminate overcrowding of seedlings, and permit sowing in perfectly straight rows. The tapes can be cut at any point for multiple row plantings, and thinning is rarely necessary.

**Pregermination**

Another method of starting seeds is pregermination, which involves sprouting the seeds before they are planted in pots or the

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**Table 3-1. Seed requirements.**

<table>
<thead>
<tr>
<th>Plant</th>
<th>Approximate Germination Time (Days)</th>
<th>Germination Temperature (°F)</th>
<th>Germinate in Light or Dark</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>12 Weeks or More to Seed before Last Spring Frost</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Begonia</td>
<td>10–15</td>
<td>70</td>
<td>Light</td>
</tr>
<tr>
<td>Browallia</td>
<td>15–20</td>
<td>70</td>
<td>Light</td>
</tr>
<tr>
<td>Geranium</td>
<td>10–20</td>
<td>70</td>
<td>Light</td>
</tr>
<tr>
<td>Larkspur</td>
<td>5–10</td>
<td>55</td>
<td>Dark</td>
</tr>
<tr>
<td>Pansy (Viola)</td>
<td>5–10</td>
<td>65</td>
<td>Dark</td>
</tr>
<tr>
<td>Vinca</td>
<td>10–15</td>
<td>70</td>
<td>Dark</td>
</tr>
<tr>
<td><strong>10 Weeks to Seed before Last Spring Frost</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dianthus</td>
<td>5–10</td>
<td>70</td>
<td>Either</td>
</tr>
<tr>
<td>Impatiens</td>
<td>15–20</td>
<td>70</td>
<td>Light</td>
</tr>
<tr>
<td>Petunia</td>
<td>5–10</td>
<td>70</td>
<td>Light</td>
</tr>
<tr>
<td>Portulaca</td>
<td>5–10</td>
<td>70</td>
<td>Dark</td>
</tr>
<tr>
<td>Snapdragon</td>
<td>5–10</td>
<td>65</td>
<td>Light</td>
</tr>
<tr>
<td>Stock</td>
<td>10–15</td>
<td>70</td>
<td>Either</td>
</tr>
<tr>
<td>Verbena</td>
<td>15–20</td>
<td>65</td>
<td>Dark</td>
</tr>
<tr>
<td><strong>8 Weeks to Seed before Last Spring Frost</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ageratum</td>
<td>5–10</td>
<td>70</td>
<td>Light</td>
</tr>
<tr>
<td>Alyssum</td>
<td>5–10</td>
<td>70</td>
<td>Either</td>
</tr>
<tr>
<td>Broccoli</td>
<td>5–10</td>
<td>70</td>
<td>Either</td>
</tr>
<tr>
<td>Cabbage</td>
<td>5–10</td>
<td>70</td>
<td>Either</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>5–10</td>
<td>70</td>
<td>Either</td>
</tr>
<tr>
<td>Celosia</td>
<td>5–10</td>
<td>70</td>
<td>Either</td>
</tr>
<tr>
<td>Coleus</td>
<td>5–10</td>
<td>65</td>
<td>Light</td>
</tr>
<tr>
<td>Dahlia</td>
<td>5–10</td>
<td>70</td>
<td>Either</td>
</tr>
<tr>
<td>Eggplant</td>
<td>5–10</td>
<td>70</td>
<td>Either</td>
</tr>
<tr>
<td>Head Lettuce</td>
<td>5–10</td>
<td>70</td>
<td>Light</td>
</tr>
<tr>
<td>Nicotiana</td>
<td>10–15</td>
<td>70</td>
<td>Light</td>
</tr>
<tr>
<td>Pepper</td>
<td>5–10</td>
<td>80</td>
<td>Either</td>
</tr>
<tr>
<td>Phlox</td>
<td>5–10</td>
<td>65</td>
<td>Dark</td>
</tr>
<tr>
<td><strong>6 Weeks to Seed before Last Spring Frost</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aster</td>
<td>5–10</td>
<td>70</td>
<td>Either</td>
</tr>
<tr>
<td>Balsam</td>
<td>5–10</td>
<td>70</td>
<td>Either</td>
</tr>
<tr>
<td>Centurea</td>
<td>5–10</td>
<td>65</td>
<td>Dark</td>
</tr>
<tr>
<td>Marigold</td>
<td>5–10</td>
<td>70</td>
<td>Either</td>
</tr>
<tr>
<td>Tomato</td>
<td>5–10</td>
<td>80</td>
<td>Either</td>
</tr>
<tr>
<td>Zinnia</td>
<td>5–10</td>
<td>70</td>
<td>Either</td>
</tr>
<tr>
<td><strong>4 Weeks to Seed before Last Spring Frost</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cosmos</td>
<td>5–10</td>
<td>70</td>
<td>Either</td>
</tr>
<tr>
<td>Cucumber</td>
<td>5–10</td>
<td>85</td>
<td>Either</td>
</tr>
<tr>
<td>Muskmeleon</td>
<td>5–10</td>
<td>85</td>
<td>Either</td>
</tr>
<tr>
<td>Squash</td>
<td>5–10</td>
<td>85</td>
<td>Either</td>
</tr>
<tr>
<td>Watermelon</td>
<td>5–10</td>
<td>85</td>
<td>Either</td>
</tr>
</tbody>
</table>
or tilled under. Detailed instructions are included in the “Composting” chapter of this manual.

Use of Cover Crops

Planting a cover crop is another inexpensive soil improvement method that should not be underestimated (Fig. 4-8). Green manures or cover crops such as annual rye are planted in the garden in the fall for incorporation in the spring. For best results, sow seed shortly before the first killing frost. In a fall garden, plant cover crops between the rows and in any cleared areas. Cover cropping provides additional organic matter, holds nutrients that might have been lost over the winter, and helps reduce erosion and topsoil loss.

Legume cover crops, such as red clover, crimson clover, or hairy vetch, can increase the amount of nitrogen in the soil and reduce fertilizer needs. A deep-rooted cover crop that is allowed to grow for a season in problem soil can help break up compacted soil and greatly improve tilth. Incorporate green manures at least two weeks before planting vegetables. Do not allow cover crops to go to seed.

Regularly adding manures, compost, cover crops, and other organic materials can raise the nutrient level and physical quality of the soil, thus reducing the need for synthetic fertilizers. Desirable soil health does not happen with a single addition, or even several additions, of organic material—it requires a serious soil-building program.

Garden Management

Tilling

Excessive tillage is harmful to soil health in a number of ways. Tillage increases oxygen in the soil, stimulating microbial activity, and results in the decomposition of organic matter. If additions of organic matter are not sufficient to counteract the losses from decomposition, organic matter levels will decline over time, reducing soil health. Inversion tillage and rototilling also reduce the soil coverage provided by crop residues, leaving soil more exposed to erosion. Tillage can also disrupt the network of soil fungi, which can lead to their decline over time. When not managed carefully, most tillage methods compact the subsoil, creating a plow pan that restricts the growth of roots and their access to water and nutrients in the subsoil. Excessive wheel and foot traffic can compact the surface soil, reducing macroporosity and impeding root growth.

Physical disturbances like rototilling can have profound effects on the biological properties of soil. Compaction and the removal of surface residue may contribute to a reduction in soil moisture and living space for soil-dwelling organisms. Diversity and abundance of arthropod predators associated with the soil surface can be greater under reduced-tillage management in comparison to conventional tillage, and natural control of pest insects in soil may be enhanced in reduced-tillage systems. Beneficial insects
Table 7-2. Orders of the class Insecta (adult characteristics).

<table>
<thead>
<tr>
<th>Order</th>
<th>Common Name</th>
<th>Metamorphosis</th>
<th>Mouthparts</th>
<th>Wings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archaeognatha</td>
<td>Jumping bristletails</td>
<td>Simple</td>
<td>Exposed; chewing</td>
<td>None</td>
</tr>
<tr>
<td>Blattodea</td>
<td>Cockroaches, termites</td>
<td>Simple</td>
<td>Chewing</td>
<td>None or two pair</td>
</tr>
<tr>
<td>Coleoptera</td>
<td>Beetles, weevils</td>
<td>Complete</td>
<td>Chewing</td>
<td>Two pair</td>
</tr>
<tr>
<td>Collembola</td>
<td>Springtails</td>
<td>Simple</td>
<td>Concealed in the head; chewing</td>
<td>None</td>
</tr>
<tr>
<td>Dermaptera</td>
<td>Earwigs</td>
<td>Simple</td>
<td>Chewing</td>
<td>None or two pair</td>
</tr>
<tr>
<td>Diplura</td>
<td>Diplurans</td>
<td>Simple</td>
<td>Concealed in the head; chewing</td>
<td>None</td>
</tr>
<tr>
<td>Diptera</td>
<td>Flies</td>
<td>Complete</td>
<td>Sponging/lapping or piercing-sucking</td>
<td>One pair</td>
</tr>
<tr>
<td>Embiidiina</td>
<td>Webspinners</td>
<td>Simple</td>
<td>Chewing</td>
<td>None or two pair</td>
</tr>
<tr>
<td>Ephemeroptera</td>
<td>Mayflies</td>
<td>Simple</td>
<td>Chewing</td>
<td>Two pair</td>
</tr>
<tr>
<td>Grylloblattodea</td>
<td>Rock crawlers</td>
<td>Simple</td>
<td>Chewing</td>
<td>None</td>
</tr>
<tr>
<td>Hemiptera</td>
<td>Aphids, scale insects, true bugs, cicadas, psyllids, leafhoppers, whiteflies</td>
<td>Simple</td>
<td>Piercing-sucking</td>
<td>None, one pair, or two pair</td>
</tr>
<tr>
<td>Hymenoptera</td>
<td>Bees, wasps, ants, sawflies</td>
<td>Complete</td>
<td>Chewing; modified for sucking/lapping</td>
<td>Two pair</td>
</tr>
<tr>
<td>Lepidoptera</td>
<td>Butterflies, moths</td>
<td>Complete</td>
<td>Chewing or siphoning</td>
<td>Two pair</td>
</tr>
<tr>
<td>Mantodea</td>
<td>Mantids</td>
<td>Simple</td>
<td>Chewing</td>
<td>Two pair</td>
</tr>
<tr>
<td>Mantophasmatodea</td>
<td>Rock crawlers</td>
<td>Simple</td>
<td>Chewing</td>
<td>None</td>
</tr>
<tr>
<td>Mecoptera</td>
<td>Scorpionflies and hanging-flies</td>
<td>Complete</td>
<td>Chewing</td>
<td>Two pair</td>
</tr>
<tr>
<td>Megaloptera</td>
<td>Alderflies, fishflies, dobson-flies</td>
<td>Complete</td>
<td>Chewing</td>
<td>Two pair</td>
</tr>
<tr>
<td>Neuroptera</td>
<td>Lacewings, antlions</td>
<td>Complete</td>
<td>Chewing or sucking</td>
<td>Two pair</td>
</tr>
<tr>
<td>Odonata</td>
<td>Dragonflies, damselflies</td>
<td>Simple</td>
<td>Chewing</td>
<td>Two pair</td>
</tr>
<tr>
<td>Orthoptera</td>
<td>Crickets, grasshoppers, katydids</td>
<td>Simple</td>
<td>Chewing</td>
<td>None or two pair</td>
</tr>
<tr>
<td>Phasmatodea</td>
<td>Walkingsticks, leaf insects</td>
<td>Simple</td>
<td>Chewing</td>
<td>Most have none</td>
</tr>
<tr>
<td>Phthiraptera</td>
<td>Lice</td>
<td>Simple</td>
<td>Chewing or sucking</td>
<td>None</td>
</tr>
<tr>
<td>Plecoptera</td>
<td>Stoneflies</td>
<td>Simple</td>
<td>Chewing</td>
<td>Two pair</td>
</tr>
<tr>
<td>Protura</td>
<td>Proturans</td>
<td>Simple</td>
<td>Concealed in the head; scraping/sucking</td>
<td>None</td>
</tr>
<tr>
<td>Psocoptera</td>
<td>Psocids</td>
<td>Simple</td>
<td>Chewing</td>
<td>None or two pair</td>
</tr>
<tr>
<td>Siphonaptera</td>
<td>Fleas</td>
<td>Complete</td>
<td>Chewing or piercing-sucking</td>
<td>None</td>
</tr>
<tr>
<td>Strepsiptera</td>
<td>Twisted-wing parasites</td>
<td>Complete</td>
<td>Chewing</td>
<td>None or one functioning pair</td>
</tr>
<tr>
<td>Thysanoptera</td>
<td>Thrips</td>
<td>Simple</td>
<td>“Punch and suck”</td>
<td>None or two pair</td>
</tr>
<tr>
<td>Thysanura</td>
<td>Silverfish, firebrats</td>
<td>Simple</td>
<td>Chewing</td>
<td>None</td>
</tr>
<tr>
<td>Trachoptera</td>
<td>Caddisflies</td>
<td>Complete</td>
<td>Chewing</td>
<td>Two pair</td>
</tr>
<tr>
<td>Zoraptera</td>
<td>Angel insects</td>
<td>Simple</td>
<td>Chewing</td>
<td>None or two pair</td>
</tr>
</tbody>
</table>
The life strategies of insects are complicated and interrelated in ways that scientists are just beginning to understand. How are hosts or prey chosen? How are they found? Why are some insects very specific feeders while others seem to generalize their food selection? How can some insects feed on very poisonous plants when others cannot? The answers for these questions are as numerous and diverse as the insects that generate them.

**INSECT FORM AND STRUCTURE: MORPHOLOGY**

All adults in the class Insecta possess the following characteristics: three body regions; three pairs of legs; one pair of antennae; and either zero, one, or two pairs of wings. Legs and other appendages are often greatly modified to suit the insect’s environment; the form of its appendages is often used to classify the insect.

**Exoskeleton**

Insects are structured very differently from humans and many other organisms. An insect’s body is not supported internally by a bony skeleton. Insects have their “skeleton” on the outside. Their tough outer body wall is called the exoskeleton. It provides protection from abrasion, helps regulate water loss, protects internal organs, and is the support structure to which the muscles are attached. The exoskeleton is made of hardened plates called sclerites. The outside covering, or integument, is made of layers. The layer closest to the inside of the insect is called the basement membrane. The layer next to the basement membrane toward the outside of the insect is the epidermis. The epidermis secretes a layer called the cuticle, which is the outermost covering of the insect. The cuticle is made up of chitin in a protein matrix. The exact chemical composition of the cuticle varies among insects and even between areas on the same insect. The cuticle is also coated with a series of layers, one of which is the wax layer. The wax layer is the primary mechanism responsible for water regulation, which is extremely important to insect survival. Their small size and relatively large surface area predispose insects to desiccation in the many terrestrial habitats they frequent. If it weren’t for the wax layer of their cuticle, insects would be bound to habitats that would provide enough humidity to prevent their bodies from drying out. Because the exoskeleton is fairly rigid and the cuticle is nonliving, the exoskeleton must be shed and replaced to accommodate growth. This process is called molting. Hormones regulate the digestion of the old exoskeleton and the formation of the new one. All insects go through a series of molts as they grow and reach maturity.

**Body Regions**

The insect’s body is made up of three regions: head, thorax, and abdomen (Fig. 7-1). The head houses the brain and includes important sensory organs, like the eyes and antennae, as well as the...
Table 13-1. Apple cultivars not resistant to apple scab but recommended for home planting in Pennsylvania.

<table>
<thead>
<tr>
<th>Cultivar*</th>
<th>Characteristics</th>
<th>Ripening Period</th>
<th>Planting**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jerseymac</td>
<td>Early ‘McIntosh’ type; crisp red apple of excellent quality; good for eating, sauce, and pies</td>
<td>Late July to early August</td>
<td>A, B</td>
</tr>
<tr>
<td>Ginger Gold</td>
<td>New golden-type apple ripening in mid- to late August; high-quality, russet-free fruit; good for eating fresh and pies</td>
<td>Mid-August</td>
<td>C</td>
</tr>
<tr>
<td>Gala</td>
<td>New orange-red fruit; sweet and hard with high quality; developed in New Zealand; good for eating fresh</td>
<td>Late August to September</td>
<td>B, C</td>
</tr>
<tr>
<td>McIntosh</td>
<td>Old-time favorite; purchase new high-coloring strains; available as a spur type</td>
<td>Early September</td>
<td>A</td>
</tr>
<tr>
<td>Spartan</td>
<td>‘McIntosh’ type but ripens later; small- to medium-sized, red fruit; high-quality dessert apple</td>
<td>Mid-September</td>
<td>B</td>
</tr>
<tr>
<td>Delicious</td>
<td>Most popular commercially grown cultivar; available in spur and nonspur strains</td>
<td>Early to mid-October</td>
<td>B</td>
</tr>
<tr>
<td>Empire</td>
<td>Dark red; excellent dessert quality; all-purpose apple that keeps well</td>
<td>Mid- to late September</td>
<td>B, C</td>
</tr>
<tr>
<td>Golden Delicious</td>
<td>Excellent all-purpose apple; heavy producer; avoid spur strains (tend to russet more than nonspur strains)</td>
<td>October 1 to 15</td>
<td>B, C</td>
</tr>
<tr>
<td>Idared</td>
<td>Increasingly popular cultivar; produces large, mildly tart, red fruit; keeps well</td>
<td>October 1 to 15</td>
<td>A, B</td>
</tr>
<tr>
<td>Jonagold</td>
<td>Developed in New York as cross between Jonathan and ‘Golden Delicious’; high-quality fruit; red blush over yellow skin; triploid; produces sterile pollen (see pollination section)</td>
<td>October 1 to 15</td>
<td>A, B</td>
</tr>
<tr>
<td>Stayman</td>
<td>Very popular old standard cultivar; red fruit usually develops some russetting at the stem end; may split on tree; good for fresh eating, pies, sauce; keeps well</td>
<td>October 1 to 15</td>
<td>A</td>
</tr>
<tr>
<td>Spigold</td>
<td>Tender-skinned, high-quality, greenish-yellow fruit; triploid; produces sterile pollen (see pollination section)</td>
<td>October 16 to 30</td>
<td>B</td>
</tr>
<tr>
<td>Braeburn</td>
<td>Newer apple cultivar; ripens in mid- to late October; red over green fruit; semi-tart but very firm</td>
<td>Mid-October</td>
<td>A, B</td>
</tr>
<tr>
<td>Mutsu</td>
<td>Cross between ‘Golden Delicious’ and ‘Indo’; very large, light-green to yellow fruit; triploid; produces sterile pollen</td>
<td>October 16 to 30</td>
<td>B</td>
</tr>
<tr>
<td>Fuji</td>
<td>Developed in Japan; one of latest ripening grown in Pennsylvania; may have difficulty maturing fruit each year above Interstate 80; very firm, sweet, red over green fruit; stores extremely well in regular refrigeration</td>
<td>Late October</td>
<td>B</td>
</tr>
</tbody>
</table>

*In order of ripening period.
**To ensure pollination and fruit set, plant cultivars having a common letter.

*Potomac: Released in 1993, this pear was developed by traditional breeding methods from a cross of ‘Moonglow’ and ‘D’Anjou’. Fruit is light green and glossy with a flesh that is moderately fine and has a flavor similar to that of ‘D’Anjou’. Harvest fruit about three weeks after ‘Bartlett’.

*Magness: Developed from a cross of ‘Seckel’ and ‘Comice’, this medium-sized pear has a greenish-yellow and slightly russeted color. The flesh is sweet and juicy with few grit cells. Fruit matures about September 12 in southcentral Pennsylvania.
\textbf{Shinseiki}: Sometimes listed under the name ‘New Century’, this cultivar matures the first week of September. Its medium-sized fruit has yellow skin with some russetting.

\textbf{Kosui}: Small, yellow-brown fruit matures in central Pennsylvania the first week in September.

\textbf{Olympic}: Also known as ‘A-Ri-Rang’ or ‘Korean Giant’, this cultivar produces large fruit that weighs nearly a pound, as the latter name indicates. Fruit is round with an attractive golden-russeted skin and stores for several months.

\textbf{Ya Li}: The greenish-yellow fruit of this cultivar has more of a traditional European pear shape and is harvested in mid-October in central Pennsylvania.

\textbf{Shinko}: This is the latest-maturing Asian pear cultivar, ripening the end of October in central Pennsylvania. Its medium-sized fruit has a golden-brown russet. Trees must be thinned shortly after bloom to prevent alternate bearing. Of the Asian pears, this cultivar probably has the most resistance/tolerance to fire blight.

\textbf{Nursery Stock Selection}

The old adage “You get what you pay for” is an important consideration when buying fruit trees. Bargain plants may be unhealthy or of a cultivar that is not adapted to your area. Buy only trees of recommended cultivars from a reliable source. Here are a few points to keep in mind when purchasing fruit trees:

- Apple and pear trees are now available as either one-year-old “whips” (without branches) or one- and two-year-old trees with branches (often referred to as “feathered”).
- Feathered trees are preferred because they will produce fruit earlier, but they cost more than one-year-old whips.
- Look for trees that are 5 to 6 feet tall and have a minimum ½-inch caliper, a good root system, and four to six branches.
### Table 19-3 (continued)

<table>
<thead>
<tr>
<th>Name, Family, and Origin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phytolacca americana</strong> (Fig. 19-32) Common pokeweed Pokeweed family (Phytolaccaceae) North America</td>
<td>Large 3- to 8-foot perennial that resembles a small tree. Arising from seeds or large, red-tinged fleshy taproot. Light-green, smooth, lanceolate to egg-shaped alternate leaves, often reddish on undersides. Reddish stems. Small, white flowers in long, purple-stemmed hanging clusters. Berries green at first, turning glossy, dark purple, leaving a purple-red stain. Poisonous.</td>
</tr>
<tr>
<td><strong>Plantago lanceolata</strong> (Fig. 19-33) Buckhorn plantain Plantain family (Plantaginaceae) Europe</td>
<td>Perennial that reproduces by seed. Basal rosette of narrow lanceolate leaves that have nearly parallel veins. Fibrous roots. Small clusters of flowers in tan-green head on erect leafless flower stalks less than 12 inches tall.</td>
</tr>
<tr>
<td><strong>Plantago major</strong> (Fig. 19-34) Broadleaf plantain Plantain family (Plantaginaceae) North America</td>
<td>Perennial similar to buckhorn plantain. Basal rosette of broad, oval leaves with five to seven nearly parallel veins. Small flowers clustered along tan-green, erect, leafless stalks less than 12 inches.</td>
</tr>
<tr>
<td><strong>Polygonum cuspidatum</strong> Japanese knotweed* Buckwheat family (Polygonaceae) Eastern Asia</td>
<td>Shrubby herbaceous perennial to height of 10 feet. Leaves 6 inches long by 3 inches wide, oval, with smooth margins. Stems similar to bamboo, but on newer foliage with a membranous sheath surrounding area where stem and leaf meet. Small, greenish-white flowers in spikes along the stems. Small, greenish, triangular fruits. Reproduces from heavy rhizomes.</td>
</tr>
</tbody>
</table>

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Fig. 19-32. *Phytolacca americana* (common pokeweed).
Fig. 19-33. *Plantago lanceolata* (buckhorn plantain).
Fig. 19-34. *Plantago major* (broadleaf plantain).
Abiotic: nonliving entities that can affect an ecosystem. These entities do not grow, reproduce, or spread from plant to plant.

Abscisic acid: a plant hormone that promotes leaf detachment, induces seed and bud dormancy, and inhibits germination.

Abscission: the natural detachment of plant parts, typically dead leaves and ripe fruit.

Acaricide: pesticide that controls mites, ticks, and spiders.

Acclimatization: the process of adapting to new environmental conditions (e.g., reducing or increasing the amount of light levels that a plant is exposed to in order to avoid shocking the plant).

Acidic: containing or having the properties of an acid with a pH below 7.0.

Active ingredient: a substance in a pesticide that is biologically active.

Adjuvants: any substance added to the spray tank to modify a pesticide's performance, the physical properties of the spray, or both.

Adsorption: the adhesion of ions, atoms, or molecules from a gas or liquid to a surface.

Adventitious: plant structures, such as buds, shoots, or roots, developing from an unusual position (i.e., other than from a terminal or axillary position).

Aeration: a method for removing plugs of soil in the turf, creating a system of large pores to increase permeability of water and air.

Aerobic: living or occurring in the presence of free oxygen.

Aerosols: low-concentrate solutions that are usually applied as a fine spray or mist.

Aggregate (soil): mass of soil particles, such as a clod, crumb, block, or prism.

Aggregate fruit: develops from a single flower that had several ovaries (e.g., raspberry).

Alien: with respect to a particular ecosystem, any species that is not native to that ecosystem; alien species may or may not be invasive; also called nonnative or exotic.

Alkaline: containing or having the properties of an alkali with a pH above 7.0.

Allelopathy: a biological modification of the environment to enhance the survival and reproduction of the plant modifying the soil while interfering with the success of neighboring plants.

Amendment: any material added to soil that improves its physical or chemical condition.

Ametabolous: no metamorphosis.

Anaerobic: living or occurring in the absence of free oxygen.

Andromonoecious: having perfect and staminate flowers on the same plant.

Angiosperms: a flowering plant whose seeds are enclosed within an ovary (fruit).

Annual: plant that lives for only one growing season, during which time it grows, flowers, and produces seed, and dies.
Anther: the pollen-producing tip of the male reproductive organ (stamen).

Anvil pruner: pruner with a top cutting blade that presses against a bottom, noncutting, flat blade, resulting in some crushing of living plant tissue; best suited for dead plant material.

Apical dominance: the influence exerted by a terminal bud in suppressing the growth of lateral buds.

Apical (terminal) bud: a bud located at the apex of a stem that exerts a strong chemical control over the lateral buds lower on the stem.

Artificial classification: classification of plants that is based on habitat, flower color, or growth pattern.

Asexual (vegetative) propagation: production of a new plant by using a part of a parent plant via budding, grafting, cuttings, or division. Reproduction of a plant without the use of a seed.

Auxin: a hormone created in the terminal bud that flows down the stem and suppresses the growth of other buds and keeps them dormant.

Avicide: chemical for controlling pest birds.

Axil: the angle formed between a leaf stalk and the stem to which it is attached. In flowering plants, buds develop in the axils of leaves.

Axillary bud: an embryonic shoot that lies at the junction of the stem and petiole of a plant; most lateral buds arise in the axis of a leaf.

Bacterium: a single-celled, microscopic organism having a cell wall but no chlorophyll; reproduces by cell division.

Baits: a formulation made by adding the active ingredient to an edible or attractive substance; often used to control slugs, snails, or small ground insects and rodents.

Band: application of fertilizer or pesticide to a strip over or along each crop row.

Bark: outermost tissue of a woody stem that usually includes phloem and xylem.

Berry: a simple fruit that is derived from one flower and contains one ovary.

Biennial: a flowering plant that takes two years to complete its biological life cycle; vegetative growth develops the first year; flowering and fruiting occur in the second year.

Binomial system of nomenclature: classification system developed by Carl Linnaeus in which the scientific name for an organism is composed of two Latin terms that designate the genus and specific epithet.

Bioaccumulate: the gradual building up of pesticide residue in the bodies of animals and humans.

Biological control: involves the use of a living organism (insects, beneficial nematodes, or pathogens) to reduce insect populations.

Biotic disease: caused by living entities such as a bacterium, fungus, mycoplasma, or virus, and can spread easily from one plant to another.

Black water: any water that is run through the toilet.

Blade: the expanded, thin structure on either side of the midrib of a leaf; usually the largest and most conspicuous leaf part.
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