SELECTING FRUITING CULTIVARS AND ROOTSTOCKS

Perhaps one of the more important pre-plant decisions to be made involves cultivar and/or rootstock choice. This decision should not be taken lightly. It should not be left to the local nursery owner, and it should not be based on what surplus nursery stock happens to be on hand for a bargain price at the time. Sometimes this decision must be made and an order placed a year or two in advance so that the propagating wholesale nursery will have time to propagate the desired cultivar on the desired rootstock and to permit obtaining disease-free plant material. Because cultivar performance affects success at every step of the enterprise, cultivars should be chosen that function well during many facets of the fruit production cycle. Specific characteristics of cultivars to be considered before the choice is made include:

1. *Adaptation response*. Within fruit and nut species, each cultivar has unique physical and physiological traits preconditioned by its genetic profile. The expression of these traits is influenced by the planting environment (e.g., climate, soil characteristics, horticultural factors) to produce a phenotype. The adaptation response of a cultivar can be defined as how well the genetic and environmental components of phenotype complement one another to form a highly productive plant with desirable characteristics. Many cultivars perform well in only specific climatic regions (e.g., warm versus cold, wet versus dry) or in specific types of soils (e.g., well-drained, high organic matter), whereas others are more widely adapted. A widely adapted cultivar, even though highly productive under broad environmental conditions, may vary in some phenotypic traits (e.g., size, vigor) when grown in different regions.

2. *Response to growing system*. A cultivar’s adaptation response is also highly dependent on the growing system under which it is cultured. For instance, highly efficient cultivars that partition more of their energy to reproduction than to vegetative growth may be the most suitable for high-density plantings. Some fruit cultivars require extensive support or trellising to perform well, whereas others can be cultured as free standing plants. In some climatic areas, small fruits, such as strawberries or raspberries, can be grown as annuals. However, successful annual production schemes require the use of cultivars that are uniquely suited to, and sometimes specifically bred for, production under this system.

3. *Growth form (habit), vegetative vigor, and size at maturity*. These three interrelated cultivar characteristics can influence light penetration and air movement within the planting
and often direct horticultural factors such as plant spacing, training, trellising and pruning systems, fertilization and irrigation practices, equipment use, and harvest techniques. The importance of considering these characteristics when selecting cultivars is obvious, especially for tree fruit genotypes, which often differ widely in size and vegetative vigor. Apples, cherries, grapes, pears, walnuts, and many other woody fruit and nut species are often propagated by budding or grafting cultivars with desired growth and fruiting characteristics to related rootstocks that exhibit superior climatic and edaphic (soil) adaptation responses. Rootstocks are frequently from a different species within the genus, and they often affect the size, precocity, and reproductive capacity of the cultivar under production. The ability of the East Malling and Malling Merton series of apple rootstocks to produce ultimate tree sizes ranging from dwarf to full stature are perhaps the most well-known examples of this phenomenon (Fig. 19–9). For some fruit species, cultivar choice is conditioned partly by selecting for the most appropriate growth habit. For instance, cane fruit cultivars can be classed as trailing, semitrailing, or erect, and they differ widely with respect to their ability to produce fruit without trellising. Half-high blueberry cultivars (interspecific hybrids of highbush and lowbush species) are short enough in stature that fruit buds are often protected from winter temperature extremes by snow cover. For growers in many northern regions, choosing a half-high cultivar is imperative because cultivars that are standard size are unprofitable to grow.

4. Flowering and fruiting characteristics. Beyond a doubt, aspects of flowering and fruiting are extremely important determinants of cultivar performance. For instance, many well-known standard apple cultivars such as ‘McIntosh,’ ‘Delicious,’ and ‘Golden Delicious’ have strains that are spur-bearing, allowing for relatively direct comparisons between the two flowering types. Spur-type strains are generally smaller than their standard counterparts; as such, their within-row spacing is often reduced by comparison. Spur-type strains also exhibit greater fruit-setting ability and higher yields per unit trunk cross sectional area. Because spur-types often produce a greater yield (i.e., higher number of fruit per tree), however, their fruit, on an individual basis, are generally smaller than those of the standard strains. Fruit from spur-type strains are usually more mature (contain less starch) at harvest, but they develop less red peel color and contain lower levels of sugars and acids. They are firmer after storage but can exhibit a greater amount of green-colored flesh. Other
horticultural differences characterizing standard and spur-type strains have been studied. For instance, spur-types are more drought resistant.

Flower initiation, as conditioned by levels of stored carbohydrates (energy) and hormones, is often balanced in the plant with the needs of the developing fruit. The alternate bearing phenomenon in fruit and nut tree crops results from a physiological imbalance usually brought about by the loss of a season’s crop to frost or a similar physiological calamity. The lack of a crop during this initial off year shifts the tree’s physiology to an extent that an overabundance of flower buds are initiated for the following season (the on year). If not severely thinned the following spring, these flowers will develop excess fruit of poor size and quality. Large numbers of developing fruit during floral initiation will severely limit the number of flower buds produced, thus triggering another off-year. This cyclic phenomenon is difficult to correct once it has been initiated. In particular, apple cultivars differ markedly in their propensity for alternate bearing; ‘Golden Delicious’ and ‘Bradbury’ are susceptible, ‘Gala’ and ‘Delicious’ are moderately susceptible, and ‘Jonathan’ and ‘Granny Smith’ are somewhat resistant to this phenomenon.

Growers must also consider differences in the dormancy or chilling requirements of species and cultivars within species when planning a fruit planting. Plants with relatively low chilling requirements may not be suitable for areas with dramatic climate fluctuations in early spring. These plants often resume growth too early during warm weather spells and then are easily damaged by subsequent frosts. Cultivars with relatively high chilling requirements and that flower later than others are better choices for these areas. Often a flowering delay of seven to ten days is significant. Conversely, successful fruit growing in southern locations often requires plants with low chilling requirements.

Until a few decades ago, blueberry production in southern states of the United States was based entirely on cultivars of rabbiteye blueberry. However, federal and state fruit breeders have developed specific low-chill highbush blueberry cultivars (e.g., ‘Sharpblue,’ Gulf Coast,’ and ‘Cape Fear’) with improved fruit quality for these regions. These cultivars are steadily gaining popularity among growers. Self-fruitfulness is also an important cultivar consideration. Most apricots, blackberries, currants and gooseberries, highbush blueberries, grapes, peaches, raspberries, sour cherries, strawberries, and walnuts are predominantly self-fruitful, but some cultivars within this group require cross-pollination for adequate fruit set.
Even though cultivars may be self-fruitful, fruit production and/or fruit size may be increased when cross pollination occurs. Cultivars of apple, almond, hazelnut, muscadine grape, rabbiteye blueberries, sweet cherries, and other species are considered to be predominantly self-unfruitful, but the degree of unfruitfulness may also vary among cultivars. For instance, the sweet cherry ‘Stella’ can be produced without additional pollinator cultivars. In contrast, some cultivars of almond must be self-pollinated. Cultivars of European and Japanese plum, pear, and chestnuts are highly variable with respect to their cross pollination requirements. Regardless of self- or cross compatibility, cultivars may vary in the timing or spatial arrangement of pollen shed and stigma receptivity, thus requiring the movement of pollen from one flower to another for adequate fruit set. Species and cultivars may also differ in their requirement for insect vectors to accomplish this task.

5. Disease and insect tolerance or resistance. The incorporation of increased insect and disease tolerance or resistance into desirable cultivars and rootstocks has perhaps received more emphasis and effort by both public and private hybridizers than any other fruit crop improvement goal. The diversity and extent of biotic stresses that may affect fruit culture is too large a topic for an adequate discussion of specific examples of tolerant or resistant cultivars or rootstocks in this textbook. However, the major biotic pests of tree and small fruit crops are listed in Tables 19–1 and 19–2, respectively. Climatic and soil conditions affect the incidence and severity of biotic pests. For instance, Phytophthora root rots may be common on heavy soils, whereas nematodes are more frequently a problem in sandy soils. Choosing tolerant or resistant cultivars or rootstocks is always wise, especially if they are available for specific disease or insect problems in the proposed production area. The culture of resistant or tolerant genotypes increases the probability of harvesting a marketable crop of high quality and lowers production inputs for chemical or biological control measures. Environmental concerns surrounding the use of agrichemicals and public awareness of and concern about health and food safety issues emphasize the desirability of tolerant or resistant cultivars and rootstocks for the production of fruit.

6. Winter hardiness and/or tolerance to abiotic stresses. Winter hardiness—the ability to withstand severe midwinter temperatures—is often the product of a plant’s unique physical and physiological characteristics and is conditioned by the success of the hardening-off process as the plant enters dormancy in late fall. Within most temperate fruit species, a
broad range in winter hardiness can be found among cultivars and among rootstocks. For example, the crowns of many strawberry cultivars are severely injured or killed if they are exposed directly to temperatures lower than \(-12^\circ C\) (15°F), but cultivars like ‘Fort Laramie’ and ‘Ogallala’ developed in the United States, in Wyoming, tolerate winter extremes approaching \(-40^\circ C\) (\(-40^\circ F\)). The degree of winter hardiness displayed by a given cultivar or rootstock often limits its range, with only the most hardy cultivars being suitable for planting in colder climates of either hemisphere. For instance, most European wine grape cultivars can be cultured successfully in California and the Pacific Northwest, but only the hardiest among them, such as ‘White Riesling,’ ‘Lemberger,’ ‘Cabernet Franc,’ and perhaps ‘Chardonnay,’ are recommended for production in northern and central US states. Fruit cultivars and rootstocks also differ in their ability to withstand heat; wind; and adverse soil conditions such as drought, waterlogging, low or high pH, and mineral imbalances.

7. Ripening period. Fruit harvest, handling, marketing, and storage are often labor-intensive, time-consuming events, so it is fortunate that cultivars differ substantially with respect to when they ripen their fruit. In most production regions, a selection of cultivars and/or cultivar-rootstock combinations can be planted to extend the harvest season through one to two months, or perhaps longer. For instance, in the US Midwest, early apple varieties (e.g., ‘Pristine’) are harvested as early as mid-August, whereas late varieties (e.g., ‘Fuji,’ ‘GoldRush’) are not harvested until very late October or early November. In the same region, highbush blueberry cultivars such as ‘Earliblue’ or ‘Bluetta’ can be harvested mid-to late June, whereas ‘Elliott’ berries ripen in mid-September. The harvest of primocane fruiting raspberry or blackberry cultivars begins in late summer and can continue until frost. Aside from horticultural advantages (e.g., greatly simplified pruning procedures), primocane fruiting cane fruit cultivars increase the market presence and consumer awareness of these crops. With the range of standard (summer-bearing) and primocane fruiting cultivars available, it is now possible to produce fresh red raspberries in the Pacific Northwest from mid-June to frost.

8. Quality and desirability. Fruit quality can be defined in many ways, and the term can be interpreted differently by producers and consumers of fresh or processed fruit products. Producers often consider fruit quality characteristics that affect the harvestability, ease of shelling (in nut crops), storage, shipping, and shelf life of the product, whereas ample evidence suggests that consumers value fruits and nuts for nutritional and health benefits as
well as for their flavor and other sensory characteristics. Fruit cultivars often differ considerably in firmness at harvest and susceptibility to bruising during handling, storage, and shipment. Furthermore, differences in post-harvest respiration rates and other physiological characteristics make some cultivars suitable for longterm storage, whereas others cannot be stored for more than a few months, or even days in the case of soft fruits. Rapid cooling and subsequent refrigeration after harvest as well as the employment of controlled atmosphere storage and modified atmosphere packaging can prolong the useful life of most cultivars. Nevertheless, cultivars respond differently to these treatments. For instance, some apple cultivars can be stored successfully for only a few months; others, such as ‘Golden Delicious,’ can be marketed eight or nine months after harvest if they are stored properly.

Consumers, on the other hand, purchase fruits and nuts based on their appearance first and then on their anticipated nutritional and eating quality. Cultivar name recognition has been a long-standing marketing instrument for crops such as apples, grapes, and pears. Consumers often purchase specific cultivars of these crops based on their intended end use (eating, cooking and baking, canning and sauce or preserve making, etc.). Newer cultivars of apples such as ‘Gala’ and ‘Honeymcisp,’ with improved flavor and texture qualities, are demanding a premium price and greater share of the market than older cultivars with good but less desirable characteristics. The use of name recognition as a marketing tool is likely to increase with time. Breeders are releasing many of their new fruit cultivars with trademarked names specifically for this purpose. Many major food outlets have begun identifying the fruit cultivars they market with specific numeric designations in cases where specific names are not available or used.

Consideration of a cultivar’s quality characteristics, therefore, is extremely important when producers plan new plantings. This may be especially important if the product is to be marketed directly to consumers via farm markets or pick-your-own operations. Admittedly, the perfect fruit cultivar does not exist. Therefore, when planning a new production field, a grower must necessarily weigh the importance of various cultivar characteristics to the ultimate success of the enterprise. Often, it is a good idea to plant several cultivars with a balance of characteristics to offset the vulnerability of establishing only one.
Information concerning the various fruiting cultivars can be obtained from several reliable sources. Most extension bulletins produced by state and federal agencies contain cultivar recommendations for the areas they serve.
Likewise, reliable cultivar information is often available from organized producer groups and/or individual growers, buyers, and packers in the area. Reputable nurseries also publish accurate catalog descriptions of the fruit crops they offer. Opinions may differ among sources, however, so it is often wise to consult several sources concerning the suitability of various possibilities before committing to a specific set of cultivars. It is risky to accept new, untried cultivars or to base the decision solely on nursery advertisements.

REFERENCE
HARTMANNS PLANT SCIENCE 4th ed