Saskatoon Botany

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Table 1. Saskatoon Botany At A Glance

Characteristic	Details
Plant Family	Rose
Latin Name	*Amelanchier alnifolia*
Related Species	Apple, pear, hawthorn, mountain ash
Native Geographic Range	Continental interior of North America
Plant Form	Small to large shrub; small tree
Hardiness	-50 to -60^{o}C
Chilling Requirements	A minimum of 2100 hours at 0 to 4^{o}C to obtain consistent breaking of dormancy
Toxins	Prunasin (cyanogenic glycoside); restricted to new wood, buds, leaves, green fruit
Lifespan	Estimated at 30 to 50 years
Precocity & Maturity	Age at first bearing is 2 to 3 years; mature yields occur at 6 to 8 years of age
Flowering	Flower buds form on 1 year old wood the season prior to bloom; flowering occurs in early- May to early-June over a period of 3 to 20 days; each cluster contains from 1 to 20 flowers
Alternate Bearing	Significant in the cultivars Smoky and Honeywood, and to a lesser extent in the cultivars Northline and Thiessen
Pollination	Self-fruitful; supplementary pollination increases fruit set marginally and fruit seediness markedly; the number of seeds/fruit varies from 1 to 10 with an average of 3
Fruit Loss	A period of well-defined fruit loss follows petal drop; this is caused by disease, insect damage, and late-spring frosts
Days To Ripening	45 to 60 days from bloom
Average Yields/Plant	3.1 to 4.4 kg/plant over a 10 year period; marketable yields are about 90% of total yields
Marketable Crop Yields	An average of 6,000 to 8,600 kg/ha (5,400 to 7,700 lbs/acre) over a 10 year period; maximum marketable yields have attained 31,850 kg/ha (28,430 lbs/acre), as extrapolated from well-managed trial sites; average planting densities are 2,170 plants/ha (880 plants/acre).

Basic Botany Of The Saskatoon

The saskatoon is a perennial, woody, fruit-bearing shrub belonging to the rose family, and native to the interior of the North American continent.

The genus *Amelanchier*, to which the saskatoon belongs, is comprised of about two dozen species of shrubs and small trees distributed in North America, Europe, northern Africa and eastern Asia. The generic name *Amelanchier* has been derived from the French Provencal name, 'amelanche', for the European species, *Amelanchier ovalis*. The word amelanche simply refers to the fruit of *Amelanchier*. Amelanche is a derivation of the Gauloise word for small apple (note - Gauloise was the language of the Celtic peoples who inhabited Gaul, the geographic region that predated modern France, and whose language predates that of old French). The word ‘amelanchier’ first appears in writing in the year 1549, and ‘amelanche’ appears in 1721.

The North American species of *Amelanchier* are variously called by the common names serviceberry, saskatoon, sarviceberry, sarvis, maycherry, Juneberry, Junebush, shadblow, shadbush, shadberry, shadblossom, shadwood, sugar pear, Indian pear, grape-pear, lancewood, boxwood, Canadian medlar, bilberry, snowy mespilus and poirier or petites poires. The French Canadians referred to *Amelanchier* fruit as 'poires' because of the pear-shaped fruit of some species. The English translation, pear, was used by British and American traders. The common name 'serviceberry' may derive from the similarity of the fruit to the service or sarvis, a forgotten English fruit (possibly *Sorbus torminalis*), or from the fact that serviceberry branches were once collected and forced to bloom for mid-winter church services. Shadbush is associated with eastern species that bloom when the shad (a fish) begin to return to their spring spawning grounds.

As botanically classified, the genus *Amelanchier* is a member of the apple subfamily (Pomoideae), within the Rose family (Rosaceae). The species of *Amelanchier* are closely related and often difficult to distinguish. Much of the confusion is due to the extreme variability in foliage characteristics within any given species; leaf shape and size can differ significantly, depending on the stage of development of the plant and the habitat in which the plant grows. The most useful distinguishing characters are associated with the form and structure of the flowers and fruit. The genus *Amelanchier* is different from other members of the apple subfamily on the basis of these same characteristics. Hybrids between the different *Amelanchier* species are common, adding to the difficulty of accurate identification.

The fruit of *A. alnifolia* and *A. canadensis* in particular, are widely used in North America. Many species of *Amelanchier* are used as landscape plants because of their very early flowering.

Amelanchier alnifolia, the saskatoon, is a western North American species, ranging from Alaska, the Yukon and Northwest Territories (close to the Arctic Circle), and south to California, Arizona, and New Mexico. In the east, its range

overlaps that of *A. canadensis* near the western borders of Ontario, Minnesota and Iowa, and in the west and southwest, its range overlaps that of *A. florida* and *A. cusickii* (both of which are considered as subspecies of *A. alnifolia* by some botanists).

The saskatoon is commonly found in open woods, coulees and bluffs, on hillsides, and along gulleys and stream banks, on dry, rocky soils in full sunlight to moist, deep, fertile soils, from near sea level to subalpine altitudes. Moisture appears to be the limiting factor in determining habitat. The saskatoon only occurs in habitats receiving a minimum of 340 mm of annual precipitation.

The saskatoon was first described botanically by Thomas Nuttall in 1818 as *Aronia alnifolia.* Its range was given as from Fort Mandan (North Dakota) to the Northern Andes (Rocky Mountains). The species was also referred to as *Pyrus alnifolia* by Sprengel in 1825 and subsequently as *Amelanchier alnifolia* by Nuttall again, in 1834. The specific name *alnifolia* means 'with leaves like the alder'. In western North America, the saskatoon is also referred to as the western serviceberry, mountain Juneberry, western shadbush, and Rocky Mountain blueberry.

The word saskatoon apparently was an anglicized version of the Cree name for the fruit which was Mis-sask-qua-too-mina or Mis-sask-a-too-mina (plural Sask-a-too-mina). However, it's also possible that the name was derived from the Cree name for the place where stems of saskatoon bushes were collected for arrow shafts; this name was Mane-me-sas-kwa-tan (note that the latter half of this word is 'saskwatan').

The saskatoon is an extremely variable species. In habit, it may range from a low and spreading to erect and slender shrub or small tree. Its height varies from 0.3 to over 6m. It often has multiple stems and may form large thickets. Vegetative propagation is through rhizomes. Its root system is a combination of vertical tap roots and lateral roots. The bark is smooth, gray on the older branches and reddish-brown on the new growth. The leaves are alternate, simple, and roughly oval; the leaf tips are usually rounded and the edges are finely to coarsely toothed. The leaves are half to fully expanded at flowering time and in general are extraordinarily variable in shape.

In the wild, the saskatoon is considered a species adapted to areas that, in the past, were often exposed to fire. Fire, as well as mowing and grazing, stimulate vegetative growth. Saskatoon seedlings require bare mineral soil to become established; humus and full shade, which promotes higher humidity, predispose seedlings to disease.

The saskatoon is capable of tolerating wide ranges of soil pH and texture and is also very cold-hardy. The flower buds have been found to have the potential for extreme resistance to low temperature injury (-50 to -60^{o}C) at maximum hardiness. However, the saskatoon is still susceptible to damage from late-spring frosts in particular.

One experimental study has reported that chilling requirements for the saskatoon are 400 to 600 hours at 0 to 7^{o}C for the cultivars Smoky and Pembina. However, in

practice, a minimum of 2,100 hours (3 months) at 0 to 4°C appear to be necessary for budbreak and subsequent growth to be normal.

The saskatoon is generally grazed by white-tailed and mule deer, elk, moose, bighorn sheep and mountain goat, primarily as winter forage in December through March. Its fruit are consumed by many species of birds and mammals including robins, magpies, grosbeaks, waxwings, coyotes, bears and rodents. Saskatoon seeds are dispersed in the droppings of these animals.

Generally, foliage and green shoots of the saskatoon are palatable to grazing animals. However, it has been observed that the twigs of one variety (var. *cusickii*, or *A. cusickii*) of saskatoon often have an unpleasant odor and bitter taste. This variety of saskatoon has been implicated as a poisonous plant because it contains a cyanide-containing sugar called prunasin. The shrub's vegetative parts are potentially hazardous to ruminant browsers such as cattle, sheep or deer, but the fruit are essentially innocuous. Chewing, and the presence of enzymes found in the stomachs of these animals, release the cyanide. Prunasin content is very high in new wood and decreases in the buds, leaves, old wood, green fruit and ripe fruit in that order; overall levels decline after flowering. While browsing on leaves, buds and twigs may be dangerous for grazing animals, a human would have to rapidly ingest 2 kg of ripe fruit (assuming a 50 kg body weight) to generate a dangerous dose of hydrogen cyanide.

Horticulturally, the saskatoon is grown in gardens, orchards, and shelterbelts, generally on its own roots, but sometimes grafted onto *Cotoneaster* rootstock. Eventually the individually planted stems produce suckers, thus creating a solid hedgerow. The extent of suckering is associated with cultivar, type and extent of pruning, depth of cultivation, and growing conditions.

Understanding Flower And Fruit Production In The Saskatoon

Flower and fruit production in the saskatoon, as in any fruit species, is a complex process influenced by a wide range of environmental and physiological factors. Understanding the processes of flower and fruit initiation and development allows the grower to better define the saskatoon's cultural requirements and thus maximize health and yield through the use of efficient and economic management practices.

Flower and fruit production in the saskatoon can be considered in terms of two primary developmental processes that occur over two successive growing seasons. The first is the initiation of flower buds during the summer and fall of the first season. The second is the actual flowering process, and then fruit set and fruit growth, all of which occur during spring and summer of the second season. These processes can be further defined in terms of flower structure, flower bud initiation and development, flowering, pollination and fruit set, fruit growth and fruit loss. These aspects are not separate and distinct from one another, but are interrelated and continuous.

Obviously many factors can affect flower and fruit production. Factors that have direct effects generally cause injury and include insect and disease organisms, frost, wind and hail. Factors that have indirect effects influence physiological processes within the plant, and include the availability of water, nutrients and other growth regulating substances.

Flower Structure And Flowering Habit

The saskatoon flower is typical of other flowers of members of the Rose family, and apple subfamily, such as the apple, mountain ash, and hawthorn. Figure 1 is a drawing of a typical saskatoon flower. The flowers are somewhat bowl-shaped and have 5 white (sometimes pink) petals. Collectively, the petals are referred to as the corolla. The petals are inserted into a part of the flower called the hypanthium. At the top of the hypanthium, between each of the petals, are green sepals. Collectively, the sepals are called the calyx. It is the sepals, along with some scales, that protectively cover the unopened flower bud. On top of the hypanthium, and within the sepals and petals, are five stigmas (surfaces receptive to pollen) on stalks called styles. Also, there are 20 anthers (pollen producing structures). The ovary is contained within the hypanthium, and it is this part of the flower that eventually becomes the fruit. Undeveloped seeds, or ovules, are contained within the ovary. The flowers of the saskatoon are characteristic of insect-pollinated flowers.

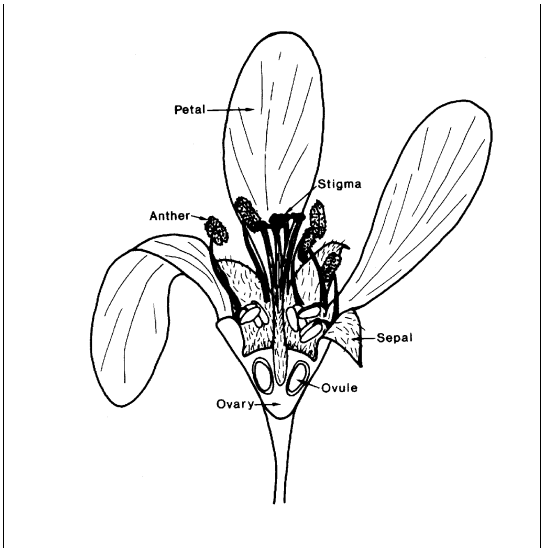


Figure 1: A typical saskatoon flower cut lengthwise; 5 times actual size (Drawing by R. St-Pierre).

Flowers of the saskatoon are borne in clusters which occur on wood at least 1 year old. Typically, twigs and branches of the saskatoon can be described as either long shoots or short shoots; short shoots do not grow to any appreciable length. Flower clusters are usually, but not necessarily associated with short shoots (Figure 2).

Timing Of Developmental Events

An overview of the timing of developmental events is illustrated in the color graphic - General Pattern Of Growth & Development Of A Woody Fruit Plant.

The production of a saskatoon fruit crop is dependent upon developmental events that occur over two growing seasons. The saskatoon typically flowers anywhere

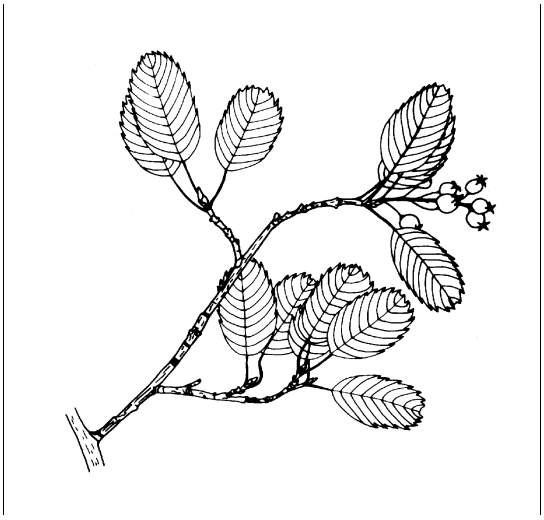


Figure 2: A typical saskatoon branch. This branch is composed of a single long shoot and 3 short shoots; the terminal short shoot has a fruit cluster. The drawing is 1/4 actual size and is modified from St-Pierre and Steeves (1990).

from early-May to early-June, but these flowers were initiated during the summer and early-fall of the previous growing season.

The expansion of new shoots begins in late-April or early-May and continues until the end of May, or early-June; sometimes shoots continue to grow into mid-summer. Growth in shrub height averages about 23-25 cm per year.

Each year, many previously vegetative shoots are converted to reproductive shoots that bear flower buds. In those shoots that will produce flower buds, the transition to the flowering state occurs during the last week of June or the first week of July. This transition takes about two weeks; at the end of this time (about mid-July), the basic pattern of the flower cluster has developed. Subsequently, the flowers themselves begin to develop. This process can continue until the end of October, but remains incomplete. Development ceases until early to mid-April but it is not until early-May that a fully functional flower has formed.

Flowering then occurs in early to late-May, and fruit ripening usually occurs anywhere from early to late-July.

Flower Bud Initiation

Flower bud initiation is the process whereby embryonic flowers begin to form. In other woody fruit species such as the apple, flowers are initiated just after shoot growth ceases and when leaves are mature. All flower parts are formed by the time of winter dormancy. The extent and quality of flower development are influenced by the presence of developing fruit, drought, low light intensity, low temperatures, the availability of adequate nitrogen and carbohydrates, adequate leaf area, and pests and diseases. The timing and intensity of flower bud initiation can be altered by fertilizers and pruning.

The presence of developing fruit is an important factor affecting flower bud initiation in the apple. Fruit with developing seeds inhibit flower bud formation. Seedless fruit do not inhibit flower bud formation. Developing seeds release a growth regulating substance called gibberellin which is associated with this inhibition. The problem of alternate bearing, that is, heavy crop years interspersed with light or no crop years as a result of a biennial flowering

pattern, is associated with this inhibition; in apple trees, this problem has led to the use of procedures to decrease the number of fruit per tree in order to produce more consistent fruit crops.

The initiation of flower buds in the saskatoon occurs during the period of late-June to mid-July with embryonic flower development following. Little information is available concerning which factors influence this process in the saskatoon. There is some tendency for shoots that produce fruit to not produce as many flowers for the following season, compared to shoots that do not produce fruit. If fruit are removed from developing fruit clusters, the bud on the same shoot that produces the next year's flowers will produce more flowers. If leaves are removed, fewer flowers are produced.

There is some indication from growers that a heavy fruit crop one year reduces the amount of bloom the following year, but this situation has not been well-defined.

Timing And Variability Of Flowering

The timing of flowering in the spring is a naturally variable process that is associated with weather conditions during the previous fall and in the spring during the weeks prior to flowering. This timing can vary or be altered depending upon orchard exposure, spring temperatures, rainfall, fall applications of ethephon (a growth regulating substance that slows flower bud development), or possibly the use of overhead irrigation applied in the spring.

The saskatoon can begin flowering anywhere from early to late-May. The length of the period of flowering is also variable, ranging from 10 to 20 days in wild populations. This period is somewhat shorter in an orchard setting where only one cultivar is grown. The length of this period appears to be dependent upon temperature, wind and rainfall. Dry, windy conditions can significantly shorten the period of flowering. Cool spring temperatures will delay or slow flowering.

Early flowering predisposes the saskatoon to damage from late-spring frosts; such damage can be devastating to the production of a fruit crop. The selection of later-flowering cultivars, or the development of cultural practices that would delay flowering, would help alleviate this problem.

The number of flowers per cluster is also quite variable, ranging from 1 to 15 flowers, and sometimes more. The most important factors that influence the number of flowers per cluster in the saskatoon have not been determined.

Pollination And Fruit Set

Variation in fruit yield can be associated with the degree of effective pollination. Pollination is the process by which pollen is transferred from the anthers (the pollen producing organs) to a stigma (the pollen receptive tissue); this process may involve two or more flowers, or only one flower; in the latter case, successful pollination and subsequent fertilization depends on whether a particular crop species is self-fruitful or not. The transfer of pollen

usually requires a vector, or carrier, such as the wind or a honeybee.

Multiseeded fruits, such as the strawberry, raspberry, currant, blueberry and cranberry, require adequate pollination, fertilization, and seed development for large, regularly shaped fruit; fruit size is proportional to the number of seeds per fruit.

In most fruits, pollination is required for fruit set and seed development, and fruit growth is dependent upon seed development. Fruit set is defined as the burst of growth of the ovary following successful pollination and is accompanied by petal wilting and loss. Pollination and fruit set are therefore influenced by a wide variety of factors. These include the temperature range before, during and after bloom, humidity, pollen source, amount of pollen, the presence and degree of activity of the required pollen carrier, leaf area, light intensity (or amount of shading), supplies of carbohydrates, nitrogen and other nutrients, amount of rainfall and wind, and the longevity and sterility of embryonic seeds. For example, with respect to the effects of temperature, long, cold winters and cold spring temperatures can reduce the amount of viable pollen, and high spring temperatures can sterilize pollen; both can result in less effective or no pollination and possible fruit loss.

Little information is available concerning pollination and fruit set in the saskatoon. Horticulturalists have long recognized that the saskatoon is self-fruitful. Some observations have indicated that pollen can be shed within the flower prior to the petals opening, but the extent and consistency of this phenomenon is not known. Wind may also play a role in pollen transfer, primarily within single flowers or clusters, because the pollen is sticky and forms clumps. Insects do not appear to be strictly necessary as pollen carriers; some beekeepers maintain that the domesticated honeybee is not very interested in the saskatoon. However, numerous wild bees, wasps and flies are present within flowers at flowering time and they may be important for pollination in the saskatoon (Figure 1.4).

Variability of characteristics for seedlings from controlled crosses and for open-pollinated seedlings is similar, suggesting that cross-pollination is common.

Greenhouse experiments done at the University of Saskatchewan suggest that supplementary pollination of the saskatoon may increase fruit set, but at the expense of producing somewhat seedier fruit. Interestingly, 20% of flowers in which pollination was completely prevented set fruit. The fact that no pollination is necessary in some cases suggests the possibility that further manipulation using growth regulating substances could result in the production of relatively seedless fruit.

Fruit Growth And Loss

Under optimal conditions, woody fruit species produce excess flowers and set too many fruits. Generally, fruit species, like the apple, cannot simultaneously support all fruit to a commercially desirable size and quality, produce an adequate number of flower buds for the following year, support root growth, and accumulate adequate

nutrient reserves to withstand winter. In apples, a natural process of fruit thinning, resulting in the loss or drop of immature fruit, is a normal occurrence. To some extent, this process adjusts fruit number so as to maintain adequate tree health and consistent yields. The process is affected by many factors including extent of pollination, light intensity, excessively high or low temperatures during flowering, availability of carbohydrates and other nutrients, availability of sufficient water, and insect pests and diseases. However, despite the natural occurrence of this process, the degree of thinning is often insufficient and the result is alternate or biennial bearing (where heavy crop years are followed by light crop years). For commercial apple production, artificial thinning is often necessary, not to increase fruit size, but to allow flower bud initiation and thus the prevention of alternate bearing.

The saskatoon appears to produce an excess of flowers. In the saskatoon, a significant loss of fruit occurs sometime during the period of mid-May to mid-June. The loss occurs early in the period of fruit development; only small, immature fruit are lost (Figures 1.5 & 1.6). In wild populations of saskatoons, the extent of this loss is considerable, ranging from 55 to 98% of the potential crop. In orchards, the loss is considerably less, but still occurs. Generally, much of this early loss is a result of damage by frost, or insects, such as the saskatoon sawfly and various caterpillars (leaf rollers and bud moths).

However, up to 50% of early fruit loss in the saskatoon can be undamaged. The reasons for this loss are not known. In apples, developing fruit compete for nutrients and the losers abort and drop off the tree. There is limited evidence for such a phenomenon in the saskatoon. A study made at the University of Saskatchewan indicates that thinning flower clusters does not appear to affect the loss. Removing leaves (thus removing a source of sugars), or nearby short shoots (thus also removing a source of sugars, but also reducing competition if other fruit are present), increases the number of fruit lost, to a small extent. These experiments suggest that the availability of sugars does have some influence on continued fruit development.

The production of ripe fruit in the saskatoon takes 45-60 days from the time of flowering.

Yield

Vigorous growth during the first two years is essential for early flowering because the plants must attain a certain minimum size before they have the capacity to flower. Under normal circumstances, saskatoons begin to bear fruit when 2 to 3 years old. Saskatoons produce significant fruit yields at 7 to 8 years of age; maximum yield may not occur until the plants reach 12-15 years of age. A reasonable expectation is 2 to 4 kg of fruit per mature bush; some mature Thiessen bushes have produced about 16 kg. If properly cared for, orchards should be productive for 30 to 50 or more years. Growers routinely report yields of 3,000 to 5,000 kgs/hectare, although in some years, no production can occur. Some growers have recorded yields over 13,500 kg/hectare, but such high yields are dependent on

weather, management techniques, and cultivar.

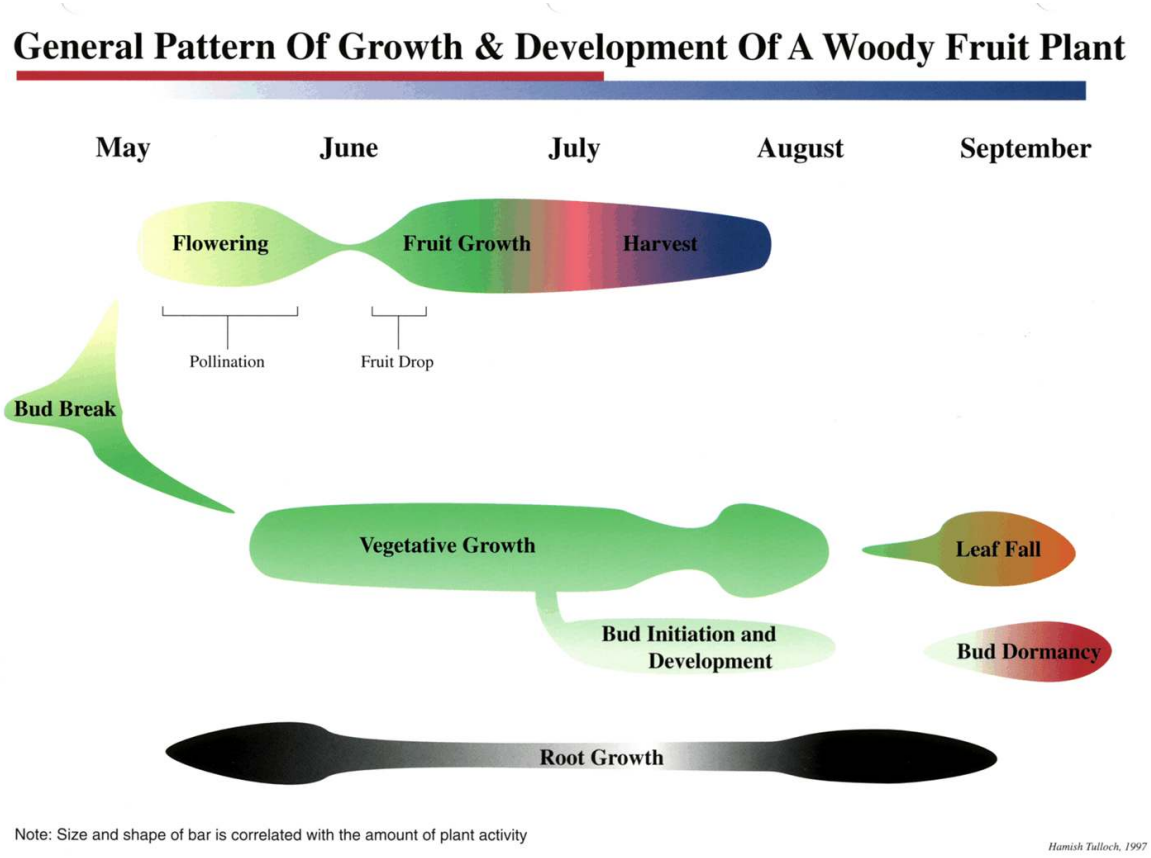


Plate 1. Saskatoon Botany

Figure 1.1: Green-tip stage of bud development; 1/2 actual size.

Figure 1.2: Beginning white-tip stage of bud development; actual size.

Figure 1.3: Advanced white-tip stage of bud development; 1 1/4 times actual size.

Figure 1.4: Saskatoon flowers and wild insect visitor.

Figure 1.5: Stages of fruit development; arrows indicate stages that commonly abscise (Photo by A.R. Olson).

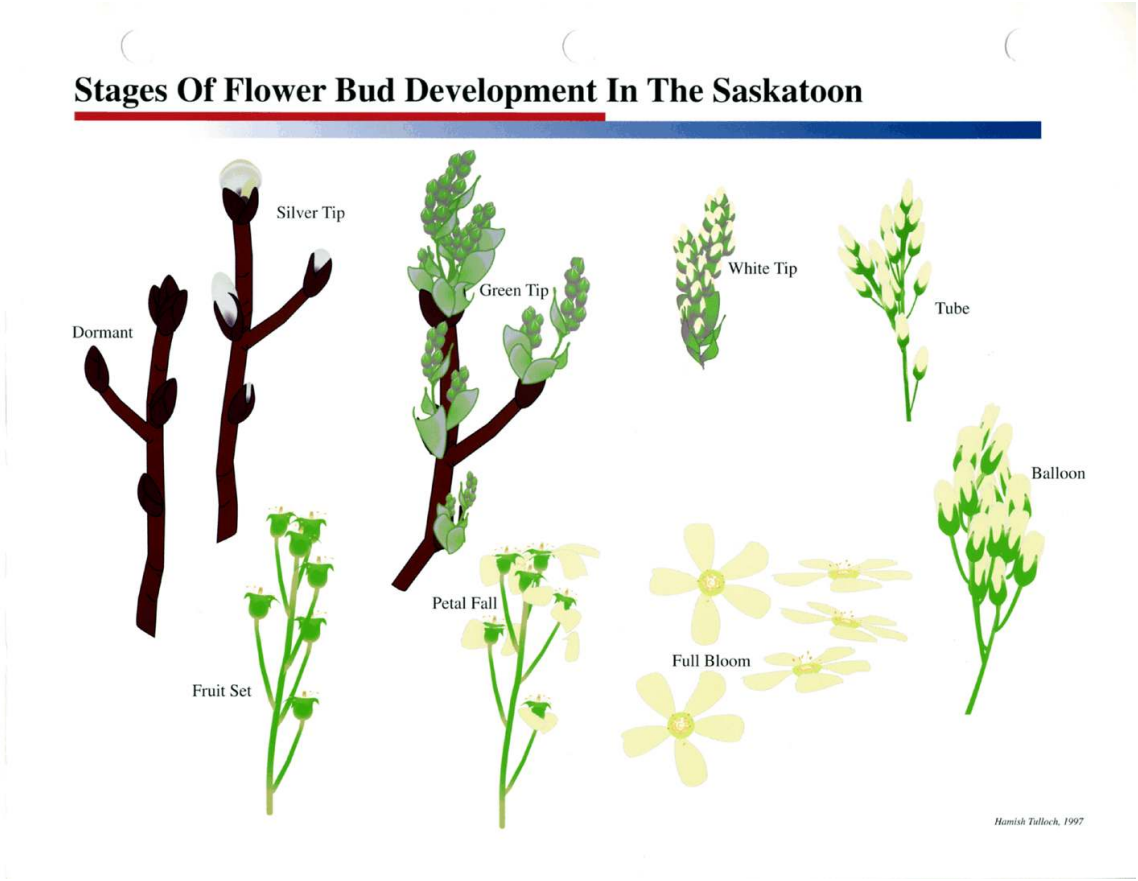
Figure 1.6: Abscising immature fruit (indicated by arrows); actual size.

Stages Of Flower Bud Development In The Saskatoon

A knowledge of flower bud development in the saskatoon will help the grower to monitor for the incidence of insect pests and diseases, and to appropriately time the application of pesticides and other control procedures. Eight different stages of development are defined in Table 2. These stages are illustrated in Figures 1.1 to 1.3 and the color graphic - Stages Of Flower Bud Development In The Saskatoon.

Table 2. Stages Of Flower Bud Development In The Saskatoon

Stage	Description
Dormant	- buds are tightly enclosed by brown bud scales
Silver Tip	- stage immediately following dormancy where the brown bud scales have split open, and are falling off; the bud beneath appears silver because of the presence of many hairs
Green Bud or Green Tip	- the flower bud cluster is visible; the flower buds are very small and tightly packed together; the entire cluster appears green in color
White Tip	- the flower bud cluster has expanded so that the individual buds are no longer tightly pressed against each other; the white petals of the individual flowers are visible as a small cone
Tube	- the petals of the individual clusters have elongated to form a tube or cylinder
Balloon	- a very brief stage immediately prior to full-bloom when the tube of petals has loosened and the petals are beginning to separate
Full-bloom	- the petals have fully expanded and the anthers (pollen-bearing structures) and pistil (pollen-receptive structure) are visible; the flower is receptive to pollination and fertilization at this stage
Post-bloom	- the petals fall off of the flower and the ovary begins to swell, indicating fruit set



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