Factors Affecting Fruit Yield & Quality

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Factors Affecting Fruit Yield In Saskatoons

The production of fruit yield is an astonishingly complex process dependent on a wide variety of factors and processes. Fruit yield depends on such things as number of plants in the orchard, plant maturity, plant structure, number of flower clusters/plant, number of flowers/cluster, and fruit size. Processes that affect fruit yields include pruning, irrigation, fertilization, and pollination. Environmental factors that affect fruit yields include the occurrence of frost, amount of sunshine, length of the growing season, amount of heat available during the growing season, insect pests and diseases. Two critical periods during the growing season include the time surrounding flowering when cool and freezing temperatures can have significant negative effects on effective pollination and fruit set, and during July and August when the flower buds for the following year begin to form.

Actual yield is a result of interaction among weather, soil, insect pest and disease problems, and orchard management. Specific insect and disease problems of fruit obviously directly reduce yield and are simple to observe. Harvest losses due to overripe fruit, bird damage, harvester efficiency, and culls from cleaning may substantially reduce marketable yield.

Other causes of yield reduction are not as simple or direct in their effects. Yield is correlated with the amount of light intercepted by the plant. This is associated with orchard planting design, pruning, training, and leaf damage. Shading of stems in the center of a shrub may decrease potential yield by 25%. A north-south row orientation and adequate thinning of stems will help maximize light interception. Control of leaf-feeding insects is important because the activity of these pests reduce the capacity of the plant to harvest light. Water stress reduces the photosynthetic activity of the plant. Under conditions of water stress, the leaf stomata (pores) close, and the amount of carbon dioxide that is converted to sugars (plant food) may be substantially reduced. Consequently, it is important to monitor soil moisture levels and irrigate adequately when necessary. Growers have little control over factors such as the amount of sunshine, length of the growing season, or the amount of heat available during the growing season.

The primary causes of poor fruit crops in saskatoons include: a) saskatoon bud moth (causes flower loss); b) *Entomosporium* leaf and berry spot (makes fruit unmarketable); c) wind and heavy rain during flowering (decreases effective pollination resulting in loss of potential fruit); d) frost (causes flower and fruit damage and loss); e) saskatoon sawfly

(causes fruit loss); e) brown fruit rot (causes fruit loss); f) saskatoon-juniper rust (makes fruit unmarketable); and g) damage from bird feeding (reduces marketable yield).

How Growers Can Maximize Fruit Yield In Saskatoon Orchards

Stressed, unhealthy plants of low vigour produce little or no fruit yield; the maintenance of plant health and reasonable vigour is very important to the production of consistent and economically acceptable fruit yields.

Windbreaks should be used wherever possible to prevent water stress, reduce shoot breakage and leaf tattering, and to reduce bruising of fruit.

When pruning, adequate thinning of stems, plus maintaining a vertical orientation of stems, will maximize leaf exposure to the sun, thus maximizing photosynthetic efficiency of the leaves; thick, or overly dense canopies limit the penetration of light which results in poor flower bud formation on interior branches.

Insects and diseases that cause defoliation must be controlled because the loss of leaves may decrease flower bud formation.

The excessive application of nitrogenous fertilizers increases shoot growth and vigour, but decreases the formation of flower buds.

Growers should ensure that leaf chlorosis does not occur in their orchard by monitoring and, if necessary, correcting soil pH and poor drainage.

The excessive application of water also increases shoot growth and vigour, which again inhibits flower bud formation.

Intermittent overhead sprinkling may be used during very hot days to decrease the negative effects of high temperatures, low humidities and to reduce plant stress; grassing down alleys between rows will also help prevent the soil from absorbing too much heat.

Overhead irrigation may be used to prevent frost damage.

Plant Vigor - A Question Of Balance

Adequate plant vigor is important for the maintenance of fruit plant health, and for consistent, adequate fruit yields. Vigor is defined in terms of adequate yearly shoot growth, shrub size, leaf color, and yield. Initial vigor is important for effective plant establishment and fruit production at an earlier age.

Poor plant growth may be associated with an excessively low or high soil pH, moisture stress, poor soil structure, low soil nitrogen levels, insufficient available phosphorus, cold or heat stress, poor quality planting stock, insect or disease damage, damage from pesticide drift, inadequate hardening prior to transplanting, root damage, very heavy yields, lack of pruning, or inadequate weed control.

The primary symptoms of poor plant growth include shrubs that appear smaller than normal, short internodes between the leaves, small leaves, and/or poorly developed root systems with few, fine feeder roots. Vegetative growth may be consistently low from year to year, and the plants in question may never be as productive as healthy ones.

Plant vigor is enhanced by rich soils, high soil nitrogen levels, use of mulches, effective weed control, heavy pruning, ample irrigation, and low yields.

High vigor is not necessarily the best for fruit plants. Excessive vigor can contribute to poor fruit flavour and a longer period of non or light bearing. Excessive vigor creates the necessity for more pruning, and may increase the risks of some disease problems and physiological disorders.

Pollination & Fruit Set In Saskatoons

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 in the flower) to a stigma (the pollen receptive organs in the flower); 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.

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 (petal drop). 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.

Pollination and fruit set are 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, 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.

Variability of characteristics for seedlings from controlled crosses and for open-pollinated seedlings is similar, suggesting that cross-pollination is common. Cross-pollination creates seeds that vary in their similarity to the parent plant. Reports differ with respect to the amount of dissimilarity in seedlings compared to the parental material. Propagators report a range of 70 to 95% similarity to the parental stock, with the seedling plants being more or less of equal quality to the parental stock. Because a certain amount of cross-pollination is possible, it is important to only use F1, or first generation, seed. Seed of subsequent generations will be more dissimilar to the parental stock.

Studies 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.

Irregular Bearing In Saskatoons

Irregular, alternate or cyclic fruit crop production (also called alternate or bienniel bearing) is characteristic of many fruit crops, such as the apple, pear and hazelnut. This phenomenon often consists of a heavy flower and fruit crop one year (the 'on' year), followed by a light one the next year (the 'off' year), although a regular bienniel pattern (one year on, one year off in terms of fruit crop load) does not necessarily exist. It is not unusual for many fruit crop and forest tree species to produce fruit or seed in an irregular, alternate or cyclic manner. However, what this means to the fruit grower is that fruit crop production is inconsistent from year to year, with the consequence of a reduction in yield in the long run.

Irregular bearing appears to be characteristic of saskatoons. The 1995 crop on the prairies was excellent, but flower production appeared considerably lower in the spring of 1996. It is said that over a 10 year period, a grower of saskatoons can expect 2 excellent years, 6 average years, and 2 off years.

Causes Of Irregular Bearing

Irregular bearing is a complex phenomenon. Irregular bearing can be expressed over a large geographic area involving many orchards, on individual plants within individual orchards, and even within individual branches of a single plant.

To some extent, irregular bearing has a genetic basis. In apples, some cultivars

such as Golden Delicious, are characterized by irregular bearing, while other cultivars such as Rome Beauty or Jonathon, bear much more regularly. In general, increasing alternation of bearing occurs as the age of the plant increases.

Two sets of situations may bring about irregular bearing: a) an off year caused by a lack of flowers, poor fruit set, or excessive fruit loss; and b) an on year with excessive fruit set, little fruit loss, and too large a fruit crop. The triggers for these circumstances are varied, but appear to be a combination of environmental and physiological factors. Perpetuation of the cycle is of a physiological nature.

It's important to note that, in woody, perennial fruit crops like the apple and saskatoon, flower bud production for the following season begins while the current season's fruit are growing and ripening. The presence of fruit with seeds inhibits flower initiation. The reason for this inhibition is somewhat controversial but appears to be associated with the presence of chemical growth regulators called gibberellins, which are produced by seeds, and the depletion of the tree's carbohydrate supply below that required for flower bud production. The presence of few fruit, or seedless fruit has little effect on flower bud production, therefore many more flower buds are initiated.

Flower loss, poor fruit set, or excessive fruit loss (and subsequently, high numbers of flower buds initiated), may occur for the following reasons:

Frost destroys flower blossoms. The consequence is a smaller fruit crop, and much greater flower bud production with a heavy fruit crop the following season. This heavy crop in turn inhibits flower bud production, and therefore an off season follows.

Cool weather may reduce fruit set by decreasing pollinator activity, or by slowing or stopping pollen tube growth, once pollen is transferred. Low air humidity may decrease the germination of pollen once it has been transferred. Low fruit set results in a smaller fruit crop.

Drought directly reduces fruit set and therefore yield with a potential increase in flower bud production later in the season if conditions are favourable. However, drought later in the season may also directly reduce flower bud production.

The capacity for self-pollination (which is not characteristic of most fruit species, but is for the saskatoon) may actually contribute to excessive pollination in years where cross-pollination associated with increased pollinator activity also is greater. Subsequent excessive fruit set and/or excessive seed production per fruit result in a heavy crop load, or seedier fruit, both of which inhibit flower bud production and therefore result in a poor fruit crop the following year.

Excessive leaf damage and loss from insect feeding or disease can alter the plant's carbohydrate supply thus reducing flower bud initiation, although this may not directly affect the current season's level of fruit production.

The reverse of the above circumstances, seasons characterized by little flower loss, high fruit set, and little fruit loss, mean that low numbers of flower buds will be initiated. The following year, an excessive fruit crop substantially reduces the carbohydrate supply within the plant, which causes root starvation and loss, and consequent mineral deficiencies and imbalance among growth regulators. All of these processes are directly or indirectly related to an inhibition of flower bud initiation, a subsequent off year, and so the cycle continues.

Management Practices Used To Regulate Yields In Other Fruit Crops

Reducing excessive crops in on years, or increasing bloom or fruit set in off years, are two potential means of evening out irregular bearing.

In apples, flower and especially fruit thinning in on or heavy crop years are considered satisfactory ways of evening out crop production, although the use of regularly-bearing cultivars has also helped. A variety of chemicals, including ethephon and carbaryl (Sevin), are registered for fruit thinning in apples. Reducing the crop load by thinning helps regulate the initiation of flower buds.

Excessive irrigation actually may intensify alternate bearing in apples because it stimulates vegetative growth and trunk expansion at the expense of flower development.

Mineral requirements for fruit production are high. In apples, approximately one-third of the nitrogen absorbed per tree per year is used in fruit growth. In years of heavy fruiting, nitrogen reserves may become depleted. Nitrogen deficiencies limit both leaf growth and flower bud production, as well as fruit set. Flower bud production in apples is stimulated by nitrogen fertilization, thereby reducing alternate bearing, and summer applications of nitrogen fertilizers increases fruit set in some cultivars.

However, the relationship between nitrogen fertilization and increased flower bud initiation or fruit set is not a simple one. The carbohydrate to nitrogen ratio appears to be more important. As a result, a balanced approach to crop management is considered a better way of evening out fruit yields.

Managing Irregular Bearing In Saskatoons

At present, it's difficult to say how widespread irregular bearing is in saskatoons, or what the causes are. The following management practices may help even out crop production.

When pruning, yearly thinning of older stems (greater than 2.5 cm in diameter) will help maximize leaf exposure to the sun, thus maximizing photosynthetic efficiency of the leaves. Thick, or overly dense canopies limit the penetration of light which results in poor flower bud formation on interior branches. Additionally, younger stems appear to produce more consistently.

The excessive application of nitrogenous fertilizers which increase shoot growth and vigour, but decrease flower bud initiation, should be avoided. The excessive application of water, which also increases shoot growth and vigour, and again inhibits flower bud formation, should also be avoided. Insects and diseases that affect leaves and cause defoliation must be controlled because the loss of leaves may decrease the formation of flower buds.

Many environmental factors including cool temperatures during bloom, frost, insect pests and diseases are difficult to predict and control, and our knowledge of the timing and amounts of irrigation and fertilization for saskatoons is limited. Consequently the problem of irregular bearing may be ongoing until we become more knowledgable at managing saskatoons as a crop.

Improving Fruit Quality In Saskatoon Orchards

Producing quality fruit requires appropriate plant management. A number of factors influence fruit quality, but plant vigor and light conditions are particularly critical.

Vigor is defined as the amount of shoot growth. Plants of high vigor produce large fruit but the fruit is invariably poorly colored, soft and prone to storage disorders and short storage life. Fruit from plants of low vigor will be small but well-colored and firm, will seldom suffer from storage disorders and will have a longer storage life. A number of factors influence vigor but nitrogen has the most influence. The application of nitrogen should be based on leaf tissue analysis and visual observations. If trees are too vigorous, applications of nitrogen should be reduced or eliminated until the need for it is shown. If trees are too weak, the application of nitrogen should be increased. In addition to reducing or eliminating nitrogen, vigor can often be reduced by reducing irrigation, and/or allowing weeds and a cover crop to grow.

The management of nutrition and irrigation will help control plant size, but will not prevent self-shading; the challenge then is to find the optimum density of stems.

The interception of light and penetration of light to the interior of the plant are both important. Fruit quality is proportional to the amount of sunshine present during the period of ripening, and to the degree that light is able to penetrate the plant canopy. High light levels are required for optimum fruit size, color and sugar content. Consequently, shading within the plant canopy, and shading by other plants must be minimized. Shading can be minimized by controlling vigor, removing shading and upright branches, and adequate thinning of stems.

Fruit cracking is associated with high soil water levels and high humidity. Ripening fruit can only lose excess water by transpiration through the skin; conditions that reduce the fruits' ability to transpire, including high humidity and minimal air movement within the plant's canopy, are likely to increase the incidence of fruit cracking following rain. Cultivars also vary in their susceptibility to fruit cracking.

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