Fertilizing Saskatoon Orchards

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General Aspects Of Fertilization

Nutrient Availability In Soils

The availability of soil nutrients to plants is variable because of the complex interactions among a number of factors including soil structure and texture, soil parent material, organic matter content, pH, and drainage. For example, sandy soils low in organic matter content and in regions of high rainfall are usually deficient in nitrogen; the availability of iron decreases in alkaline, calcareous soils; and acidic, sandy, light soils are low in potassium.

The most favourable soil pH is between 6 and 7 where all nutrients are easily absorbed by plant roots. At soil pH levels below 6, phosphorus, potassium, sulphur, calcium and magnesium deficiencies can appear. Lime or dolomite amendments are usually required. At soil pH levels above 7.5, iron, manganese, boron, copper or zinc deficiencies might appear. Sulphur amendments may be required.

Ion-holding capacity is the ability of the soil to store and to supply nutrients. Clay soils have a high ion-holding capacity, and sandy soils have a low ion-holding capacity. Ion-holding capacity is difficult to change, but can be managed.

Soil salinity is determined by local soil characteristics and the amount of rainfall versus evaporation. Saskatchewan soils are generally low in salinity but local effects are possible. Fruit crops have a low tolerance of saline soils. Excessive application of fertilizers and over-irrigation may increase soil salinity.

Soil organic matter is comprised of residues from decayed plants. Soil organic matter increases aeration, moisture and nutrient holding capacity and helps to reduce erosion. Soil organic matter content declines in heavily managed soils and must be replaced with manure or cover crops.

Saskatchewan soils may be considered low in nitrogen and phosphorus relative to the needs of fruit crops. Potassium and sulphur deficiencies may occur in certain areas and on certain soil types. Our soils also have occasional problems with excessive or insufficient calcium or iron.

Past recommendations for fruit orchards on prairie soils generally indicated that minimum soil nutrient levels at 0 to15 cm depth be maintained at 28 to 56 kg N, 56 to 112 kg P, and 336 to 672 kg K per hectare. At a depth of 15 to 30 cm, minimum levels should be 39 to 84 kg N, 90 to 180 kg P, and 560 to 1120 kg K per hectare. Fertile loam soils may not require additional fertilizer.

Amount & Placement Of Fertilizers

Fertilizer should be placed in the root zone for efficient use. Low rates of fertilizers applied often ensure even distribution within the root zone and prevent root damage due to excess salt concentrations. Potassium and phosphorus should be drilled deeply or plowed in so as to be available in the root zone where moisture can be maintained. These nutrients move little from where they are placed. More fertilizer is required for closer rows and plant spacing. Irrigation or rain can result in the leaching of soluble nutrients, especially nitrogen, into deeper areas of soil. Extra nitrogen may be necessary under these circumstances. More fertilizer, especially phosphorus, must be supplied than the crop will utilize. Most soils fix significant quantities of phosphorus which then becomes unavailable to the plant.

Because the crop removes relatively few nutrients from the soil, it is likely that little fertilizer will be required during the first 3 to 4 years when the orchard is becoming established, provided that the minimum recommended soil nutrient levels exist.

Timing Of Fertilizer Applications

Fertilizers often are best applied as split applications early in the growing season. Fertilizers may be applied late in the fall or early in the spring before bud-break, and subsequently following petal fall.

Micronutrients

Micronutrients are not necessary unless a nutrient deficiency is diagnosed. Micronutrient deficiencies are uncommon on prairie soils. Deficiencies often first appear on sandy sites. Copper deficiency problems also may occur on black soils, gray-black transition soils, and organic soils.

Organic Soil Amendments

Organically-derived materials are an important means of soil improvement and maintenance of crop productivity. The practices of tillage and irrigation, harvesting, and high temperatures decrease the quantity of soil organic matter because these factors increase the rate at which decomposition proceeds. Organic matter from local sources is a high quality, low-cost resource for the maintenance of soil fertility.

The presence of soil organic matter may provide a large number of benefits including: a) an increase in the available carbon resulting in increased biological activity of beneficial soil organisms (eg.decomposers); b) an increase in soil water-holding capacity (water-holding capacity increases by about 2.5 cm of water for each percentage increase in organic matter content; c) the suppression of pathogenic organisms; d) the provision of a nutrient reservoir (the decomposition of soil organic matter releases nitrogen, phosphorus and sulphur in particular, retains nutrients in available form for plants by improving the cation exchange capacity; e) the increase in availability of micronutrients (iron, manganese, zinc, copper); f) an increase in soil aggregation, thus improving soil structure; g) an increase in soil porosity, therefore improving water retention, infiltration rate, and soil aeration; and h) a moderation of changes in pH when acid or alkaline substances are added to the soil.

A wide variety of organic amendments include animal manure, compost, and green manures, leguminous cover crops, bacterial inoculants, blood, fish or feather meals, rock phosphate, mined granite, greensand, basalt, feldspar, langbenite and potassium sulphate, kelp and seaweed extracts and powders, dolomite, gypsum, keiserite, langbenite, limestone, oyster, clam, lobster and crab shells. The availability of such materials will, of course, be dependent on where the orchard is located.

Animal manures must be fully composted. Raw manure can cause substantial root burning and may also cause unwanted late-season growth. Pig and poultry manures are high in phosphorus content and may provide a positive growth response, but are hazardous if not well composted. The use of sheep, horse or cow manures may require an additional source of phosphorus.

Nutrient Utilization & Fertilization Practices

Plant growth and development requires 15 nutrient elements. Carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, magnesium, sulphur, and calcium are referred to as the macronutrients. Boron, molybdenum, iron, manganese, copper, and zinc are referred to as micronutrients.

Of all the essential mineral nutrients, nitrogen (N), phosphorus (P), and potassium (K) are the ones used in quantities that may require replacement. Nitrogen is the most common nutrient requirement, but it has been observed that excessive levels of nitrogen occur more frequently in fruit orchards than deficient levels.

Magnesium, manganese and boron are only rarely required. Iron, although present, may not be available to plants on alkaline, or excessively wet soils. Members of the rose family are particularly susceptible to a lack of iron, which is indicated by a yellowing of the foliage (termed iron chlorosis).

Generally speaking, the nutrient requirements of fruit crops change with geographic location, as climate and soil type change.

Adequate levels of nitrogen increase shoot growth, blossom formation, and reduce alternate bearing. Excessive nitrogen levels may delay bloom, decrease hardiness and increase susceptibility to a variety of diseases. Deficiencies of nitrogen are more common on sandy soils, but also may occur on heavy, wet soils.

The storage of nitrogen in the plant at the end of the season is somewhat dependent on late-summer and early-fall temperatures. Warmer temperatures, and late, light frosts allow the plant to reabsorb nitrogen from the leaves before they fall. Early, hard frosts cause leaves to senesce and fall quickly, and therefore the plant isn't able to reabsorb the nitrogen in the leaves.

In fruits such as the apple, phosphorus fertilization improves the growth of seedlings and increases yields at a younger age. Apple seedlings may be fertilized with a soluble fertilizer high in phosphorus (11-55-0 or 10-52-10). Such a fertilizer promotes better root growth, stiffer, thicker stems, thicker leaves, and some branching. New plantings of apples may benefit from an application of water soluble 12-48-8 or 10-52-10.

Generally speaking, nutrient requirements for fruit crops increase as the plant ages and becomes more productive. Fertilization practices for fruit crops vary considerably, but some examples are useful. Recommendations by the Ontario Ministry of Agriculture and Food for apples are 30 to 40 g nitrogen per tree for each year of age, and 50 g of potassium per tree for each 2.5 cm of trunk diameter, annually. Fertilizer recommendations for currants and gooseberries are 5 to 20 g per bush of nitrogen, depending on plantation age and soil type. For highbush blueberries, it is suggested that 14 to 48 g nitrogen be applied per bush per year, again depending on plantation age and soil type. Recommendations for other mineral nutrients are dependent on soil and leaf tissue analyses.

Foliar Fertilization

Foliar fertilization refers to the application of fertilizer sprays to plant leaves. Although foliar sprays appear to have the potential for more efficient fertilization, they are generally not considered to be a replacement or alternative to soil and root health and function, but rather a supplement. As a general rule, the uptake of nutrients in the soil by roots must be maximized in order to obtain the most benefit from foliar sprays.

Foliar sprays may provide for a temporary, rapid response by the plant. Their most effective usage in commercial fruit crops is to alleviate iron chlorosis, to supply boron for increased fruit set, and to supply calcium and phosphorus to alleviate various physiological disorders of the fruit.

Foliar sprays of nitrogen, usually in the form of urea, are not considered adequate to maintain tree vigor unless sufficient nitrogen reserves are available in the soil. Nitrogen sprays applied in late-summer may increase flower bud production and fruit set, but the studies that have been done conflict in their results.

Where iron chlorosis is a problem, a spray of chelated iron may be used 4 weeks following bloom, and 3 weeks later. However, such sprays are considered a temporary measure only. A better method is to make a soil application of Fe-EDDHA chelate, but also to amend the soil pH appropriately with applications of sulphur.

Foliar sprays can be toxic if the concentrations applied are too high. Additionally, fall-applied nitrogen may delay leaf fall and reduce shoot winter hardiness.

Determining Fertilizer Requirements

The determination of the specific nutrient requirements of a fruit crop is complex and inaccurate to a certain extent because of variable responses by the fruit crop. Plant growth and yield is associated with the concentration of mineral nutrients available, but especially the ratio among these nutrients.

Soil tests estimate nutrient availability, pH and salinity. Leaf tests reflect the nutritional status of the plant. What a plant can obtain from the soil is more important than the concentrations of nutrients found in the soil.

Fertilizer requirements are best determined through annual monitoring of soil and leaf tissue analyses for several years, in relationship to records of shoot growth, yield, fruit quality, pest problems and weather.

In general, reduced growth and yield, and visible nutrient deficiency symptoms may be indicative of additional nutrient requirements, or of a nutrient imbalance. Crop foliage should be regularly examined for symptoms of nutrient deficiency or excess.

It is important for growers to monitor new shoot growth, leaf color and luxuriance, and fruit production and size. Unfertilized saskatoon orchards may begin to show a lack of nitrogen after about 3 years of growth, depending on soil type and adequacy of initial site preparation. Pale leaf color and reduced shoot growth are indicators of nitrogen deficiency.

Collecting Samples For Soil Analysis

Soil analysis will indicate the nutrient status of the soil, that is, the potential of the soil to supply nutrients to the plant. Soil samples are analysed for texture, organic matter content, nutrients (N, P, K, S), pH, and salinity. Soil test results will vary from season to season because of varying crop yields and precipitation. Higher yields remove larger quantities of available nutrients. Available nitrogen in particular can change considerably from year to year. On the other hand, potassium and phosphorus levels may not change substantially for several years.

When To Sample

Soil tests should be taken in the fall before soil freeze-up, but prior to any fertilizer application. It is usually safe to sample soil after the beginning of October when soil surface temperature is less than 7°C, and soil microbial activity has declined. The nutritional status of the soil at this time of year will reflect the crop's demand over the previous few months. This time of sampling will also provide the grower with the time to adequately determine the orchard’s nutrient requirements.

Where To Sample

Soil samples should be collected under bushes in the area that is wetted by the irrigation system. Samples should be collected near to the same plants sampled for leaf tissue analyses. Locations sampled should be marked for future reference.

The samples should be uniform and representative of the orchard. Areas which are visibly different (hill tops, depressions, saline spots, old manure piles or corrals, areas where soil color or crop response differ) should be sampled separately, or avoided if they are not characteristic of the orchard location. At least 15 to 20 samples are required to provide a good mixed sample representative of the orchard. Care must be taken to avoid contamination of the samples with fertilizer, manure, salt, water or dirt.

How To Sample

Clean tools and containers (preferably plastic pails) must be used. Metal pails should not be used if samples are to be tested for micronutrients. Samples can be collected using shovels, trowels or soil sampling probes. A soil sampling probe is best for taking samples to the 45 cm depth and is a worthwhile investment.

Samples should be uniform throughout the sampling depth. If a shovel is used to collect the samples, the samples will be wedge-shaped and therefore must be trimmed to form an even core. The leaf litter must be removed. A small sample is dug to a depth of 15 cm. If salinity is a suspected problem, samples must be collected at 0 to 15 cm, 15 to 30 cm, and 30 to 45 cm. Samples from different soil depths must not be mixed. Samples from 10 to 25 different locations in the orchard should be collected and mixed thoroughly in a pail to provide a good composite sample.

The mixed samples should then be spread on clean paper and air dried, but not heated. The use of a fan, and mixing every few hours will speed up the drying.

Once the sample is dried, it may be sent by mail or bus to the nearest soil testing laboratory. It is important to ensure that the soil testing lab does not group samples from different depths, and that the analysis indicate the specific concentrations of the various mineral nutrients. It would be best not to request specific recommendations for fertilization of a saskatoon orchard because current recommendations are not based on adequate information of the response of saskatoons to fertilization.

Foliar (Leaf Tissue) Analysis

Foliar analysis, or leaf tissue testing, provides an index of a plant's nutritional status. Foliar analysis is the most accurate method of determining which nutrient or nutrients are limiting to the fruit crop, provided that optimum nutrient concentrations are known, and provided that normal, deficient and excessive concentrations have been established. Foliar analysis also is used to diagnose nutrient disorders and to prescribe remedial action.

Nutrient levels within leaves vary substantially from plant to plant, season to season, and with growth stage, part of plant sampled, disease and insect damage, weather conditions, and availability of nutrients in the soil. Optimum soil moisture conditions and well-developed root systems are conducive to high nutrient uptake by the plant. Low moisture levels, cool temperatures, poor soil aeration, or a small root mass are usually reflected by a low nutrient uptake.

Consequently, the timing of sampling and the leaf material sampled are very important. The sampling procedure must be followed carefully for the samples to provide valid results.

How To Sample

Remove leaf samples with a sharp, clean knife (rust-free). The petiole (leaf stem) must remain attached to the leaf. Remove soil particles and other debris with a clean, dry cloth or soft brush. It is preferable not to wash samples. If necessary, wash for less than 1 minute with a mild solution of dish detergent in water, blot the excess water from the leaf sample with a paper towel, and subsequently air dry.

Do not place in an air-tight or damp container. Samples should be placed in paper bags, and kept cool but not frozen. They should be shipped to the testing laboratory as soon as possible.

Plants To Sample

Each sample should be comprised of 50 leaves collected from 5 plants of the same variety, the same age group, and the same vigour. Collect 2 samples for every 2 hectares of orchard. Collect leaves for the 2 samples from plants that are at right angles from one another. Where a problem in the orchard seems to exist, collect samples from 5 to 10 affected plants and 5 to 10 unaffected plants.

Plants that are stressed because of heat or lack of moisture should not be sampled. Plants that have been recently sprayed with foliar fertilizers or pesticides must not be sampled. The use of such sprays in the orchard must be noted.

Tag or mark plants sampled for future reference and testing.

Leaf Material To Sample

Collect the youngest, fully-expanded leaves from the middle third of current year's growth that is growing upward and outward at a 30 to 60 degree angle. Collect 10 leaves per plant; each leaf should be collected from a different shoot, with shoots being randomly selected from all sides of the plant. A sample of 50 leaves will therefore be collected from 5 plants. Dead or damaged leaves should not be collected.

When To Sample

Collect samples in mid-July through August because this is the period when leaf nutrient concentrations are most stable. Better background data will be collected if samples are collected at 2 to 3 week intervals from budbreak to leaf fall. The number of days following bloom should be noted for future reference. Samples should be collected in the morning, but not immediately following a rain.

Nutrient Analyses

The testing lab should analyze for nitrogen (N), phosphorus (P), potassium (K), sulfur (S), calcium (Ca), magnesium (Mg), boron (B), iron (Fe), manganese (Mn), zinc (Zn), and copper (Cu).

Typical Leaf Nutrient Concentrations For Saskatoons

Information on leaf nutrient concentrations is necessary to provide standards for the annual comparison and interpretation of leaf tissue (foliar) analyses for any fruit crop. No extensive research has yet been done to develop comprehensive standards of foliar nutrient concentrations for saskatoons, nor is there information available that correlates leaf nutrient concentrations with fertilizer requirements. However, data collected by the Native Fruit Development Program at the University of Saskatchewan has provided values of leaf nutrient concentrations that likely are typical for saskatoon orchards. The table in this factsheet contains averages and ranges of leaf nutrient concentrations derived from data based on a total of 36 leaf samples collected yearly between the last week in July and mid-August, over three years, from 14 different locations in Saskatchewan, Manitoba and Alberta. Samples consisted of a composite of 50 leaves (10 leaves from from each of 5 trees) collected from the mid-portion of the current season's shoot growth. Not all locations were sampled each year.

Leaf nutrient concentrations vary throughout the season for a number of the nutrients. For growers to make valid comparisons of their own leaf tissue analyses to the values presented in the table, leaf samples of saskatoons must be collected during the last week in July through mid-August using the correct sampling procedure as described in the factsheet "Foliar (Leaf Tissue) Analysis For Saskatoon Orchards".

Leaf nutrient concentrations can vary from site to site and from year to year. Site differences can occur due to variations in soil conditions such as levels of fertility, moisture, and pH. Yearly variations can occur due to differences in rainfall. These variations have not been well-documented for saskatoons. However, it has been noted that saskatoon orchards on lighter-textured soils may be susceptible to deficiencies in some micronutrients. Some of the leaf nutrient concentration data collected suggest that the lowest copper and zinc levels were correlated with low soil concentrations of these nutrients.

Large yearly variations in leaf nitrogen concentrations occur according to changes in crop load. This is a common occurrence in apple trees and appears to also occur in saskatoons to some extent. Leaf nitrogen levels during years of heavy fruiting, or 'on' years, tend to be higher than during lighter cropping, or 'off' years. The values presented in the table represent the average of two 'on' years and one 'off' year. Therefore, a grower might expect nutrient values to be slightly lower during 'off' years than the averages presented in the table.

Other leaf nutrients such as phosphorus, potassium, calcium and magnesium also may vary according to crop load, although generally not as dramatically as nitrogen. The maximum value shown here for manganese in saskatoon leaves is somewhat higher than the limit for most fruit crops but still acceptable. However, foliar manganese concentrations 2-3 times higher than this have been reported for saskatoons without noticeable signs of toxicity.

Typical leaf nutrient concentrations commonly differ slightly among cultivars of apples and other tree fruits, however, this has not yet been studied in saskatoons.

The values provided can be used as a general guideline, however more extensive research is required to determine the optimum ranges of leaf nutrient concentrations and critical values of nutrient deficiency and toxicity for saskatoons.

Suggested Fertilization Practices For Saskatoons

Fertilization is an inexact science for fruit crops such as the saskatoon whose nutrient requirements are unknown. It is certain however, that fruit production utilizes soil nutrients and that these must eventually be replaced.

Proper use of fertilizers is important to reducing costs, to growing healthy plants, and to minimizing the ecological impact of fertilizers on water bodies. An excess of fertilizer can result in problems as serious as a deficiency, and is an unnecessary expense.

Although a wide variety of fertilization practices have been suggested for saskatoons in the past, it isn't known how effective or generally applicable these practices are. Scientific studies of mineral nutrient utilization by saskatoons have not been made. In light of the lack of knowledge regarding specific fertilization practices for saskatoons, how should a grower look after the nutritional requirements of their saskatoon crop? There is no simple solution. The following is considered a reasonable approach to creating a solid information base on which a grower can make fertilization management decisions.

If adequate attention has been paid to site preparation in regards to site selection, soil fertility, and organic matter content, there should be a sufficient supply of nutrients to sustain the orchard for the first few years.

It is likely best to ensure that the orchard's soil meets the minimum fertility requirements recommended for orchards on prairie soils, prior to planting. Past recommendations for fruit orchards on prairie soils generally indicated that minimum soil nutrient levels at 0 to15 cm depth be maintained at 28 to 56 kg N, 56 to 112 kg P, and 336 to 672 kg K per hectare. At a depth of 15 to 30 cm, minimum levels should be 39 to 84 kg N, 90 to 180 kg P, and 560 to 1120 kg K per hectare. Fertile loam soils may not require additional fertilizer. Ideally, soil salinity levels should be less than 1 mS/cm.

On coarse-textured, infertile soils, a solution of 10-52-10, 11-55-0 or 20-20-20 may be required for better establishment and initial growth. Caution should be used when fertilizing young plants.

The nutrient status of the orchard's soil and plant leaf tissue, appropriately sampled, must be annually monitored. Consistent, clear, yearly records of shoot growth, yield, fruit quality, pest problems, and weather should be kept.

Fertilizer should be applied based primarily on changes in soil and leaf tissue nutrient status, and secondarily, on changes in crop performance, relative to the minimum soil fertility requirements. Soil testing laboratories will suggest appropriate formulations and amounts of fertilizer to make up for nutrient loss. It is generally considered that fertilization should replace what nutrients are lost from the harvest of a fruit crop. Fertilizer will have to be applied if visible nutrient deficiency symptoms appear.

If required, fertilizers should be applied as a split application in May (prior to bud break) and in early-June (shortly following petal fall).

It is best not to fertilize on a prophylactic basis without there being a defined need for fertilizer. Over-fertilization with nitrogen in particular may decrease plant resistance to diseases and insect pests, reduce the ability of the plants to harden-off properly for winter, and promotes vegetative growth at the expense of flower bud production. It is best not to fertilize after harvest prior to leaf fall because high levels of soil fertility delay the development of winter hardiness.

Typical Leaf Nutrient Concentrations For Saskatoon Leaves Collected From Late-July Through Mid-August

Nutrient	Average Concentration	Typical Range Of Concentrations
Nitrogen (%)*	2.48	2.05 - 2.90
Phosphorus (%)*	0.18	0.13 - 0.28
Potassium (%)*	1.16	0.75 - 1.73
Sulphur (%)*	0.15	0.12 - 0.22
Calcium (%)*	1.54	1.03 - 2.30
Magnesium (%)*	0.52	0.30 - 0.92
Iron (ppm)*	105	47 - 172
Boron (ppm)*	28	16 - 44
Zinc (ppm)*	17	10 - 34
Copper (ppm)*	7	4 - 12
Manganese (ppm)*	130	43 - 289

[a] Samples consisted of a composite of 50 leaves (10 leaves from from each of 5 trees) collected from the mid-portion of the current season's shoot growth. Averages and ranges were derived from data based on a total of 36 leaf samples collected yearly between the last week in July and mid-August, over three years, from 14 different locations in Saskatchewan, Manitoba and Alberta.

* % = % dry weight
ppm = parts per million

educational resource for individuals who are interested in growing saskatoons, in orchards, shelterbelts, or gardens. Every effort has been made to ensure the accuracy and effectiveness of the information in this publication. However, the author makes no guarantee, express or implied, as to the information and procedures contained herein. The information cannot be guaranteed because knowledge of the biology and culture of the saskatoon may not be applicable to all locations every year. Additionally, the information that is available often changes over time. Little scientific research has been done on many aspects of the culture and management of saskatoons. Consequently, this publication can only serve as a guide. All actions taken which are based on the information presented in this publication are solely the responsibilities of the readers or users, and the author is not liable for any direct, indirect, incidental, or consequential damages in connection with or arising from the furnishing, performance, or use of this material. Comments on information contained in this publication are welcomed.