51. Fertilization in Wild Blueberry Production

INTRODUCTION

The wild blueberry (Vaccinium angustifolium Ait.) is a perennial, shrubby, slow-growing plant that is native to northeastern North America. In Québec, natural populations of blueberry plants are found in various types of soil, including organic, but generally the blueberry grows in sandy soils of deltaic or eolian origin. Such soils are acid and poor in nutrients, with a thin surface layer of partially decomposed organic matter. As an undemanding plant that is well-adapted to nutrient-poor, acidic environments, the blueberry has just what it takes to tolerate such growing conditions.

Despite the blueberry’s limited nutrient requirements, many studies have shown that its potential productivity is increased by fertilization.

SOIL FERTILITY

The soils where blueberry fields are developed are for the most part podzols. These soils are characterized by a surface layer of organic matter, a highly leached mineral layer, and an accumulation zone of leached organic material, iron and aluminum. Such soils are very well drained, the essential condition for podzolization to take place. A cold, wet climate is another important factor in the formation of these soils.

Lying above the mineral soil, the surface layer of partially decomposed organic matter is the sole reservoir of nutrients for the blueberry plants; it also determines how much water is available. The thickness of this organic layer varies considerably, and can be up to ten or more centimetres. However, in some blueberry fields it has been significantly reduced by excessive burning to rejuvenate the plants, diminishing the soil's capacity to supply nutrients and water.

Blueberries grow in soils that have an acid pH. In Québec blueberry fields, pH can vary from 4.0 to 5.5, but optimal growth is obtained when pH is between 4.6 and 5.2 (NBDAAF, 1998). The blueberry is highly adapted to such conditions, taking up nutrients efficiently where other farm crops would have difficulty tolerating that level of acidity.

Nitrogen (N) promotes plant growth, giving the leaves a dark green colour. Lack of nitrogen reduces the size of both plants and leaves, which can turn pale green. Nitrogen-deprived plants are also more vulnerable to disease. Nitrogen is made available to plants by the decomposition of organic matter in the soil; therefore, if the soil is poor in organic matter, or if drought arrests the process of decomposition, less nitrogen will be provided by organic matter.

Phosphorus (P) is essential to plant growth. It is highly mobile within the plant, moving from older tissues to younger tissues. Phosphorus deficiency is revealed by a premature reddening of older leaves and by purple spots on them. The availability of phosphorus is also linked to decomposing organic matter. The acid pH of the soils of blueberry fields promotes the fixing of phosphorus to iron and aluminum oxides, reducing its availability to the plants. However, blueberries can obtain organic phosphorus through a symbiotic association with a fungus (mycorrhiza). Living on the roots of a blueberry plant, the fungus provides it with phosphorus, nitrogen and water in exchange for compounds that the blueberry produces through photosynthesis.

Potassium (K) plays an important role in many plant reactions. It is involved in the formation, movement and storage of sugars as well as nitrogen metabolism. The availability of potassium is linked to the mineralogy of the soil, with sandy soils generally containing little potassium.

Little research has been done on the minor elements in wild blueberry cultivation. Generally, they are provided by the soil in sufficient quantities to meet the needs of the plant.

FERTILIZATION STRATEGY

In wild blueberry production, fertilization is only done in the spring, and at present only when fields are in a growth year. With other crops it is often recommended to split fertilization over several applications, both to improve uptake efficiency and to reduce nitrogen losses to the environment. This approach has been tested in various ways for wild blueberries. In a Newfoundland study, fertilizers were applied in the spring of either a growth year or a crop year. Greater yield was obtained from parcels fertilized only in the crop year than from those fertilized only in the growth year.
Research done in the Saguenay–Lac-Saint-Jean region has indicated that fertilization can be split over the growth and crop years, with yields comparable to when it is only done in the growth year. The difference was that with split application, less ammonium (N-NH₄) accumulated in the soil profile, reducing the risk of leaching and groundwater pollution (Lafond, 2010).

FORM OF NUTRIENT INPUTS

Blueberries absorb nitrogen preferentially in the form of ammonium (N-NH₄). Fertilizers containing nitrates should be avoided because blueberries don't absorb them efficiently. You should use a formulation in which nitrogen is provided as a sulfate (21-0-0). Urea (46-0-0) should be avoided because when it is hydrolyzed it lowers the acidity of the soil, which is undesirable in a blueberry field. The recommended source of phosphorus is either monoammonium phosphate (11-52-0) or diammonium phosphate (18-46-0). This formulation contains 11 to 18% nitrogen in the form of ammonium. Potassium should be in the form of a sulfate (0-0-50). Potassium chloride (KCl, 0-0-60) should not be used because blueberry roots are sensitive to chlorides.

DIAGNOSING NUTRITIVE STATE

Leaf analyses done in the growth year at aouting (cessation of growth) are used to evaluate the nutritive state of blueberry plants in the field. By comparing the results to known reference values, a producer can determine fertilization needs precisely. For the major elements (N, P, K, Ca and Mg), new reference values have been established for the Saguenay–Lac-Saint-Jean region (Lafond, 2009), while for the minor elements the values determined in Maine are used (Trevett, 1972). Both are presented in Table 1.

### Table 1. Reference values for minimum and maximum nutrient concentrations in wild blueberry leaves

<table>
<thead>
<tr>
<th>Element</th>
<th>Minimum (%)</th>
<th>Maximum (%)</th>
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</thead>
<tbody>
<tr>
<td>Nitrogen (N)¹</td>
<td>1.64</td>
<td>2.06</td>
</tr>
<tr>
<td>Phosphorus (P)¹</td>
<td>0.12</td>
<td>0.17</td>
</tr>
<tr>
<td>Potassium (K)¹</td>
<td>0.54</td>
<td>0.71</td>
</tr>
<tr>
<td>Calcium (Ca)¹</td>
<td>0.29</td>
<td>0.39</td>
</tr>
<tr>
<td>Magnesium (Mg)¹</td>
<td>0.13</td>
<td>0.18</td>
</tr>
<tr>
<td>Boron (B)²</td>
<td>24</td>
<td>60</td>
</tr>
<tr>
<td>Copper (Cu)²</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>Iron (Fe)²</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Manganese (Mn)²</td>
<td>750</td>
<td>1490</td>
</tr>
<tr>
<td>Zinc (Zn)²</td>
<td>25</td>
<td>50</td>
</tr>
</tbody>
</table>

¹Lafond, 2009.
²Trevett, 1972.

Source: Jean Lafond

SOIL ANALYSES

Unlike other crops, for wild blueberries no fertilization table has been established on the basis of soil analyses. However, according to the Agricultural Operations Regulation (AOR), soil analysis is required in order for the phosphorus report to be prepared. The AOR stipulates that in any period when fertilizers are applied, fields must be sampled every five years. The phosphorus report determines how much phosphorus can be added in subsequent applications. Generally, for blueberry fields there is no restriction on phosphorus because the recommendations are below the maximum amounts permitted.
FERTILIZATION STUDIES

Research has demonstrated that blueberry plants respond to fertilization with greater productivity. However, as shown by studies in Newfoundland, when fields are being developed it is critical that effective weed control be done before fertilizing, because blueberries are relatively uncompetitive and weeds will take advantage of any input of nutrients.

In Québec, the average recommended nitrogen dose is 25 kg N/ha, with a possible range of 20 to 40 kg N/ha depending on the terrain, the different clones in the fields, and whether rejuvenation pruning is done by mowing or burning (Lapierre et al., 1999; MAPAQ, 2000). Doses recommended for Québec are relatively low compared to New Brunswick, Maine and Newfoundland, primarily because of differences in climate and soil. Recent studies in Saguenay–Lac-Saint-Jean (Lafond, 2010) have shown that for maximum yield the nitrogen dose can go as high as 50 to 60 kg N/ha. By splitting this dose so that 50% is applied in the spring of the growth year and 50% in the spring of the crop year, negative environmental effects can be avoided.

Blueberries respond only weakly to phosphorus. In Québec, research by Lapierre et al. (1999) has shown that a dose of 20 kg P₂O₅/ha is sufficient to meet crop needs. In Prince Edward Island studies, phosphate inputs did not increase yield despite the fact that leaf analyses showed higher concentrations of phosphorus. What was increased was the amount of phosphorus in the soil, which from an agro-environmental point of view is undesirable. Finally, in research done in Maine, crop response was positive when DAP (diammonium phosphate) was applied in strong doses. In sum, since the results vary depending on the study, a minimal dose of phosphorus is recommended to ensure plant nutrition and maintain productivity.

Little research has been done into the role of potassium in blueberry production. According to Lapierre et al. (1999), potassium inputs have no significant effect on yield. An input of 20 kg K₂O/ha was found sufficient to maintain the productivity of the crop.

In a Prince Edward Island study, the application of gypsum (calcium sulfate) led to increased productivity, although the effect was limited to the first crop year. In Québec there is currently no recommendation for calcium inputs, even though the soils of blueberry fields have low reserves of available calcium. Boron inputs are recommended however, in low doses, because boron is involved in cell division and elongation, important in fruit set. The impact on yield has not been clearly demonstrated however. The availability of boron in acidic soils is relatively low.

A mix of primary and secondary paper sludge can be used as a fertilizer in wild blueberry production. The nitrogen content of such sludge can range from 1 to 3%. For an input of 100 kg total N/ha, some 15 to 30 t/ha of sludge (on a wet basis) would need to be applied. Around 25 to 30% of the nitrogen in such sludge is in a form available to the blueberry crop. An additional benefit of applying paper sludge is that it has a mulching effect, contributing to the conservation of water in the soil.

It is possible to produce organic blueberries in developed fields. Nutrient requirements are easily met by organic fertilizers such as compost, but the principal challenge in organic blueberry production is weed control. The Organic Agriculture Centre of Canada has produced a useful guide entitled Organic Wild Lowbush Blueberry Information, available online at: www.organicagcentre.ca/DOCs/Organic%20Blueberry%20Guide.pdf.

RECOMMENDED DOSES OF CHEMICAL FERTILIZERS

Nitrogen (N): from 25 to 60 kg N/ha, depending on the field’s past productivity, the initial height of the plants, the concentration of nitrogen in the leaves and the type of rejuvenation pruning practised. To limit losses to the environment, heavy doses of nitrogen (over 50 kg N/ha) should be split between the spring of the growth year and the spring of the crop year.

Phosphorus (P): 15 to 20 kg P₂O₅/ha

Potassium (K): 20 to 25 kg K₂O/ha

Boron (B): 0.72 kg B/ha to 0.40%

Nitrogen and potassium are applied in the form of sulfates. The sulphur contained in such fertilizers acts to acidify the soil, maintaining the acid conditions required for optimal growth of the blueberry plant.

Fertilizer application generally starts in mid-May, on fields where pruning has been done. Ideally, fertilizers should be spread when the ground is warm and the blueberry plants are on the verge of budbreak. To ensure uniform application, avoid spreading on windy days. Very warm days should also be avoided to avoid nitrogen losses through volatilization.

According to pesticide manufacturer DuPont, chemical fertilizers should not enter into contact with hexazinone herbicides (VELPAR® and PRONONE®). For this reason, after any treatment with a hexazinone herbicide it is important to wait 7 days before applying fertilizer.
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At present, the recommended formulation is 14-8-14 with 0.40% of boron at a dose of 180 kg/ha (MAPAQ, 2000). At this dose, the complete fertilizer contributes 25 kg/ha of nitrogen, 14 kg/ha of phosphorus, 25 kg/ha of potassium and 0.72 kg/ha of boron. In special cases, new formulations are prepared to provide the crop with more nitrogen while maintaining the amounts for phosphorus and potassium.

REFERENCES