Potential of the European wild blueberry (*Vaccinium myrtillus*) for cultivation and industrial exploitation in Norway

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Abstract

Today there is no commercial exploitation of the Norwegian wild blueberry (*Vaccinium myrtillus*), in contradiction to the highly exploited lowbush blueberry of Canada. Because *V. myrtillus* have a higher content of biological compounds important for human health than the lowbush blueberry, there is an increasing demand for this berry on the market. In a new four year project (2008-2011) the potential for commercial production of *V. myrtillus* in Norway will be examined. We will examine semi-cultivation practices on forestland, including clear-cutting of forest, periodic pruning, fertilization and water management and the effect of competition from other plants. Methods of planting and cultivating plants on agricultural land will also be examined. Goals include the selection of superior clones adapted to several regions in Norway and the development of effective propagation methods. We will also study how blueberries react on climatic parameters using controlled experiments and data from meteorological stations in forest fields. Different hand operated equipment for harvesting will be examined, and methods for transport to pilot receiving stations with subsequent rinsing and freezing will be developed. This paper describes the background and goals of the project.

INTRODUCTION

Lowbush blueberries from eastern Canada and the state of Maine, USAare the primary source of product for processed uses. These berries are produced by managing natural stands of the two species of blueberries, *V. angustifolium* and *V. myrtilloides*. Lowbush blueberries are important horticultural crops that are grown on land unsuitable for most other agricultural production. They have become the number one fruit crop in the province of Nova Scotia Canada, in terms of total acreage and export sales. The production has increased steadily over the past 50 years, and was 18 000 tons in 2005, due to a strong production base of privately owned land, continuous research and promotion of improved cultural practices by governments, aggressive

and innovative industry entrepreneurs, ample modern processing facilities, strong and active producers' associations and steadily expanding markets.

Lowbush blueberries are not commercially produced in Europe,. However, the European blueberry (*V. myrtillus*) native in Norway is strongly preferred by the Norwegian processing industry, and the annual production in Norway is approximately 100 000 t. The European blueberry has a much higher content of antioxidants (Halvorsen et al., 2002; Skrede et al., 2004) and better taste than lowbush blueberry. In spite of the abundance of *V. myrtillus* growing wild in Norway, industrial demand is mainly met by imports from Sweden and Eastern Europe. Lowbush blueberry growing techniques may be applicable in exploiting native stands of *V. myrtillus* in Norway. However, there are some significant differences between the two species in vegetative growth, fruit characteristics, and quality compounds, and probably in reactions to nutrition and climate. The main challenges in developing an industry in Norway are labour costs, product prices, and accessibility of production areas. Fields with good growth conditions have a potential to produce a stable crop. At these selected fields climatic stress, optimal nutrition and water availability, weed and disease management have to be handled. In the end efficient harvesting and receiving will be necessary.

GROWTH CONDITIONS AND YIELD

Knowledge about establishment of cultivation fields for *V. myrtillus* is limited. Lowbush blueberry will cover the field approximately 10 years after clear cutting forests (Kinsman, 1993). In contrast, clear cutting *Picea abies* forest in the Nordic countries has been reported to affect natural stands of *V. myrtillus* negatively. Clear cutting reduced shoot survival, ground covering and the production of annual shoots. The improved light conditions made leaves turn red (Atlegrim and Sjöberg, 1996; Palviainen et al., 2005). However, a selective removal of trees made the *V. myrtillus* perform better. Moreover, *V. myrtillus* remained a marked nutrient sink in spite of the temporary decrease in rhizomes after clear cutting.

The yields vary greatly from year to year both in managed fields of lowbush blueberry and in fields of native *V. myrtillus*. Percival (2005) recorded variations in managed lowbush blueberry fields from 224 to 1200 kg da^{-1}, and in the Arkhangel region of Russia *V. myrtillus* yielded an average of 16.1 kg da^{-1} over several years (Puchnina,1996). This indicate the challenges in order to establish half cultivated fields of *V. myrtillus* and increase growth soon after clear cutting, as well as to achieve yields that are somewhat near the half cultivated lowbush blueberry.

CLIMATIC EFFECTS ON OPTIMAL YIELD

It is important to choose the right fields for half cultivation of *V. myrtillus* in order to avoid frost during flowering, extreme wind conditions and drought. Temperatures below -3ºC may kill developing flowers. Such frost injury may be reduced by windbreaks (Percival et al., 2002; Hicklenton et al., 2002; Olson and Eaton, 2001). The mild winters of the last decade have injured *V. myrtillus* in Sweden, especially during misty and wet weather (Ogren, 1996; Taulavuori et al., 2001). This shows the importance of selecting fields with reliable snow cover during winter or moderated sites. Lowbush blueberry is adapted to partition its resources into vegetative growth at low soil moisture conditions and into reproductive growth when moisture levels are sufficient (Glass et al., 2005; Seymore et al., 2004). Therefore the selected fields must have drought tolerant soil.

SOIL CONDITIONS

V. myrtillus is the most common understory species in Norwegian coniferous forest (Fremstad, 1997), and is associated podsol soils. For proper growth and development, *Vaccinium* species demands a relatively low soil pH. Several studies have shown that forests of medium fertility produce the largest *V. myrtillus* yields in the boreal zone (Ihalainen et al., 2002; Kuchko, 1988; Wallenius, 1999). *V. myrtillus* have a shallow, limited root system (Kutschera and Lichtenegger, 1992). The humus properties therefore appear to be of great importance to the *V. myrtillus* vegetation. Deficiency symptoms for N and P have not been reported in native stands of *V. myrtillus* even when plant yields are high. This is mainly due to the symbiosis with ericoid mycorrhiza which provides access to N and P sources that would not be available to plant roots alone (Myers and Leake, 1996; Read, 1996). The effect of fertilizer on lowbush blueberry has been studies and show that both foliar and soil application of fertilizers may be beneficial alone or in combination. It will be necessary to test the potential of different fertilizers. On abandoned farm land, the applied fertilizers must be able to reduce soil pH.

PROPAGATION AND ESTABLISHMENT OF FIELDS

To establish *V. murtillus* on farm land, it will be necessary to propagate superior clones or use seed propagation. *V. myrtillus* cuttings root when treated with 4.9 µM IBA or 5.4 µM NAA (Shibli et al., 1996). Basal nodal segments of *V. angustifolium* cultured *in vitro* on a modified cranberry tissue culture media containing 2-4 µM zeatin produced many new shoots (Debnath, 2004). The viability of the propagated plantlets is important. After 16 years, plots with *V. angustifolium* grown from seedlings had greater row width than plots from cuttings, while plots of micropropagated plants were nearly as wide as those of seedlings. The enhanced rhizome production of the micropropagated and seedling plants did, however, not always lead to a greater fruit production (Jamieson and Nickerson, 2003).

Mycorrhiza is highly important in *V. myrtillus*. Thus, to succeed in full cultivating of *V. myrtillus* it will be necessary to ensure proper mycorrhizal colonization and to optimize the conditions for mycorrhizal establishment through inoculation and other management practices.

HARVESTING

Lowbush blueberries in Canada are harvested mechanically by tractor-mounted or walk behind picking heads, or manually using rakes. Mechanical harvester picking heads have been improved for greater harvest efficiency. These modifications have given yields equivalent to hand harvesting while retaining high quality fruit of lowbush blueberry (*V. angustifolium* and *V. myrtilloides)* (Yarborough, 2002). In this project both mechanical walk behind and manual equipment will be tested for harvesting,. However, for large scale production tractor mounted mechanical harvest equipment is necessary. Therefore, the suitability for future mechanical harvesting will be evaluated in comparison with our Canadian partners.

FRUIT QUALITY

In general, the food and nutritional quality of *V. myrtillus* regarding the content of health-beneficial compounds (Camire, 2002) is recognized by the abundance of proanthocyanidines and anthocyanins (Faria et al., 2005) together with the occurrence of other potent natural antioxidants such as flavonoids (Cho et al., 2005), phenolic acids (Zadernowski et al., 2005, Tarusciao et al., 2004), and high

amounts of vitamin C (Stewart, 2004). Additionally, *V. myrtillus* seed oils are an excellent source for α-linolenic acid, essential fatty acids, tocopherols and carotenoids (Parry et al., 2005).

Identified distinct structures give the opportunity to distinguish between clones and genotypes, and to characterize berry quality upon environmental and production/processing factors. In this project, fruits will be analysed at critical steps along the line, and methods to maintain the quality will be developed. During processing, the breakdown of biological compounds important for human health (antioxidants) will be described. Our goal will be to maintain fruit quality from harvest to freezing

PROJECT SUMMARY

The main objective of the project is to learn how the European blueberry (*Vaccinium myrtillus*) might be commercially produced in Norway. Our sub-objectives are:

- Collect superior *V. myrtillus* clones in Norway
- Develop half cultivated *V. myrtillus* fields on forest land at three regions in Norway
- Develop fully cultivated *V. myrtillus* fields on farmland at three regions in Norway
- Examine the effects of climate, soil conditions, nutrients, mycorrhiza and different cultivation practices on *V. myrtillus* growth and development.
- Develop efficient vegetative propagation methods for *V. myrtillus*
- Describe the variation in contents of bioactive compounds in natural populations of *V. myrtillus* in Norway
- Develop fruit handling and storage procedures
- Develop new processed products of *V. myrtillus* in Norwegian processing industry and in small-scale production.
- Disseminated knowledge of growing and processing of *V. myrtillus*

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