

# Breeding red wine grapes for Minnesota north of the Twin Cities

Vineyards in the northern two-thirds of Minnesota, the region north of the city of Minneapolis-St. Paul, require varieties that ripen earlier and tolerate colder winter temperatures than vineyards in the south of Minnesota. Also, damage to vines from fluctuating late winter temperatures followed by late spring freezes have become a rather widespread problem in Minnesota and surrounding states. In some states, such as Nebraska, some crop loss from late spring frost occurs every year. Since 1996, I have been attempting to breed grapes for red wine production that satisfy these three needs and have the potential to invigorate the grape and wine industry in the northern two-thirds of Minnesota.

When I started my work in 1996, several lines of cold climate grape breeding were already well established. Over 60 years, Elmer Swenson produced 15 named varieties and dozens of selections to work with in breeding. The University of Minnesota grape breeding project started in the 1970's, as did David Macgregor's. Both have produced several named varieties and many valuable selections for use in breeding. Grape breeding at Beijing Botanical Gardens and Inner Mongolia Agriculture University has been going for decades, producing many selections with a very large cluster and berry.

My grape breeding work has taken advantage of all these lines of breeding, and has combined parents from two different breeding lines to make a cross. A good example is my named variety, Petite Pearl, which was selected as a seedling of Minnesota 1094 x E.S. 4-7-26. The seed parent is from the University of Minnesota and the pollen parent from Elmer Swenson's work. Two promising hardy red wine selections, T.P. 1-1-12 and T.P. 1-1-34, have come from a cross of David Macgregor's Riparia x St. Croix #1 with Elmer Swenson's E.S. 5-4-16. T.P. 1-1-12 will be named and available in both Canada and the U.S. in 2013.

In my breeding for frost resistance, I have made use of the species, *Vitis palmata*, which is a native to the Mississippi River bottomland around St. Louis. *Vitis palmata* begins growth extremely slowly in the spring. This is most likely a way to reduce oxygen demand during annual spring flooding along the Mississippi River. However, this also has value for avoiding early spring frosts. I have produced one quite cold hardy F1 selection, T.P. 3-1-3, from a cross of E.S. 10-18-06 x *Vitis palmata*. Also, I have produced a set of F2 seedlings, hopefully with better wine quality, by crossing T.P. 3-1-3 with Petite Pearl. Second test vines of T.P. 3-1-3 are being grown in Lexington, Nebraska, an area known for spring frost vulnerability.

# International Cold Climate Wine Competition

While there are dozens of wine competitions around the United States, there were none devoted to the promotion of quality wines made exclusively from cold hardy grape cultivars. In response, the Minnesota Grape Growers Association and the University of Minnesota have joined in partnership to host the International Cold Climate Wine Competition in St. Paul, Minnesota. The ICCWC was established in 2009, in conjunction with the Minnesota State Fair, to encourage greater exploration of wine making styles and techniques using grape varieties that can survive cold climate conditions.

## What kinds of wine can be entered in this competition?

Any commercial winemaker producing wine using cold hardy grape varieties generally found to be hardy without winter protection in USDA zone 4 may enter. There are 30 different competition categories, including Minnesota Hybrids, French & American Hybrids, Sparkling, Specialty & Fortified and Non-Grape. Only commercially available wines (minimum production of 20 cases) are eligible. The competition is eager to receive entries from countries outside the U.S. and Canada. Wine grapes varieties that may be entered include:

Alpenglow	Joffre	Prairie Star
Baltica	Kay Gray	Riparia (native grape)
Brianna	King of the North	Sabrevois
Castel 19637	L'Acadie Blanc	Sipaska
D M 8521-5	La Crescent	St. Croix
E.S. 6-16-30	LaCrosse	St. Pepin
E.S. 10-18-30	Leon Millot	Swenson White
Edelweiss	Louise Swenson	Troubador
Elvira	Luci Kuhlmann	Valiant
Frontenac	Marechal Foch	Vandal-Cliché
Frontenac blanc	Marquette	Ventura
Frontenac gris	Petite Amie	
GR7	Petite Pearl	

The 2012 competition included 335 wines from 57 commercial wineries in 12 states and Canada. Awards were based on blind tastings by 21 expert judges, who include wine writers, restaurateurs, retailers and wine educators. In addition to Double Gold, Gold, Silver and Bronze medals, the ICCWC awards three Best of Show wines (red, white, specialty/fortified) as well as the Minnesota Governor's Cup Award, given to the top wine made in Minnesota.

This year the Governor's Cup was awarded to Four Daughters Vineyard and Winery for their 2011 La Crescent. Four Daughters' La Crescent also won "Best of Show" for the top white wine. Other "Best of Show" awards went to the Shelburne Vineyard (Vermont) for its 2010 Marquette Reserve, as best red wine and to Danzinger Vineyards (Wisconsin) for its Midnight Voyage Dessert Red Wine, for best specialty/fortified wine.

# Forgotten tradition of vineyards in Szczecin

## (the past and the present)

This article presents the history of cultivation of vines on Gocław hills in Szczecin from the Middle Ages to modern times. It points out the existence of conditions suitable for the restoring the vineyards from the post-II WW damages. A description of vineyard development in Radebeul (RFN) emphasizes the similarities in landscape features and climatic conditions of both places. Comparison of current development of the hills surrounding Radebeul and Gocław is focused on existing, similar architectural accents. The vineyard development in Radebeul was used as a model for a similar effort in Szczecin, which also includes the need of a comprehensive revitalization of natural environment, which in the past made Gocław an area very attractive for recreation. The forgotten tradition of local viniculture can serve as a basis for creating real opportunities for restoration of vine cultivation in Szczecin, if only as a tourist attraction. A correct interpretation of the tradition of „lost” areas of the city seems to be necessary for finding the right way of developing them. Only development concepts which take into consideration the tradition of a place may allow to keep its most genuine features, while becoming a part of its history and restoring its importance.

# Improvements of the Danish grape and wine quality

**Key words:** grape cultivars, cool climate, yield and quality potential, maceration, wine style, aroma, sensory training

Denmark is a new cool climate wine region with an emerging small scale wine industry. Selecting the best suitable cultivars is crucial and the emergence of new generations of cultivars with good adaptation to short season, cool temperature climates and high disease tolerance are the main foundation for the development. For a commercial scale production of quality wines good growing techniques and cultivar specific vinification techniques have to be developed and implemented. In order to be able to support this development of a wine industry in Denmark and to study the aspects of vinification, cellar facilities have been developed at Copenhagen University for oenological research in micro scale (mostly 5 and 10L scale). Together with the association of Danish wine growers a ministry supported innovation project has been running since 2010. Guidelines for good growing practice are being developed with focus on canopy management. Growers have delivered fruits of selected grape cultivars to the micro vinery and with focus on maceration and extraction techniques the grapes have been vinified to identify optimal procedures and effects on wine style. Aroma profiles of both juice and finished wines have been established by GC-MS and with sensory panels. To improve the vinification skills and quality management of the wine producers sensory training courses have been developed with focus on use of sensory tools in winemaking. White wines based on 6 hours cold maceration showed a range of fresh green to fruity, flowery and exotic flavours depending on cultivars. A direct press showed lighter wines with green fruit and citrus flavours while a longer cold maceration times of 24 hours or short skin-fermentation enhanced body but also the risk of astringent and bitter taste. From blue grapes optimal skin maceration time was identified to be around 12 days for red wine but rosé produced with a few hours cold maceration showed a high potential for fresh aromatic wines high in berry flavours.

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# Relative bud fertility, an indicator of spring frost damage on some grapevine varieties

## Introduction

On May 3, 2011 an arctic air mass reached Hungary. The 10 Celsius colder air spread all over the country followed by drier air that flowed into our region. On May 5 to 6 at night the wind stopped. In the quiet morning the air was very dry, the sky was cloudless, the temperature dropped quickly and significantly. In Kecskemet region the minimum radiation temperature was -5.7 Celsius. This low temperature damaged young grapevine shoots.

## Material

pontica	occidentalis	intraspecific	resistent
Kövidinka	Rhine riesling	Narancsízű (Queen of Vineyards x Chasselas)	Merlan (Merlot x Seibel 13666)
Kadarka			Pannon frankos (V. amurensis x irsai oliver)
Pirosszlanka			

varieties observed



vineyard located in Kecskemet

## Methods

1. Calculating *relative bud fertility* (RBF)

RBF = total number of bunches/total number of shoots

2. *One way analysis of variance* to find statistical differences between yields of different varieties

## Results

SUMMARY				
Variety	No.	Sum	RBF Mean	Variance
Merlan	47	34	0,723404	0,682701
Pannon frankos	55	14	0,254545	0,193266
Kadarka	45	19	0,422222	0,431313
Chasselas	43	2	0,046512	0,045404
Kövidinka	33	15	0,454545	0,380682
Pirosszlanka	17	8	0,470588	0,764706
Rhine Riesling	32	19	0,593751	0,700605



partially frost  
bite shoot



frost bite shoot on 1  
bud lateral cane spur



Rhine Riesling



Kövidinka



Merlan



Pannon frankos



Narancsízű

## Conclusions

- early bud break results partial shoot frost, and lateral buds, that break afterwards, are less fertile
- if bud break is late the whole shoot gets frosted and more fertile basal buds emerge (see Merlan and Rhine Riesling varieties)
- in cane pruning 1-2 bud lateral cane spurs can be useful because the fertile auxiliary main bud breaks after spurs' shoots are frosted
- yield depends on the average bunch weight too, therefore Kövidinka, which has the highest average bunch weight, had the higher yield

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# Vignoble les Murmures

The vineyard „Les Murmures“ was founded by two agronomists who perfected their knowledge through diploma in oenology in Beaune (Bourgogne, France) where they study, among other things, further processes for fermentation on the lees, carbonic maceration and the aging of red wines. The objective is to develop technical adapted on our grape must.

The first priority has been to choose a very good site: the warmest area in Quebec on south hill side to optimize the sun, a slope allowing the cold air to go down, a Rocky soil to keep the roots warm and dry, a surrounding of mature forest on three sides to protect against strong winds. And finally, we chose to be near of a city (Montreal) to be close to a client pool.

We have chosen vine varieties from Quebec and USA well adapted to our climate, to not have to protect them during winter (except with snow), but also to harvest grapes with full maturity, enough tannins with also phenols, and not too high acidity.

The cultural practices are oriented to frequent pest scouting and high training system (ventilation) to minimize spraying. The choice of adapted varieties helps prevent the earthing-up the vines and keep coverage of grass which reduces erosion and preserves bacterial life in the soil.

# Impact of cluster thinning on maturity and grape quality of Seyval and Vandal-Cliche, two hybrid grape varieties grown in Quebec, Canada

Cluster thinning is one of the cultural practices aiming to enhance maturity and fruit quality in vigorous crops such as hybrid grape varieties. In Quebec (Canada), Seyval blanc and Vandal-Cliche, two hybrid grape varieties grown for wine production, are known to be particularly fruitful. In order to evaluate the impact of cluster thinning on grape maturity and quality, we tested three fruit load levels (100%, 70% and 40% cluster thinning), along with three maturity stages, on Seyval blanc vines grown in Montérégie and Vandal-Cliche vines grown in the region of Québec City. Growth parameters (leaf area, yield per plant, average cluster weight, etc.) were measured, while grape maturity and quality were evaluated using technological parameters (total soluble solids, titrable acidity, pH) and berry sensory analysis. Data of the season 2012 will be presented and discussed in terms of the best thinning management to reach high quality under northern growing conditions.

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# Assessment of the frost resistance of several dozen vine cultivars grown in the Western Pomeranian region

**Keywords:** *Vitis vinifera*, frost hardiness, cultivars.

In recent years, viticulture and winemaking have been gaining in popularity in Poland, also in terms of their commercial use. As a result, new hybrid vine cultivars have appeared, adapted to the cultivation in cooler regions, as well as enotourism, which consists of tours of vineyards, wine cellars, and participation in vintage and wine tasting.

The viticulture of the Western Pomeranian Province dates back to the 13th century. At that time, vineyards were located around the area of the Pomeranian Dukes' Castle in Szczecin, Schwerin, Gustrow and Stargard. Vine plants were grown until the beginning of the 20th century in Połczyn-Zdrój and Szczecin, as confirmed by old photographs showing vineyards located on the hill, formerly known as the Wine Hill (Weinberg).

The aim of the study was to determine the frost resistance and suitability for cultivation of the tens of grape wine cultivars and hybrid cultivars in the Western Pomeranian Region. The major parts of the Western Pomeranian Province and Mecklenburg-Western Pomerania are located in the 7A zone of plant resistance to frost, according to Heinze and Schreiber (1984<sup>1</sup>). In recent years, small vine plantations have been established in the federal state of Mecklenburg-Western Pomerania in Rattey, Loddin, Burg Stargard. The cooperation with Prof. G. Flick, from the Higher School in Neubrandenburg, resulted in obtaining the funds from INTERREG IVA funding programme for the establishment of the training base.

Tens of vine cultivars, of a dessert and processed type, were planted in the Research Station. The research indicated that the cultivars derived from the *Vitis vinifera* grapevine are not suitable for cultivation in our region due to frost damage. It was determined that during the winters (2010/2011 and 2011/2012), the majority of cultivars experienced frost damage to their ground parts. As regards the hybrid cultivars, the least damaged were the plants of the following cultivars: Regent, Gołubok, Johanniter, Gewuerztraminer, Muscaris, Bianca, Solaris and Aurora.

<sup>1</sup> Heinze W., Schreiber D., 1987. Eine neue Kartierung der Winterhärtezonen für Gehölze in Europa. Mitt. D.Deutsch.Dendrol.Ges. 75: 11-56.



# Evaluation of the enological characteristics of promising varieties in Quebec

For twenty years, Quebec's viticulture has been in development. Special conditions of Quebec require a specific evaluation of agronomic and oenological parameters for promising varieties. However, few public scientific studies have been conducted. So, the Agricultural Research Center of Mirabel has established a vineyard to assess hardy varieties. Thus, the main objective of this ongoing study is to assess the agronomic and oenological qualities of several rustic varieties in regard to sustainable economic development for a producer. For five years, agronomic characteristics of eighteen varieties have been studied and for two years, the oenological parameters have been considered. The results obtained since the implementation of the vineyard reveal that some varieties have valuable agronomic traits, such as appropriate lignification, tolerance to winter and spring frosts, a well-balanced vigor, and a substantial yield in grapes. In addition, initial assessments of oenological parameters demonstrate the potential of some grape varieties that stand out for their ripening within our seasonal limitations and for their good winemaking characteristics. The annual observation of various agronomic and oenological parameters allows development of a public database on promising hardy varieties. Using this established scientific database, it will be possible for growers to select a variety according to its agronomic characteristics and the different climates and soils found in parts of Quebec. The selection of varieties may be made according to criteria of yield in grapes, for example, and depending on the specifics of each wine grape variety. Moreover, at the end of this project, it will be possible to offer varieties that will produce good wines according to their oenological characteristics. This data can also be used by other Canadian provinces by adapting the results according to their growing conditions, soils and weather.

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# Grape growing in Latvia

Traditional home grape growing in Latvia is accompanied now by several industrial-scale grape fields and in total about 20 ha are occupied by grapes in Latvia today. However, still no clear picture exists about perspective and reliable commercial varieties for Latvia, and many varieties are under investigation for their ripening, quality and productivity in specific short season of Latvia. Paul Sukatniek's varieties Supaga and Zilga remain on the list as local productive hybrid varieties with distinctive taste qualities. In the recent time Supaga and Zilga wines have been found palatable by wine experts and recognized as varieties representing local wine character for growing tourism industry: Zilga Rose, Zilga Sparkling, Supaga and Sukribe wines have been on the top of local wine tastings in last years. Varieties developed by Gunvaldis Vesmins regularly are getting highest ranking in annual grape tastings, mostly as white muscat varieties. In Pure Experimental Station about 500 seedlings from the breeding program of Andrash Fazekash have been evaluated in recent years and several selections have shown wine potential. In total more than 700 grape cultivars of different regional origin are grown for evaluation in different sites of Latvia. Short season with cool and rainy periods, downy mildew and recent atrachnosis attacks are serious challenges for Latvian grapegrowing.

# IN VITRO MICROPROPAGATION OF GRAPEVINE CULTIVARS 'SOLARIS' AND 'REGENT' THROUGH LATERAL BUD DEVELOPMENT

Grapevine (*Vitis vinifera* L.) is one of the most important crops. New methods of propagation and genetic improvement are searched. In vitro techniques could be used for vine breeding to overcome the difficulties in conventional breeding studies by obtaining numerous identical plantlets and new cultivars. Since in vitro morphogenesis depends on the interaction between genotype, explant source and culture medium, it is necessary to develop specific regeneration protocols for each *Vitis* cultivar. In this study shoot apical meristems were used for in vitro regeneration in 2 grape cultivars – 'Regent' and 'Solaris'. Meristems were taken from 2 cm length shoots. The culture media used in this study was MS (Murashige & Skoog, 1962) without growth regulators and MS with 1 mg l<sup>-1</sup> TDZ, 1 mg l<sup>-1</sup> BAP and 1 mg l<sup>-1</sup> IBA. Obtained results of plants morphological traits indicated that growth regulators may have important impact on the culture initiation.

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# Grapevine improvement for northern regions

Mount Ashwabay Vineyard & Orchard (MAVO), at the northern extreme of the state of Wisconsin (USA), has a 20-year-old effort to develop very early ripening grapevine cultivars for northern regions. The effort has been largely based on using germplasm material with a *Vitis riparia* background as a donor of disease resistance and cold hardiness. Both traditional vinifera and elite European hybrids have been used as donors of fruit quality traits. Numerous advanced selections have been developed and are under test at multiple locations in northern USA, Canada, and northern Europe. Most selections ripen with or earlier than established wine grapes in the northern viticultural region, such as Rondo, Solaris, and Marechal Foch. Winter hardiness generally meets or exceeds -32C (-25F). MAVO also has a more recently started effort to develop improved table grapes for these same conditions.

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# North Dakota State University grape germplasm enhancement project

Tourism and Agriculture are the top two primary industries that consistently contribute to North Dakota's economy. Viticulture and the value-added industry of winemaking are agro-tourism enterprises that show great potential for growth in a state such as North Dakota. One of the greatest obstacles to growth of viticulture in North Dakota is the lack of viable grapevine cultivars that consistently produce commercially acceptable wine. North Dakota presents numerous challenges to viticulture, including extremely cold winter temperatures, short growing season, high pH soils, and dry conditions. Recent successes by public and private programs in other states using the wild grape, *Vitis riparia*, that is native to North Dakota, suggest that progress could be made fairly quickly. Collections of superior hardy and extremely early ripening *V. riparia* biotypes from around North Dakota and northwestern Montana are being characterized for fruit quality, including flavor, acidity, and polyphenol profile. These superior riparias are being crossed with extremely early ripening "quality" parents, *V. vinifera*, such as Perle Csaba and Siegerrebe, and interspecific hybrids such as Solaris and Burmunk to create well-adapted, early-ripening, fully hardy, grape cultivars for North Dakota that produce quality wines. The project is utilizing conventional outdoor hybridization as well as a greenhouse culture and hybridization, so year-round crossing can occur. A collection of over 50 grape varieties and 30 North Dakota *riparia* selections is being maintained in greenhouse culture for this purpose. In addition, it is anticipated that adapting Tyler Kaban's accelerated grape breeding procedures to NDSU greenhouse operations will enable fruit quality assessment earlier and shorten the period from cross initiation to micro-vinification.

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# Cold Hardiness: It takes more than a cold hardy cultivar

Nebraska winters can be harsh, even brutal and certainly damaging to grapevines. With ambient temperatures that can plummet to the -10 to -25 (degrees F) range for anywhere from one night to a week; volatile temperatures which result in 60 degree F temperatures in January and February, and late frosts ( even late into May), extensive damage to early budding grapevines can and will occur. The purpose of this research was to evaluate techniques designed to enhance grapevine cold hardiness, specifically effects of late spraying of dormant vines with vegetable oil designed to delay bud break. Results across the past five years and across three different microclimate locations were profound. The application of vegetable oil resulted in significant delay in bud break, ranging from five days to three weeks across different cultivars. This delay made the difference between grapevines producing on primary buds vs secondary or tertiary buds, or, not producing at all. Additional benefits included uniformity of ripening and most certainly, quality of fruit. The impact of these findings on the viticulture industry in Nebraska could potentially be quite significant and enable the industry to take a giant stride toward sustainability.

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# Determination of quality markers driving consumer acceptance of cold hardy grape wines in Quebec, using sensory analysis

In Québec, the government-owned Société des Alcools du Québec (SAQ) controls wine imports and sales throughout the province, providing local market with one of the largest product range in America. Such an availability of world wines contributes to the development of Quebecer's palate for high quality products, but makes it difficult for the relatively new local wine industry to break through Quebec's market, especially because Quebec wines are still regarded as low quality products by many Quebecers. In order to evaluate quality markers for wines produced in Quebec, 24 wines, including 21 wines from Quebec, made from cold hardy grape varieties, and 3 wines from northern France and Italy, made of *Vitis vinifera* varieties, were evaluated by a panel of 62 average consumers, on a 9-points hedonic scale. Then, descriptive analyses were conducted by an expert panel, constituted of sommeliers, wine writers and enologists.

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# Management of Boron and its influence on yield of “New York Muscat” grapes in Eastern Canada

The Canadian acreage of grape production has been expanding rapidly in recent years. Nova Scotia is gaining recognition in Canada and around the world for high quality wines. With this increase in awareness of Nova Scotia as a grape growing and wine producing region, there is also increased interest in the production of grapes. According to experienced sommeliers, New York Muscat grape is always in the top three in tastings. The oval reddish-blue grapes have the best Muscat flavor of any hybrids. However, in Eastern Canada climatic conditions the New York Muscat vines yield about 1.5–2 t/acre (3.2–4.4 t/ha) which is quite low compared to other varieties. Double the present yield would bring it to the expected level for this variety and, in turn, double the production. The objectives of the project were to examine Boron fertilizer management of ‘New York Muscat’ vines and to find a practical method that would improve yield of this grape in NS conditions. Foliar and soil drench applications of Boron to the established vines at Jost Vineyards, Malagash, NS Canada, were studied during the three growing seasons, 2010-2012. Eight levels of additional Boron fertilizers (four as foliar application, four as soil drench) were applied to vines. The same selected rows of vines were used in three consecutive growing seasons. Yield data from 2010 season were inconclusive and leaf tissue analyses showed very low Boron levels, <30 ppm. Following the treatments, these levels improved and reached 50 ppm by the end of the season. The 2011 data showed a significant increase in yield from Boron treated vines, 6-7 t/ha. The 100 and 200 ppm foliar Boron application were the most effective. The 2012 yield data are to be collected by mid-October and included in the poster presentation. Additionally, the effect of Boron treatments on flowering and consecutive fruit set will be discussed.

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# Spring frost protection in viticulture

Viticulture in northern climates is threatened by two types of frost. During winter low temperatures can damage hibernating buds. In spring late frost events can harm green tissues after bud break thus leading to yield loss. Global warming has led to an earlier onset of vegetation with bud break happening 2 – 3 weeks earlier than the long-time median. Thus late frost events hit the vines at a very sensitive stage.

Besides site and variety selection there exist a lot of methods to prevent or minimize damage in plants caused by spring frost. In addition of giving an overview of these protection methods a research project at the Bavarian State Institute for Viticulture and Horticulture will be presented that aims to adapt these methods for viticulture in Franconia, an area in the heart of Germany located along the river Main. Their practical and economic effectiveness as well as environmental aspects e.g. noise, pollution and ecology will be evaluated.

## Technical methods to prevent frost damage

- reduction of heat emission: fog grenades, fogging machines; smoke grenades;
- cover foils for vines or trellis, hail netting
- artificial air circulation: wind wheels and large fans; helicopters; cold air drain units
- orchard heating: heat blower, oil heaters or infrared radiators; heating cables on the trunks or the trellis wires
- sprinklers: over canopy sprinklers increase temperature by solidification heat
- mulching or spraying herbicides to increase temperature in the vines

## Physiological methods to prevent frost damage

- delay of bud break: delayed and/or double pruning; other pruning measures i.e. minimal pruning, frost spurs or oil application;
- application of phytohormones: ethylene, gibberellins
- application of plant additives: Cropaid, special nutrients for prevention or induction of ice nucleation to lower freezing point in the vascular tissues

In our project a variety of promising methods was selected for testing. The outcome of all measures will be documented by data loggers for temperature distribution in the experimental sites. Developmental stages of the vines and damage symptoms will be monitored visually.

Preliminary results indicate that different pruning times have little influence on the onset of bud break. In contrast oil application led to a delay in development. Further studies shall prove if this effect is sufficient enough to prevent frost damage.

# Results of studies on effects of ectomycorrhizas on vineyard

Mycorrhizas can be treated as one of best ideas which was created by the nature to improve plants' performance and especially their health status. At the moment in symbiosis with mycorrhiza can live majority of plant species and this mechanism has been developing for millions of years. Mycorrhiza it is first of all exchanging of nutrients between partners but it seems that the equally important role of mycorrhiza is creating the "bridge" between higher plant or even between plants and the soils because fungal mycelium are able to penetrate soil and at the same time to colonize root system.

Thanks to enhancement of penetration zone of consortium roots and mycelium (sometimes in factor of thousand) flow of water and nutrients increases what directly affect plant growth rate. If mutual balance plant – mycorrhiza maintains mycorrhized plants can show higher competitiveness in colonization of new environment comparing to plant grown without mycorrhizas.

Mycorrhiza is a natural phenomenon but it is worth to mention that under conditions of horticultural production when sterilized media are used in nurseries and a lot of chemicals (pesticides, fertilizers) is applied mycorrhizas are eliminated from the soil.

If plants from nurseries are planted in permanent place they can found fungal partner but certainty that symbiosis with proper fungi is effectively established in a short time is achieved only when to rhizosphere fungal inoculum is applied. It seems to be very natural and environmentally friendly method of supporting growth of many usable plants.

After many years of studies on mycorrhization of vineyards it can be stated that mycorrhizas' effects is visible as:

- increase of sugar content in fruit;
- considerable increase of anthocyanins and polyphenols (better quality of wine);
- higher effectiveness of photosynthesis;
- faster lignification of wood with longer leaves lifespan;
- increase of assimilation area of leaves (better supplying fruit with assimilates what directly affect yield and extract content);
- longer internodes (what improves air circulation what reduce humidity and protects plants against pathogens infection);

# Effect of canopy pruning on the grape maturity parameters in Estonian conditions

Canopy management gives in cold climate zones the possibility to manipulate vine crop productivity and quality. In Northern condition could autumn pruning lead to earlier start of vine growth in spring and earlier maturity of fruits? In the case of early start the limiting factor will be night frost in late spring and therefore the later beginning of the vine growth is recommended. On the other side, the ripening of grapes will be problematic because of shorter growing period.

The aim of the present experiment was to evaluate the influence of pruning time and system on the grape maturity parameters like °Brix, titratable acids, sugar/acids ratio and pH. The focus of the research was on the red outdoor growing grapevine hybrid cultivar of *Vitis vinifera* and *V. amurensis*, Hasanski Sladki. The planting was established with double trunk training at the experimental garden (northern latitude 57-59°) in June, 2007. The experiment was carried out in 2010 and 2011. The vine treatments were the cane and spur pruning in autumn and in spring.

Pruning time and system influenced the grape maturity parameters significantly. The sugar content in grapes pruned in spring varied from 18.5 to 19.6 as a result of later growth start contrary to autumn pruning numbers reaching from 19.4 to 19.8 °Brix. The titratable acids content in spring and autumn pruning treatments were from 1.3 to 1.5 but however high compared to the recommended for vine production. The spring and autumn cane pruning treatments affected positively sugar/acids ratio which were respectively 14.1 and 14.8 compared to spur pruning in the same seasons (11.9 and 13.6). Higher pH appeared in autumn pruning grapes but there were no statistically significant differences between treatments.

The hypothesis found confirmation that in case of autumn pruning vine growth and berry ripening starts earlier than in spring pruning. Also there were differences in grape biochemical composition. In Estonian conditions it is advisable to prefer autumn pruning, which achieved higher optimum ripeness indicator than spring pruning. In areas where late spring night frosts appear, the spring cane pruning is advisable.

# N-sensor as a tool for demand based nitrogen supply to grapevine

Nitrogen is a major nutrient for plants. To mitigate the environmental impact of nitrogen fertilization in intensive crop production, nitrogen supply needs to be based on the crop's demand. Grapevine is a novel crop in Scandinavia. There is little scientifically based knowledge on adequate nutrient supply. At the same time, cultivation of grapevine is primarily performed as a leisure based activity and little attention is given to the nutritional preconditions in the vineyard using soil or leaf analysis prior to fertilization. We therefore studied the potential of a nitrogen sensor for prognosis of the leaf nitrogen content.

The experiment was performed in a recently established vineyard in Northern Scania where four white wine cultivars (Solaris, Ortega, Pinot gris, Siegerrebe) are grown in plots with three different floor managements (open soil, foil or gravel cover). Leaf samples (leaf opposite to the first grape) for color analysis were taken when berries were pea-sized and bunches hang (BBCH 73) with three replicates. Leaf color was measured using a commercial N-sensor (N-tester), used in cereal production, and Hunter scale displaying the relation between green to red (a), blue to yellow (b) and black to white (L). Based on the results of a preliminary study, N-tester measurements were grouped into five categories. Leaf samples were analyzed with respect to nitrogen, carbon, phosphorus, potassium, calcium, magnesium, sulfur and micronutrient content (Mn, Fe, Zn, Cu, Mo, B).

From this study, b and L measurements in Hunter's color scale were correlated negatively and linearly to N-tester values, while a measurements did not show a common over all correlation to Hunter scale. Color measurements were dependent on cultivar, where cultivar 1 and 3 showed higher N-tester values. Differences occurred between different cultivars. The N-tester measurements were not a reliable tool for nitrogen content assessment, however measurements using Hunter's color scale can be used to determine leaf nitrogen content. As an impact of time and cultivar is expected, more studies need to be performed to reliably make statements on leaf nitrogen content based on leaf color.

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# The wine industry in Denmark

**Key words:** grape cultivars, climate, yield, wine types, plant protectants

Commercial production of wine has been allowed in Denmark since 2000 with an area quota of 100 ha. A large number of hobby growers had already started in the 1990'ies after the first small group established the Danish Vineyards Association so 8 were fast to register as commercial producers and an industry has been emerging since then to about 90 producers in 2012. They are wide spread in almost all parts of the country with about 29ha on the Island Sealand, 12 ha in Jutland, 7 ha and 3½vha on the islands Fünen and Bornholm, respectively. In addition more than 1200 hobby producers grow an unknown area but often with areas with a few hundred plants.

The climate is mild coastal, with relative warm winters (average of January about 0 °C) and cool summers (average in July about 17 °C). The accumulated temperature sum of the growing season is based on 30 year norm values is about 1000 calculated with 8 °C as base temperature.

A high number of cultivars are tested (almost 70) with the largest area (about 34ha) as blue cultivars with 'Rondo' as the dominant one (almost 17 ha). Other important blue are 'Regent', 'Leon Millot', 'Cabernet Cortis' and 'Bolero'. Green cultivars account for about 18 ha with 'Solaris' as the most important (5½ha). Other important green cultivars are 'Orion', 'Ortega', 'Zalas Perle', 'Madeleine Angvine' and 'Phönix'. Recently new cultivars are planted such as 'Muscaris', 'Villaris', 'Johannitter', 'Acolon' and 'Cantor'. Red wine production has initially been very dominating based on 'Rondo', but a shift with more focus on white wine, rosé and sparkling wine has been seen in the last years.

After some optimistic years with relative warm summers the last 3 years have been problematic due to late spring frost, low summer temperatures and high levels of rain. Very few fungicides are approved by the Danish authorities so growing is strongly depended on disease tolerant cultivars.

The wine industry has so far been favoured by a positive interest by media's and consumers so wines are sold at high prices. A significant share of the commercial areas is still very young and prices are expected to decrease when full established. However, many also need to improve the growing techniques to obtain higher productivity. The development in wine quality has been very promising with several producers getting rewards also in international wine shows.

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