Bilberry (*Vaccinium myrtillus*) - from Natural Sites to Farming?

University of Natural Resources and Life Sciences, Vienna
Department of Crop Sciences

BALAŠ Johannes*, Andreas BOHNER, Renate MAYER, Monika SOBOTIK, Melek KOYUTÜRK, Karin MANDL, Rita KAPPERT

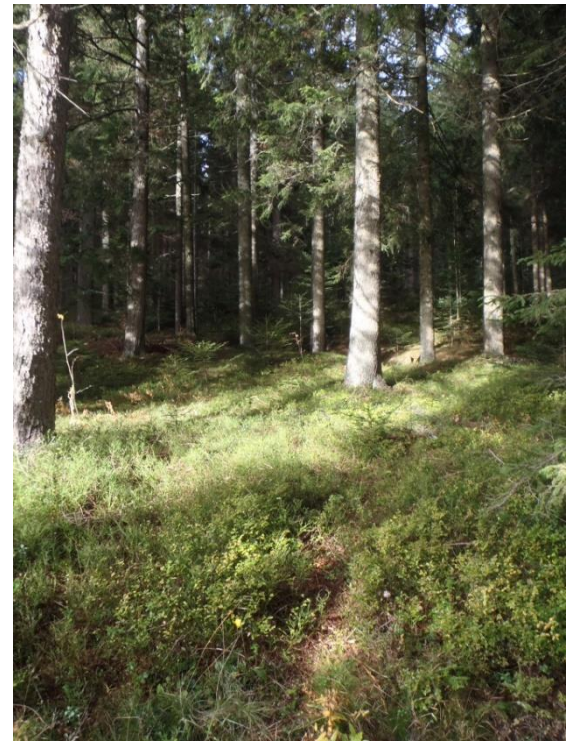





Contents

University of Natural Resources
and Life Sciences, Vienna
Department of Crop Sciences

Bilberry-plants in their natural environment



Photos: J. BALAS

University of Natural Resources and Life Sciences, Vienna
Department of Crop Sciences

Introduction

Vaccinium myrtillus L. (Ericaceae)

Common English names:

Bilberry; European bilberry
Myrtle Blueberry, Myrtle Whortleberry,
Whortleberry

A perennial dwarf shrub (50-70 cm / 19,6-27,5 in)

Vegetative growth: subterranean shoots

Storage organ: thick, lignified primary root

Lives in the understory of forests – and on heath-lands, moors and on open kollin-alpine pastures.

Strictly only on acidic soils present

Forms raw humus

https://upload.wikimedia.org/wikipedia/commons/thumb/9/9f/Vaccinium_myrtillus_Sturm09055.jpg/400px-Vaccinium_myrtillus_Sturm09055.jpg

University of Natural Resources
and Life Sciences, Vienna
Department of Crop Sciences

Introduction

Vaccinium myrtillus L.

- Shoots are green with winged edges,
  plants form underground runners (“shoot system“)
- Leaves are summer-green; decidous
- Spherical flowers appear single in leaf-blades.
  (greenish – whitish- red),
  Early flowering-season
- Fruits are dark-blue, pruinose (waxy shine), and
  relatively small (diameter < 1cm / 0,39 in)
  Fruit-flesh and sap are dark-blue due to high concentrations of phenolic bioactive compounds!

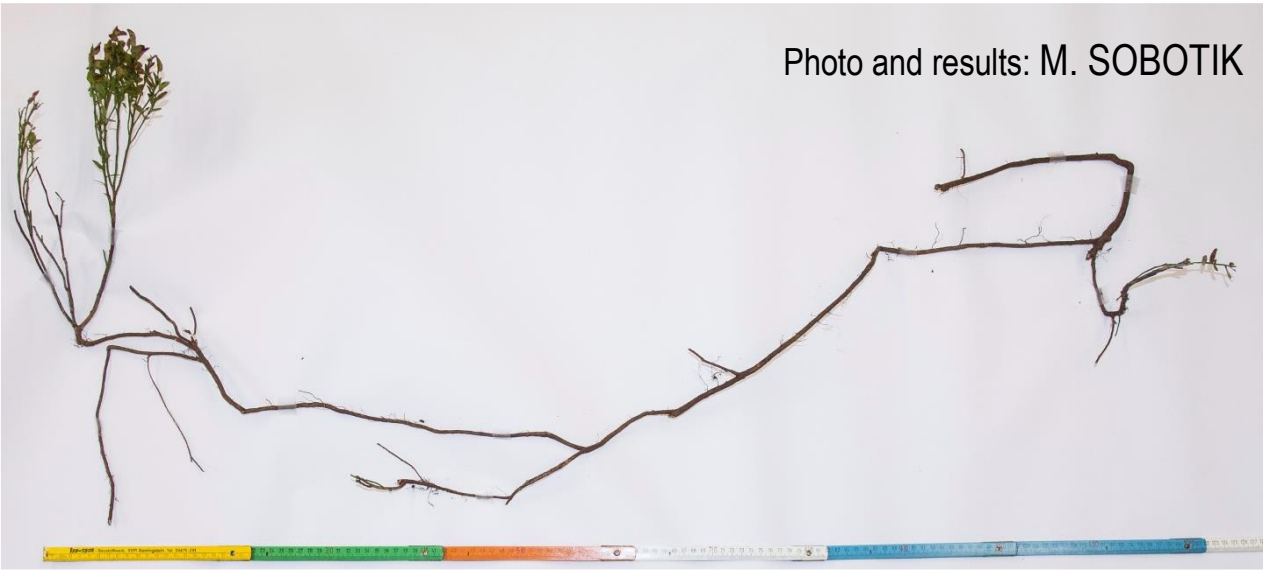
Photo: Renate MAYER

https://www.awl.ch/heilpflanzen/vaccinium_myrtillus/heidelbeere-fruechte-180-1.jpg

University of Natural Resources
and Life Sciences, Vienna
Department of Crop Sciences

Introduction

Vaccinium myrtillus L.



Length: 160 cm
Diameter: 4-10 mm
Just few green sprouts
Main axis is " zig-zaging" while real roots appear "wound"
Adventitious roots are rejuvenated near injuries of the main shoot

- Aboveground shoots are green with winged edges, underground shoots whitish to brown ("shoot system")

Propagation? Initation of fruit-bearing sprouts?)

University of Natural Resources and Life Sciences, Vienna
Department of Crop Sciences

Introduction

Vaccinium myrtillus L. – a superfruit (!)

- Bilberry has a very long tradition as a food and (registered) medicinal plant in Europe (fresh fruit, food colorant, processed food and beverages - non alcoholic, alcoholic).

- Till date berries are commonly picked privately and/or commercially in Europe from natural sites.
- But this is connected with damages in natural plant-stands, ecologic problems and disturbance of wild-life

-> production in horticulture would support environmental protection.

https://freiburg-schwarzwald.de/fotos08juli/heidelbeeren3-080725.jpg

University of Natural Resources and Life Sciences, Vienna
Department of Crop Sciences

Introduction

Vaccinium myrtillus L. - occurrence

- It definitely is of economic relevance for rural regions in Austria as well as other regions in Europe.
- And - its berries are among the best plant-based sources of anthocyanins, other phenolic compounds and carotenoids (Wendelin et al, 2018)
- Bilberry has not been subject of breeding or cultivation programs – at least not on the larger scale…. (Zoratti, 2016).

Source: Zoratti et al, (2016)
https://www.sciencedirect.com/science/article/pii/B9780124081178000040
https://ars.els-cdn.com/content/image/3-s2.0-B9780124081178000040-f04-02-9780124081178.sml

Introduction

Vaccinium myrtillus L. - occurrence

University of Natural Resources and Life Sciences, Vienna
Department of Crop Sciences

Photoe: Balas J.

Objectives of our horticultural trial

University of Natural Resources
and Life Sciences, Vienna
Department of Crop Sciences

Assumption: Domesticating bilberry for regular farming in nurseries presumably has a potential of creating an additional source of revenue and contributing to agro-biodiversity in rural areas:

- Is it possible to grow wild-type *Vaccinium myrtillus* in a horticultural system?
- Which way respond bilberry plants on commercial horticultural growing media?
- Can pure PEAT be improved through inoculation with mykorrhiza or adding of woodchips?

University of Natural Resources and Life Sciences, Vienna
Department of Crop Sciences

Material and Methods

Research on natural sites (Austria)

At first we collected data on natural sites for later horticultural crop-management:

- Leaf and fruit samples
- Soil samples
- Degree of shadowing & Light climate
- Rhizosphere – rooting system
- Rhizosphere – mycorrhiza species
- Average temperature and precipitation (literature)
- Duration of snow-cover (literature)
- Pests and diseases

(Sattler 2012; Bohner et al, 2014, Friedrich 2015)

Material and Methods

Research on natural sites (Austria)

Shading & tree-canopy; nutrients and acidity of soils, plant-samples…:

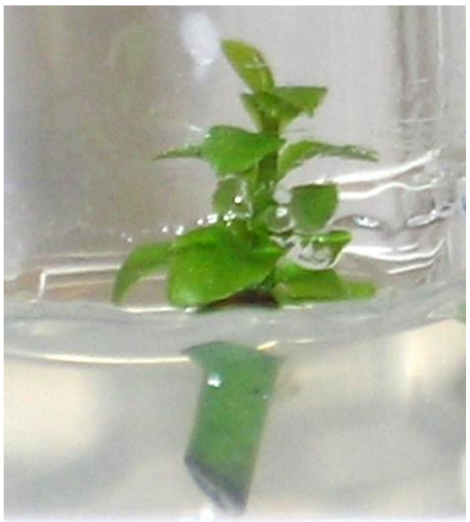
Raumberg - oben

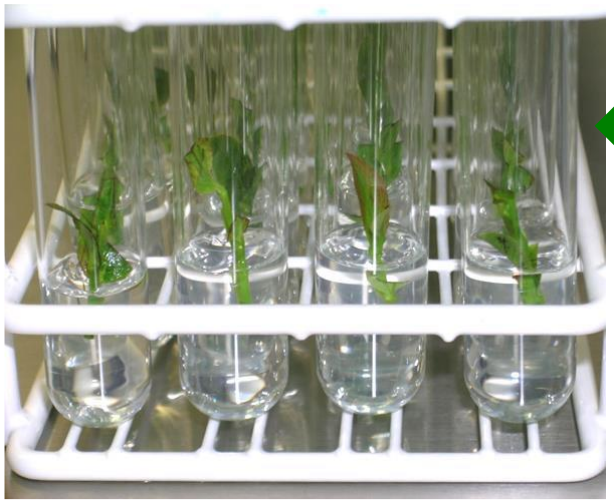
University of Natural Resources
and Life Sciences, Vienna
Department of Crop Sciences

Material and Methods

Research on natural sites (Austria)

At the Federal College and Research Institution for Horticulture (Schönbrunn) – in-vitro protocols for multiplication were established (Hristoforoglou et al 2016)





University of Natural Resources
and Life Sciences, Vienna
Department of Crop Sciences

Material and Methods

Experimental Site – Jedlersdorf (Vienna)

- 162 m above sea-level,
- Avge. temperature a^{-1}: 9,8 °C (49, 64 °F),
- Avge. precipation a^{-1} : 500-600 mm (19,68-23,62 in)
- Avge. duration of sunshine a^{-1} >1800 h
- Remote region of continental Pannonian climate.

- *Actually – not very suitable for cultivation of bilberry –*
  but additional stress might provide additional information.

Photos: Rita KAPPERT

University of Natural Resources
and Life Sciences, Vienna
Department of Crop Sciences

Material and Methods

Experimental design – growing media

- Selected growing media for the horticultural trial – the variants

1. Moorbeeterde (Kranzinger; for *Rhododendron, Erica* and other ericacious plants)
2. Ökohum (organic certified, peat-free blueberry substrate)
3. Sonnenerde (commercial blueberry substrate, peat-free)
4. Peat, commercial - spruce-woodchips added (*Picea pungens*; woodchips from a sawmill)
5. Peat, commercial - Rhodovit added (commercial mycorrhiza)
6. Peat, commercial – zero (pure peat; terraplus)
7. Peat, commercial - larch-woodchips added (*Larix decidua*)
8. Peat, commercial - mykorrhiza added (isolated from soils on natural sites; grown on PDA).

University of Natural Resources
and Life Sciences, Vienna
Department of Crop Sciences

Material and Methods

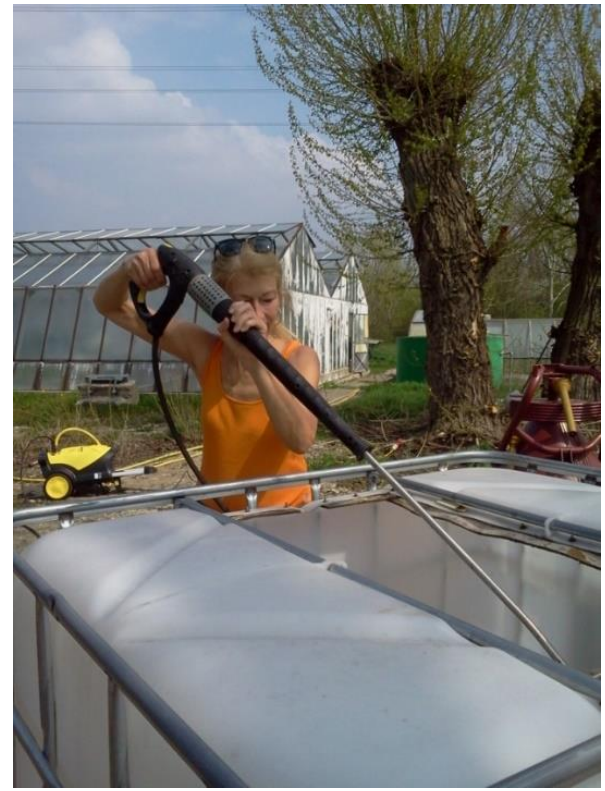
Experimental design -containers

- Large, round containers (black) – containing 100 L (26,4 gallonS) of substrate
- 3 replicates per variant;
  single containers in randomized order
- 3 plants per container; (plants were bought from a local nursery as 2 years old seedlings)
- Irrigation-water was filtered through peat and afterwards citric acid for softening
- Duration of the trial: 3 years (2013-2016)

University of Natural Resources
and Life Sciences, Vienna
Department of Crop Sciences

Material and Methods

Experimental design - planting



Material and Methods

Experimental design in Jedlersdorf

University of Natural Resources
and Life Sciences, Vienna
Department of Crop Sciences

Growing media:

- Core nutrients: **N P K** (Austrian Agency for Health and Food Safety Ltd.)
  pH, electric conductivity (SenTix, WTW; our lab)
- Physical stability: monitored as settling of substrates (cm)
- Humic compounds (spectrometric) (E. Smidt, J. Tintner, J. Balas; unpublished data)

Plants (focus on non-destructive methods):

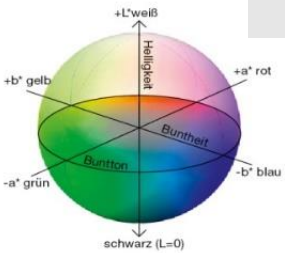
- L*a*b (CIE-colour measurement; Minolta CR 400)
- Chlorophyll fluorescence (Mini Pam, Walz)
- Chlorophyll concentration (CCM, Chlorophyll Content Meter; OptiSciences)
- "Green cover" (number of pixels from digital photos) (Vollmann et al, 2011)
- Growth-parameters: plant-height, number of shoots and runners, flowering, fruit-set

Material and Methods

Devices

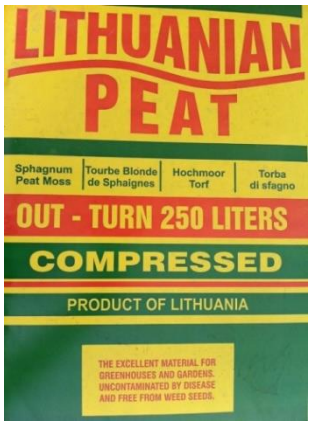
University of Natural Resources and Life Sciences, Vienna
Department of Crop Sciences

CIE L*a*b

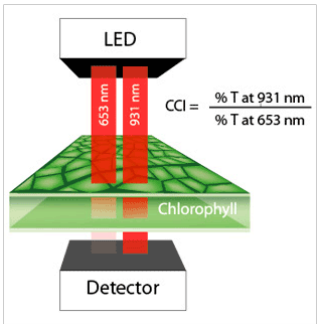


Growing media

Pürkhauer soil-drill



Chlorophyll concentration



University of Natural Resources
and Life Sciences, Vienna
Department of Crop Sciences

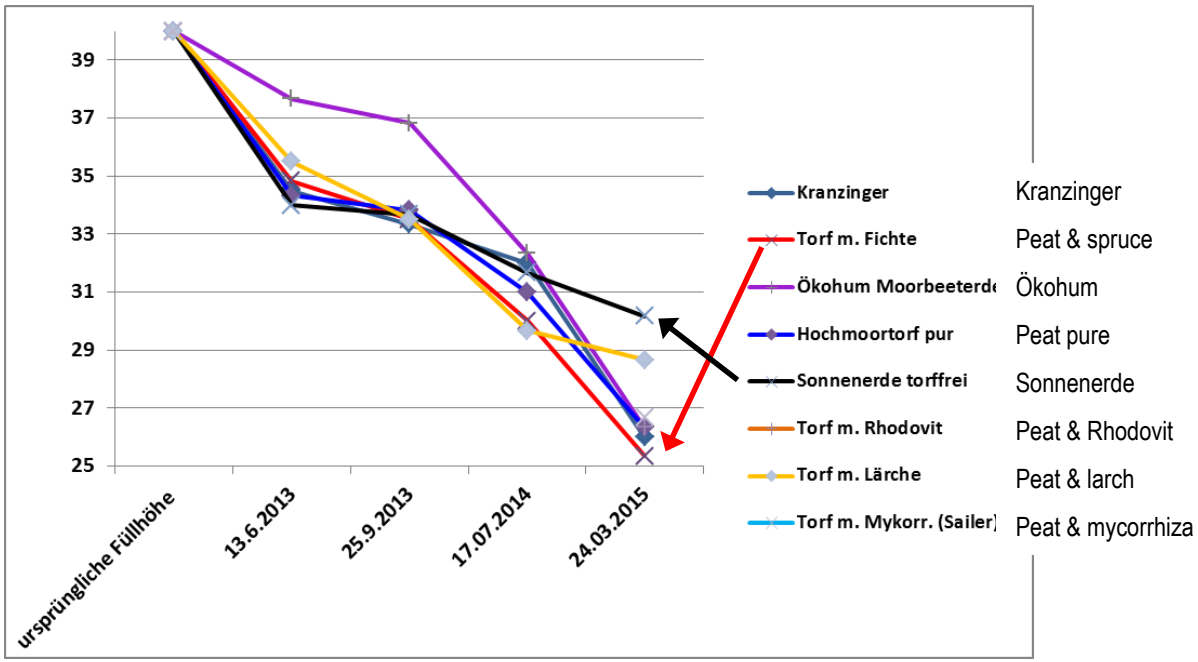
Some Results

Settling of growing media

Reduction of depth (cm) of growing media in containers (3 years) (start at 40 cm):

1) Strongest reduction:
‘peat & spruce‘

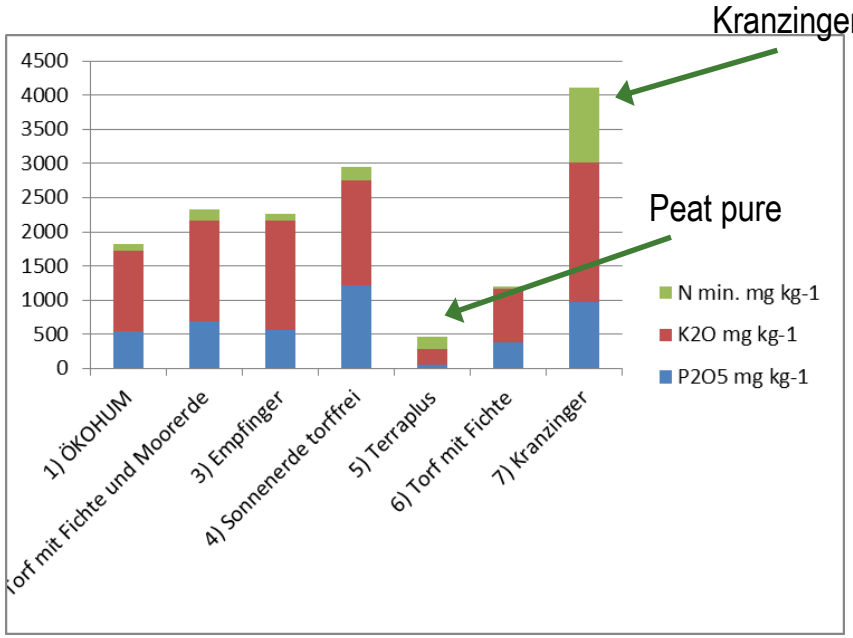
2) Lowest loss:
‘Sonnenerde (without peat)

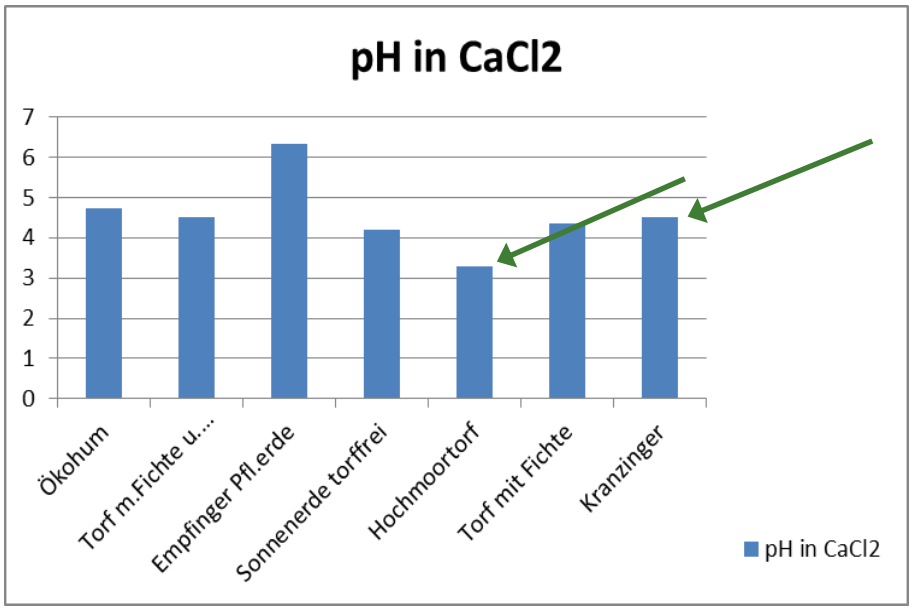


University of Natural Resources
and Life Sciences, Vienna
Department of Crop Sciences

Some Results

Core nutrients (NPK) and acidity



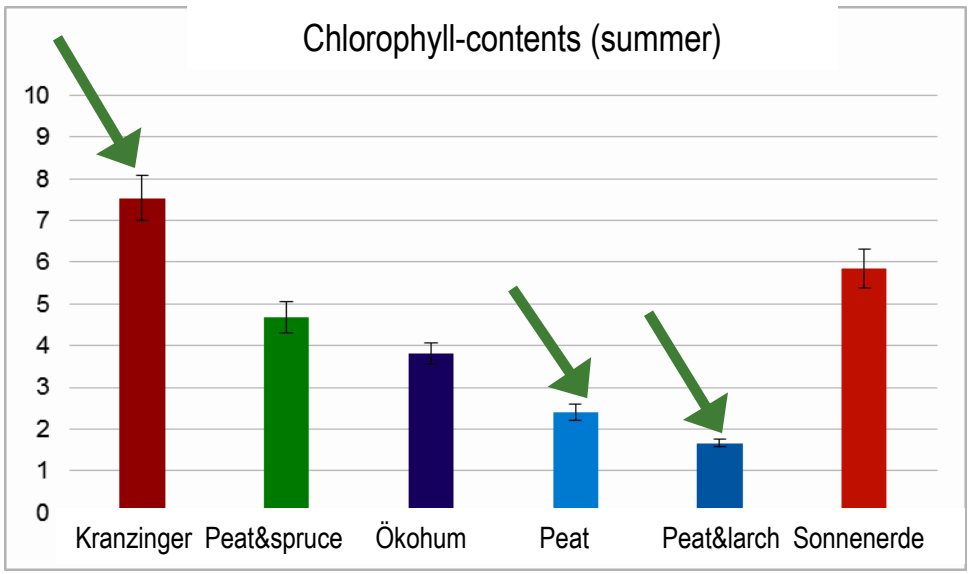


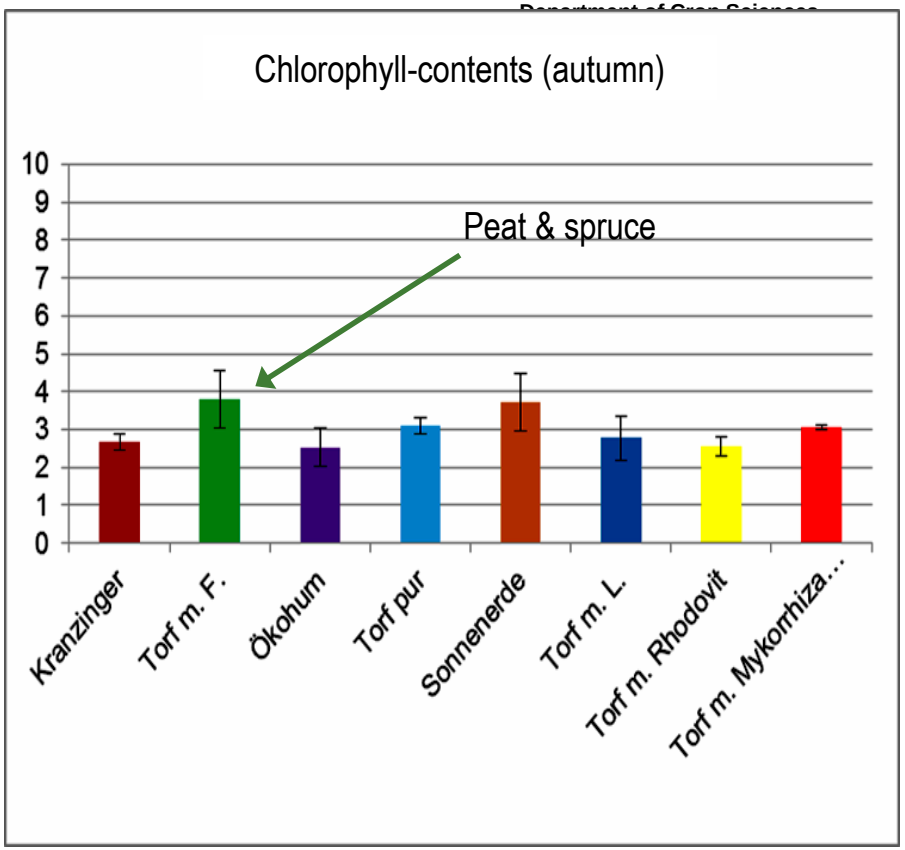
Terraplus = pure peat (= zero variant)

Empfinger = older substrate (comparison; not in the trial)

Some Results

Chlorophyll - concentrations

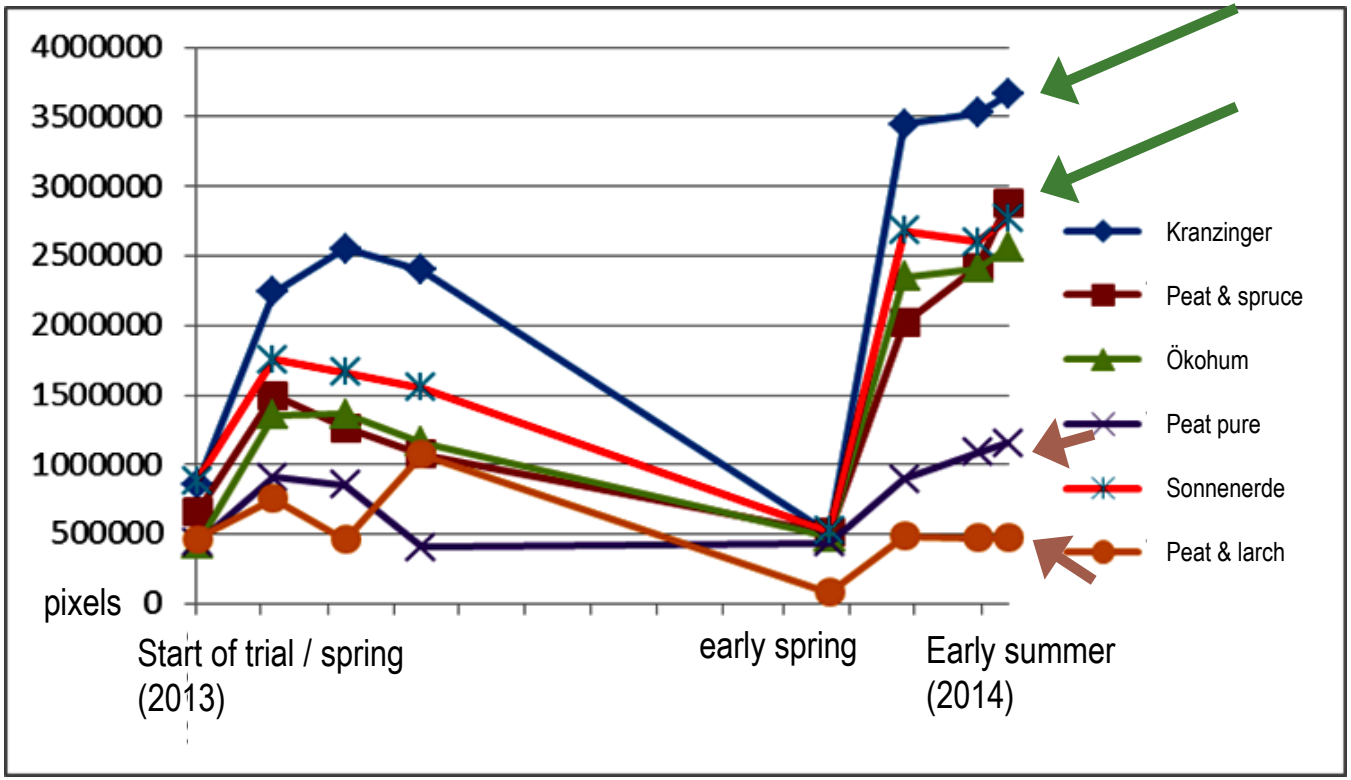




Some Results

‘Green‘ on the surface-area of the container

University of Natural Resources and Life Sciences, Vienna
Department of Crop Sciences



13.06.13
18.07.13
21.08.13
25.09.13
03.04.14
08.05.14
11.06.14
25.06.14

X-axis (day, year)

University of Natural Resources
and Life Sciences, Vienna
Department of Crop Sciences

Conclusion - Summary

Plant growth

- There was no canopy closure in all variants and replicates with peat as substrate. Exception: variant “peat & spruce woodchips“ which developed a rich leaf-canopy in the 3rd (last) year of the trial.

- Young runner-plants appeared under the fleece and through the drainage-holes of containers from shoot-growth in the underground. Comparable observations we made in the natural environment checking root-penetration in natural soils (Sobotik et al; unpublished).

- Visible runners: I) ‘Peat with spruce woodchips‘ (84 + 4 bottom), II) Ökohum (74 +1) III) peat pure (63 +1).
  Underground runners appeared primarily in autumn and winter – and they might serve as an indicator for plant-vitality (and maybe for crop management?) !

Conclusion - Summary

Plant growth – forming of runner-plants

University of Natural Resources
and Life Sciences, Vienna
Department of Crop Sciences

Regeneration of young plants (runners) from underground shoots from already dead plants

University of Natural Resources
and Life Sciences, Vienna
Department of Crop Sciences

Conclusion - Summary

Suitability of horticultural growing media?

- **Yes** - commercial growing-media performed well till excellent (Kranzinger, Ökohum, Sonnenerde) with regard to vegetative growth
  Their higher pH (~4, ~5) than in natural soils (~2-3) did not cause visible problems.
- Pure peat performed ‘average‘
- “Peat with larch-woodchips“ actually was detrimental - obviously *Larix decidua* has a strong negative allelopathic impact
- The inoculation with mycorrhiza did not result in visible effects nor in measured data.

- The improvement of peat with woodchips of spruce promoted vegetative growth after 2 years! (*That might be due positive allelopathic effects*.)

University of Natural Resources
and Life Sciences, Vienna
Department of Crop Sciences

Conclusion - Summary

Plant growth

Status of *Vaccinium* in “peat & larch woodchips“ at the end of the trial (01.2016).

Status of *Vaccinium* in “Kranzinger“ (commercial) at the end of the trial (01.2016).

University of Natural Resources
and Life Sciences, Vienna
Department of Crop Sciences

Conclusion - Summary

Vaccinium myrtillus in horticulture?

- **Maybe – Yes – Probably not reasonable**.
  Technically - it was possible to cultivate bilberry over 3 years in containers in horticultural growing media.
- In 3 years we noticed just poor setting of flowers and fruits (which were aborted or bird-feed).
  Low concentrations of mineral nutrients could have contributed to this finding.
- Yields we gained – let‘s say – were less than poor.
  This has to be judged under the sub-optimal climatic conditions on the site and injuries by late frosts after early warm periods. Which might become regular because of climate change!
- It appears to be possible but not economic to domesticate and grow *Vaccinium myrtillus*.

University of Natural Resources
and Life Sciences, Vienna
Department of Crop Sciences

Conclusion - Summary

Our final summary – horticulture:

- Bilberry in horticultural production systems seems to be too sensitive and not reliable with regard to regular yields.
- Its horticultural cultivation on a larger scale apparently is not efficient – it maybe can function as an alternative in small scale growing (raised beds cultivation in forest soils).
- Actually there are more interesting alternatives: e.g. *Aronia* and “ready“ cultivars of other *Vaccinium* species/hybrids.
- The contribution to regional agro-biodiversity and welfare (gastronomy, tourism) will be more sustainable by production under silvicultural premises:
  Harvests from managed, semi-natural bilberry-stands established in forest-clearings after harvesting the timber seem to be more promising.

University of Natural Resources
and Life Sciences, Vienna
Department of Crop Sciences

Conclusion - Summary

Thoughts – on “Bilberry in a changing environment“ :

- The flowering of bilberry is exposed to the risk of late frosts (especially after early warm springs!)- and bilberry is sensitive towards longer periods of insufficient natural precipitation. Presumably both factors will increase due to climate change. We noticed at least 2-3 years of almost no fruiting in the recent years.
- Bilberry is assumed to need snow-cover during the winter season – which again will be reduced as a consequence of climate change.
- Actually other *Vaccinium*-hybrids from horticultural plantings will/are “escaping“ (neophytes – “alien“ plants).
- We do have only insufficient information on genetic and biochemical diversity ot the species…. and almost no information on environmental effects on basis of physiology.

References

University of Natural Resources and Life Sciences, Vienna
Department of Crop Sciences

Bohner et al (2014): “Autochthonous Vaccinium myrtillus for Autochthonous Rural Value Creation? II: European Blueberry’s Soil Ecology and Root Systems” Acta Hort. 1017, Proc. Tenth Int. Symp. on Vaccinium and Other Superfruits Eds.: O. van Kooten and F. Brouns; ISHS 2014

Cox, J.A., Morris, S. and Dalby, T. (2014). Woodchip or Weedmat? A Comparative Study on the Effects of Mulch on Soil Properties and Blueberry Yield. Acta Hort. (ISHS) 1018:369-374

Martinussen J, R. Nestby. A. Nes (2009): Potential of the European Wild Blueberry (Vaccinium myrtillus) for Cultivation and Industrial Exploitation in Norway. Acta Hort. 810, ISHS 2009, Proc. IXth IS on Vaccinium (Eds.: K.E. Hummer et al

Schmid A., Suter F., Weibel F.P. & Daniel C. (2009): New Approaches to Organic Blueberry (Vaccinium corymbosum L.) Production in Alkaline Field Soils, Europ. J. Hort. Sci. 74 (3) S. 103-111.

Wendelin S., K. Korntheuer, R. Baumann und W. Brandes (2018): “Vergleich von Wildheidelbeeren (Vaccinium myrtillus) und Kulturblaubeeren (Vaccinium corymbosum) hinsichtlich ausgewählter Inhaltsstoffe” Mitteilungen Klosterneuburg 68 (2018): 221-240

Sattler I. (2011): „Landschaftsökologische Betrachtung von Vaccinium myrtillus (Waldheidelbeere)“ Thesis, Department für Integrative Biologie und Biodiversitätsforschung an der Universität für Bodenkultur Wien (supervision: Kikuta S, J. Balas)

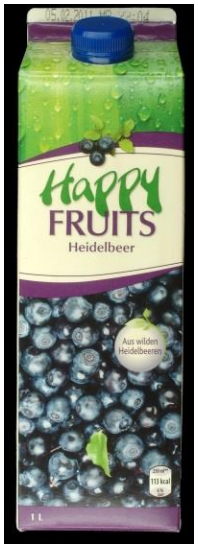
Schmid A., Suter F., Weibel F.P. & Daniel C. (2009): New Approaches to Organic Blueberry (*Vaccinium corymbosum* L.) Production in Alkaline Field Soils, Europ. J. Hort. Sci. 74 (3) S. 103-111.

Vollmann J., H. Walter, T. Sato, P. Schweiger (2011): Digital image analysis and chlorophyll metering for phenotyping the effects of nodulation in soybean, Computers and Electronics in Agriculture 75 (2011) 190–195

Zoratti, L., H. Klemettilä, L. Jaakola (2016): “Bilberry (Vaccinium myrtillus L.) Ecotypes” in: Nutritional Composition of Fruit Cultivars; Chapter 4, pages 83-99 (Academic Press)

Thank you for your interest and attention!

University of Natural Resources and Life Sciences, Vienna
Department of Crop Sciences



University of Natural Resources and Life Sciences, Vienna (Austria, EU)

Department of Crop Sciences
Institut of Vegetables and Ornamentals
Formerly we were the Working-group ‘Sustainable Horticulture‘

Ass. Prof. Dr. Johannes BALAŠ

Gregor Mendel-Strasse 33,
A-1180 Vienna/Austria,

tel: +43 1 47654-95213
johannes.balas@boku.ac.at
www.boku.ac.at/dnw/gb

This research project was funded by the Federal Ministry of Agri-, Silviculture and Water-management (Vienna, Austria): (DAFNE-Nr.100878). This is highly appreciated.
We thank the companies *Kranzinger* and *Sonnenerde*, which delivered growing-media at no costs for the project.