AARHUS UNIVERSITY

Development of a European blueberry production in Denmark

European bluebery, Bilberry (*Vaccinium myrtillus* L.)

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The Interreg IVB North Sea Region Programme

Why is bilberry of interest?

–'Superfruit'. Attractive taste, high price on berries (25-32 kr/kg = 3-5 Euro/kg)

–Health effects: Cholesterol lowering, lowers blood pressure, improve cognitive performance, antibacterial, vision

–Higher concentration of antioxidants than in american highbush blueberries

–No commerciel orchard production, only 'natural collection'

–Manual harvesting – high costs, limit production, non-sustainable

–Limited production world wide, market demand increasing

–Orchard production of bilberry with mechanical harvesting will create new product options

–No breeding or selection done, no cultivars

–Native Danish species – climate adapted genetic ressources available

–Exploit Nordic Food trend

–'Window of opportunity' for Danish growers and industry

What is needed and what are we doing on blueberry at DFS, Aarhus University?

- Significant improved berry yield/plant is needed (selection and breeding).
- Significant more efficient and non-expensive vegetative propagation Is needed.
- Developing efficient mechanical harvesting is critical to reduce cost of harvest.

Ongoing

–Collecting and comparing the best genetic plant material from wild Danish populations

–Develop propagation techniques: vegetatively in vitro or cuttings, and from seed

–Develop cultivation concept on acidic soils or on setup beds/rows

Future

–Develop mechanical harvesting machine (black currant concept will likely work)

–Develop berry products together with growers and industry

–Investigate bioactive compounds in berries and how they may be used to produce added value of blueberry products

–Investigate clinical effects of selected products for 'functional claims' for prevention of diseases/health promoting.

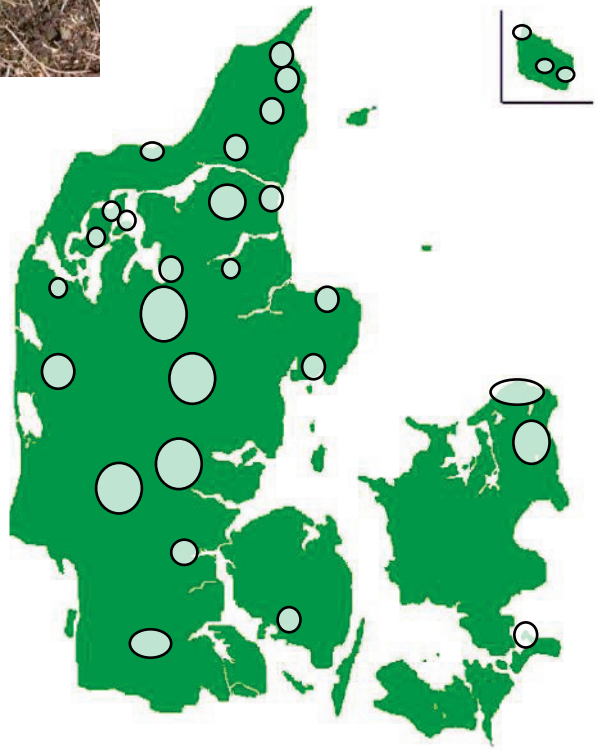
Danish Blueberries – development and activation of Danish genetic ressources
(FERV genetic ressources programme)

Project aim
To establish conservation plantings of selected clones of Danish blueberries (*Vaccinium myrtillus*) - two copies

Triple purpose of plantings
- gene conservation
- a comparison trial for clonal quality, yield and plant health
- used as a clonal seed orchard and vegetative bank for further dissemination of genetic superior material.

We collected plants and berries from more than 150 interesting clones from initally over 50 locations in Denmark. Now over 100 clones from 39 locations.

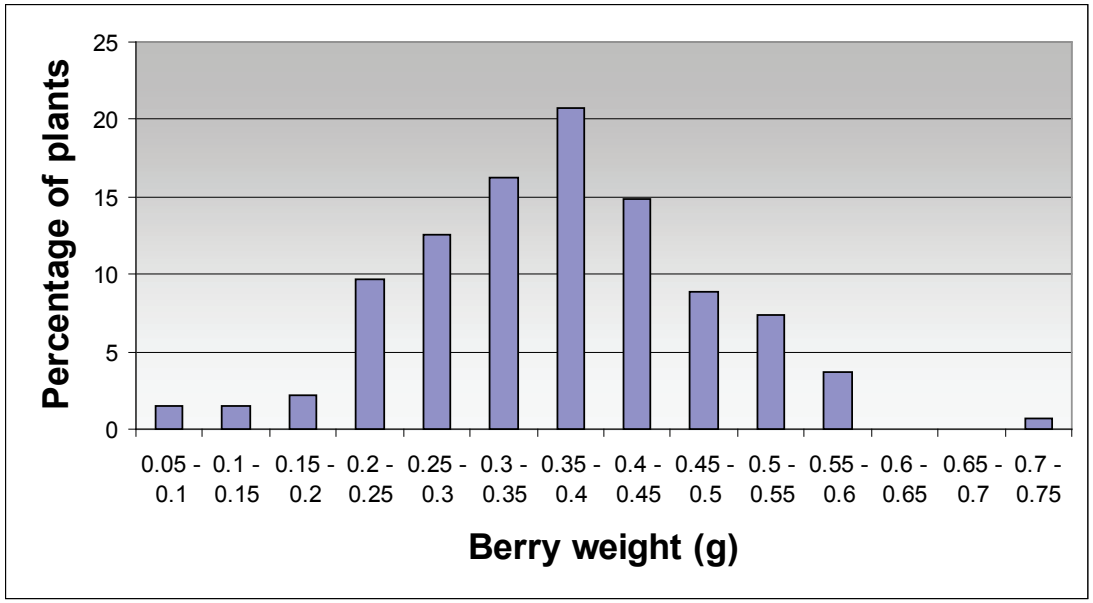
Propagate by in vitro or cuttings to 20 plants per clone and characterise for growth and attack of diseases etc.
Idea brainstorm meeting with growers, industry, food specialists in autumn for exploring options for new products.



Clonal collection: 107 clones from 39 locations. Berries, seeds and cuttings

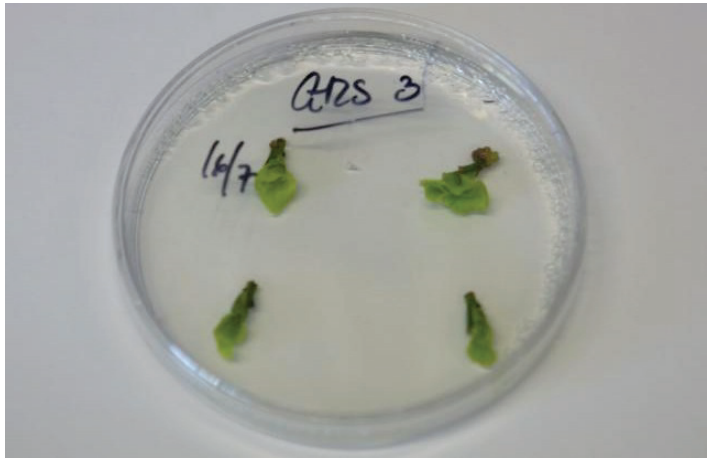
Lokalitetsliste (39)	Mols Bjerge
Almindingen	Mossø
Balkalyngen	Musebakkerne
Bøllemosen	Paradisbakkerne
Bønnerup Strand	Randbøl Hede
Børstingerød Mose	Rørbæk Sø
Draved Skov	Salgierhøj
Frederikshavn	Slotslyngen
Fuglsang	Sostrup Hede
Gærup Skov - Korinth	Stenholt Skov
Gadevang Hovmosen	Svanemose
Gilleleje Strandbakker	Svinkløv
Grene Sande	Tinnet Krat
Gudenåens Udspring	Tolne Bålhøj
Hammer Bakker	Ulbjerg Klint
Hem Hede	Ulvshale
Hønning Plantage	Vrads Bavnhede
Hårup Sande	Vranum Bakker
Kollemorten Krat	Øster Hurup
Legind Bjerge	Ålbæk

Selection of healthy plants with many and large berries

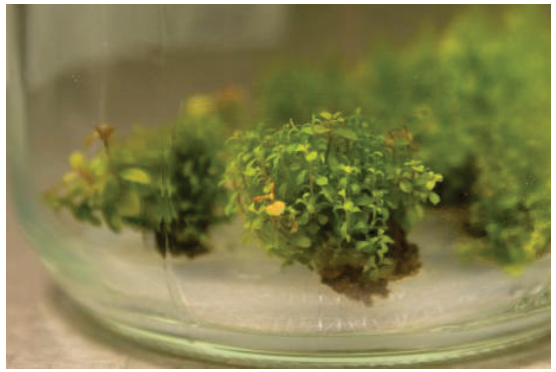
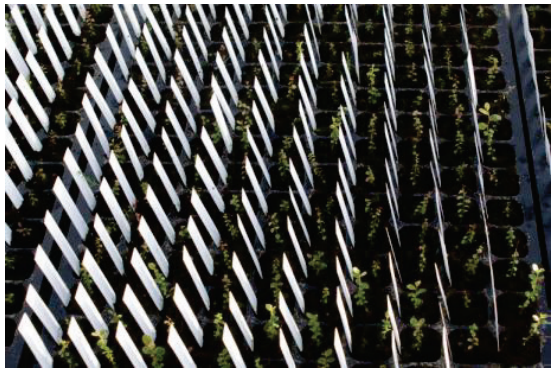


Variation in mean berry weight between clones collected in nature

In vitro propagation from surface sterilized buds Jaakola method (Jaakola, 2009)



Vegetative propagation


In vitro plants, and mikrocuttings in greenhouse


Summer softwood cuttings during July (right)

Variation in rooting of in vitro micro cuttings

Clone	No cuttings	Survival %
BL 3	6	0
DS 2	11	55
FH 3	7	29
FYN 1	13	23
GS 2	5	0
GU 2	14	29
HB2	7	71
HP 1	4	25
KH 4	10	10
KMK 4	10	30
KMK 5	7	86
MB 1	6	17
MB 2	12	100
MS 1	10	100
PB 2	10	90
PB 3	8	88
PB 4	10	90
SAH 1	10	90
SAH 4	10	0
SH 2	10	20
SHS 20	15	0
SLY 3	10	70
TB 2	7	29
UK 1	10	90
UK 2	7	0
ØH 3	10	50
Mean		**46**

In vitro cuttings on rooting media then in greenhouse, evaluated 15/9 2010

Rooting percentage of mikrocuttings in greenhouse
Cuttings taken 25/5 2010 and evaluated 17/8 2010.

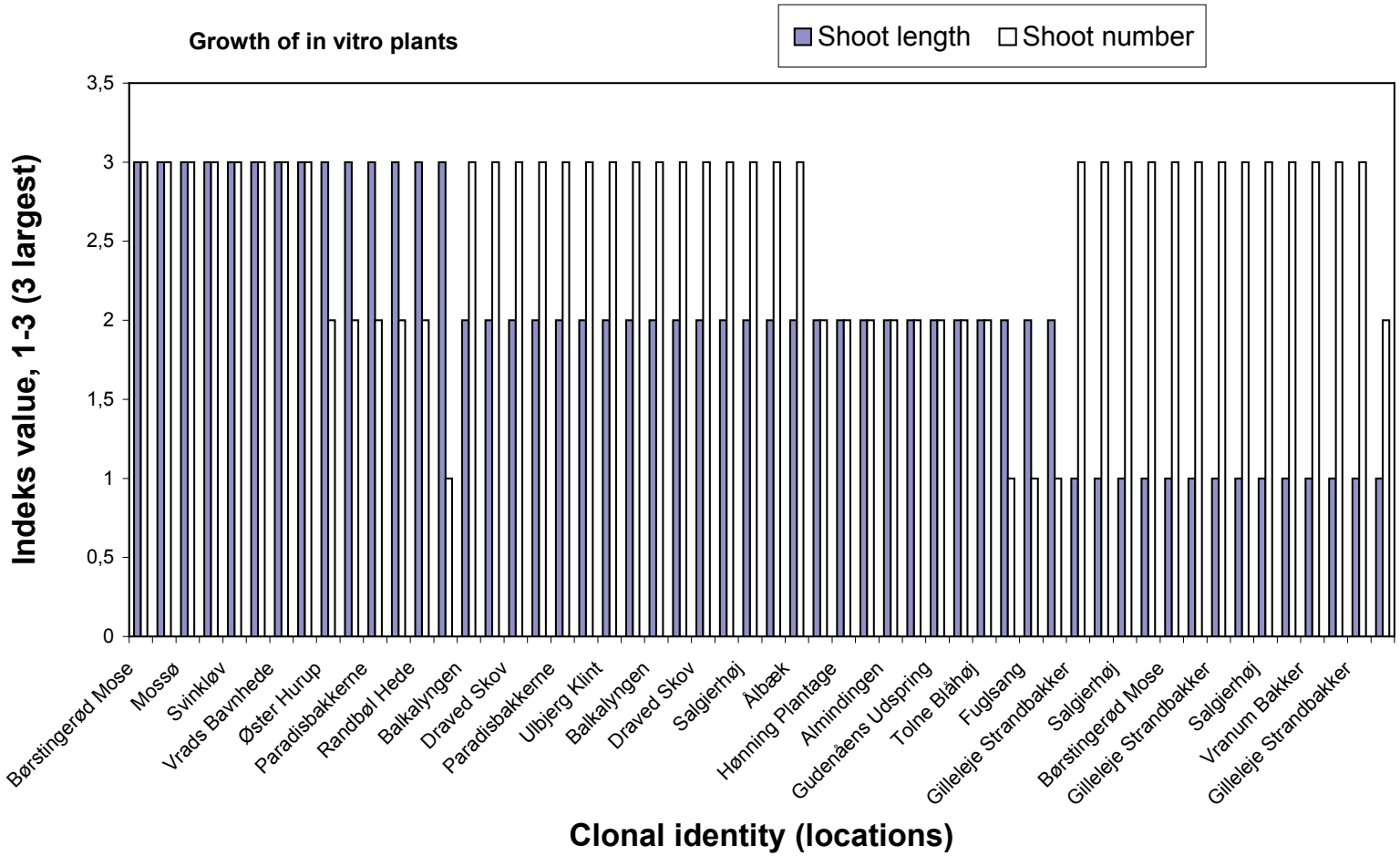
Clone	No. Of cuttings	% survival
UK 1	43	86
UK 1 (P1)	20	100
MB 2	25	68
SAH 1	20	40
ØH 3	44	93
CU 2	36	42
KMK 4	30	100
KH 4	26	69
Mean	**31**	**75**

Rooting directly in greenhouse, plugs covered with plastic tent

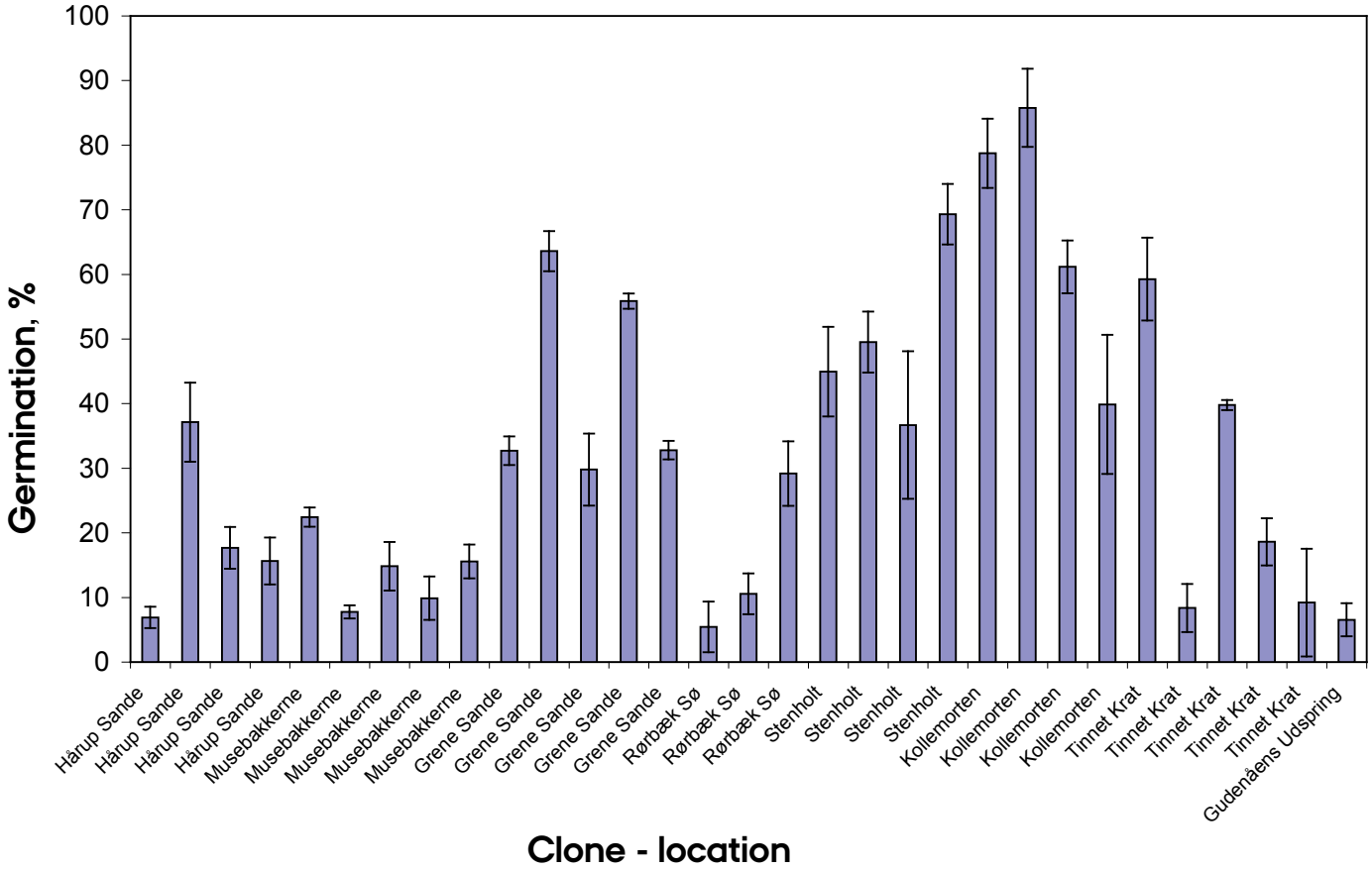
Total overall survival 30/11 2010

Clones - location	Survival, %
Almindingen	45
Almindingen	70
Balkalyngen	70
Balkalyngen	89
Balkalyngen	70
Bøllemosen	40
Børstingerød Mose	82
Børstingerød Mose	90
Bønnerup Strand	18
Bønnerup Strand	93
Draved Skov	94
Frederikshavn	93
Fuglsang	50
Fyn	88
Gilleleje Strandbakker	42
Gilleleje Strandbakker	64
Gilleleje Strandbakker	33
Gudenåens Udspring	61
Hammer Bakker	60
Hønning Plantage	56
Klosterhede	55
Kollemorten Krat	82
Kollemorten Krat	44
Musebakkerne	83
Musebakkerne	59
Mossø	82
Paradisbakkerne	59
Paradisbakkerne	78
Paradisbakkerne	97
Randbøl Hede	48
Randbøl Hede	13
Salgierhøj	60
Salgierhøj	86
Sostrup Hede	63
Stenholt Skov	65
Svinkløv	48
Slotslyngen	92
Tolne Blåhøj	73
Tolne Blåhøj	51
Ulbjerg Klint	95
Ulbjerg Klint	61
Vrads Bavnhede	13
Vranum Bakker	78
Øster Hurup	14
Øster Hurup	71
Ålbæk	31
Mean	**63**

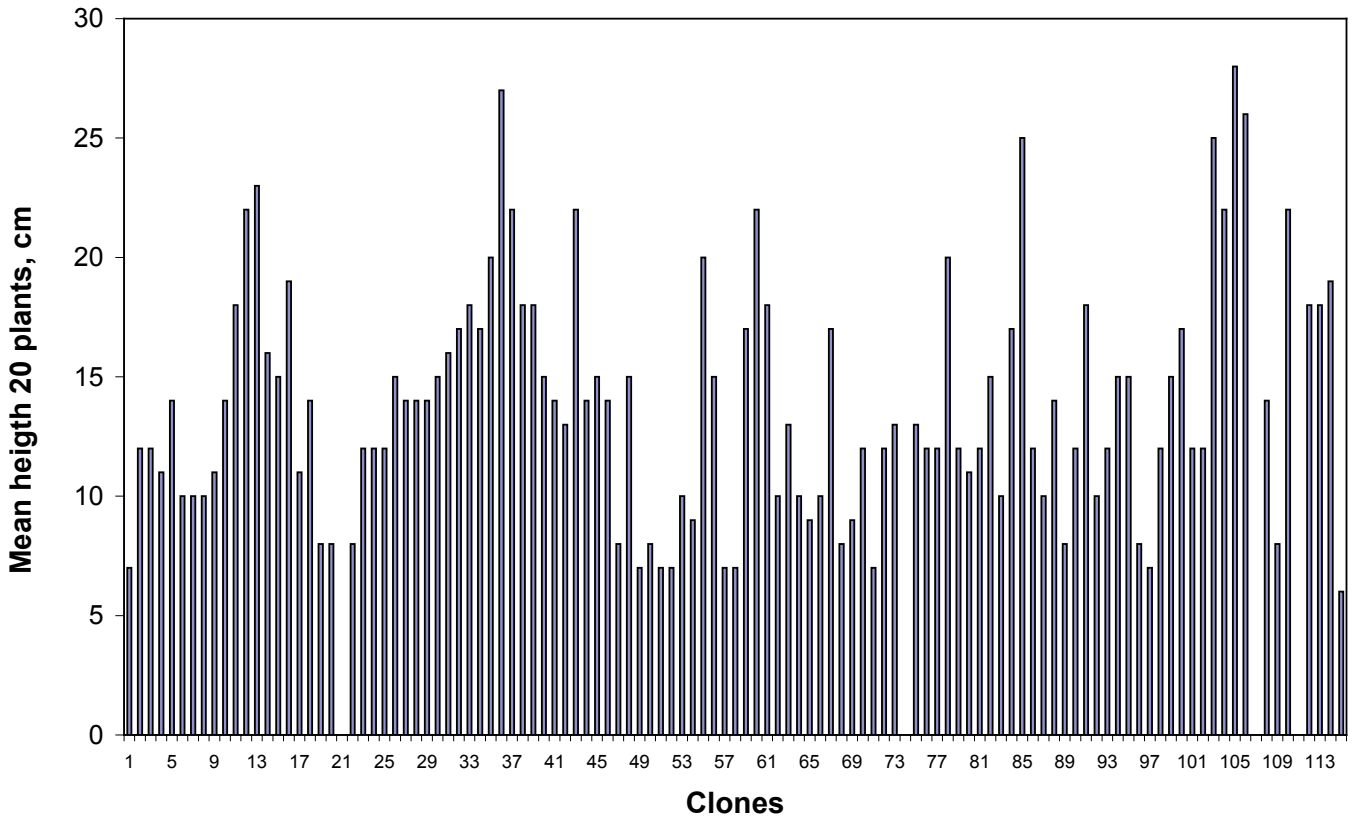
Variation in growth of clones in tissue culture (observations)



Germination: Freshly harvested un-dried seeds, 20°C, 16 hours daylength, top of paper, 31 clonal seedlots from 8 locations



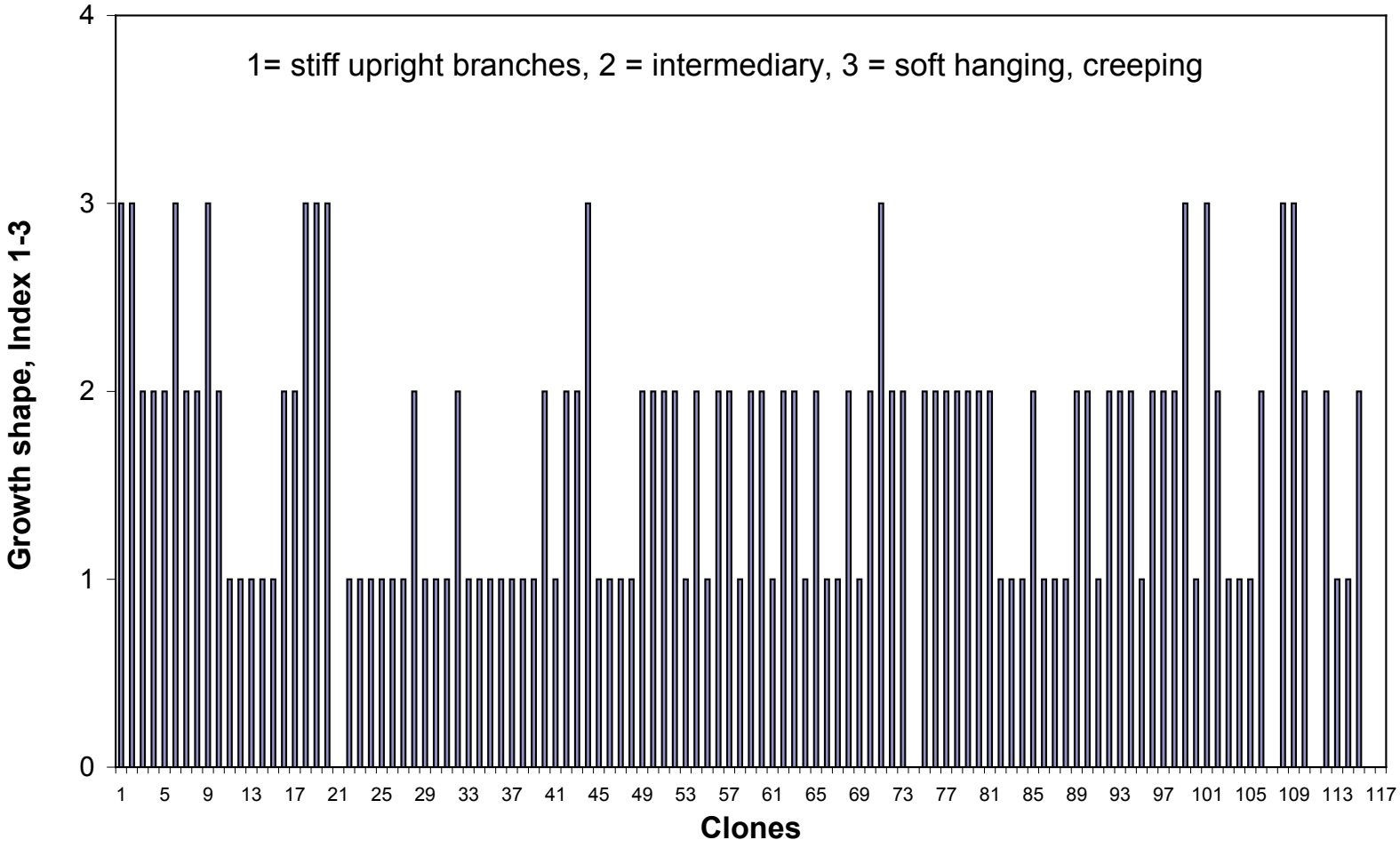
Variation in plant growth



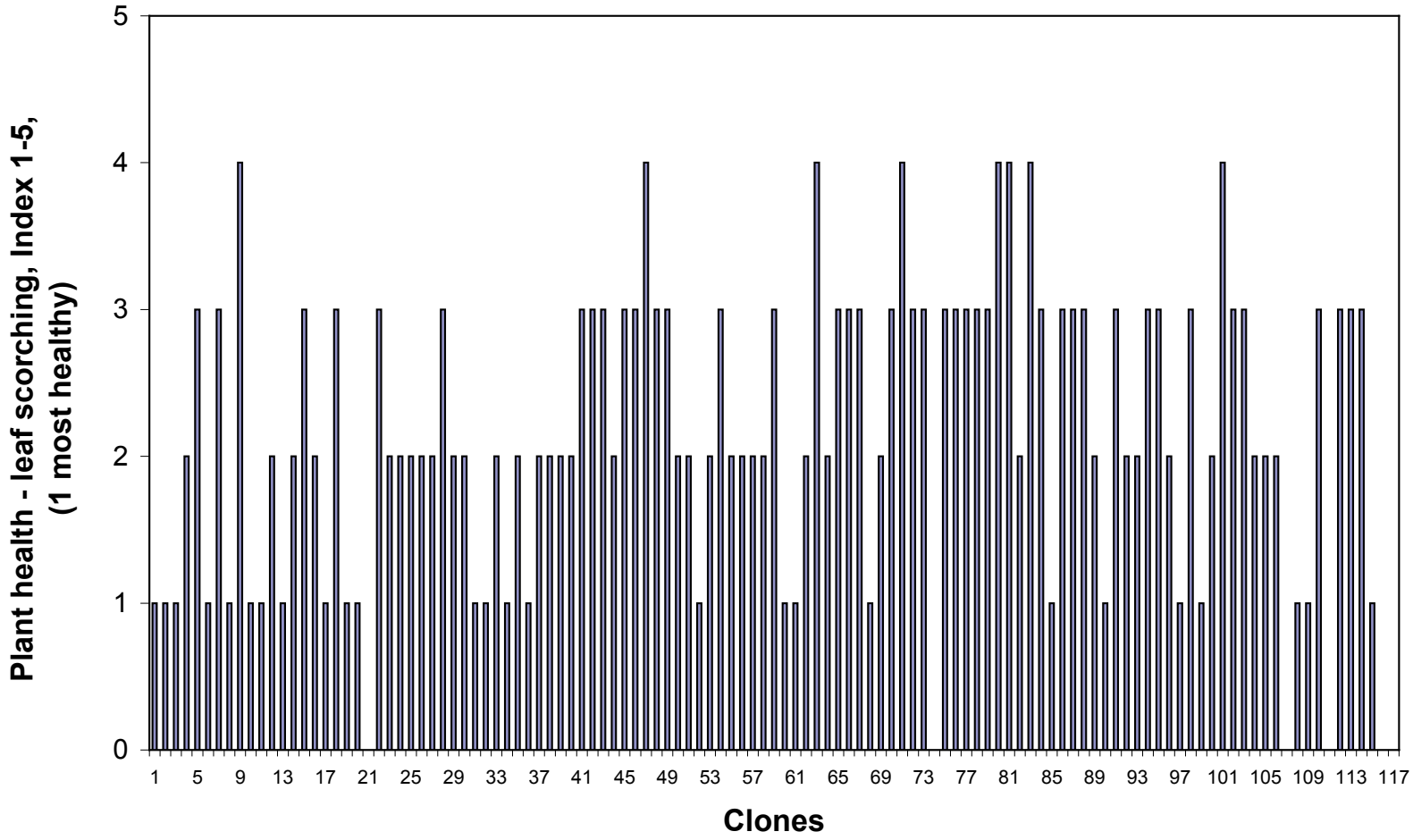
Variation in mean height in approximately one year old plants clones from both softwood cuttings and in vitro cuttings (mean of 20 plants app.)

Variation in leaf size and flowering in greenhouse environment

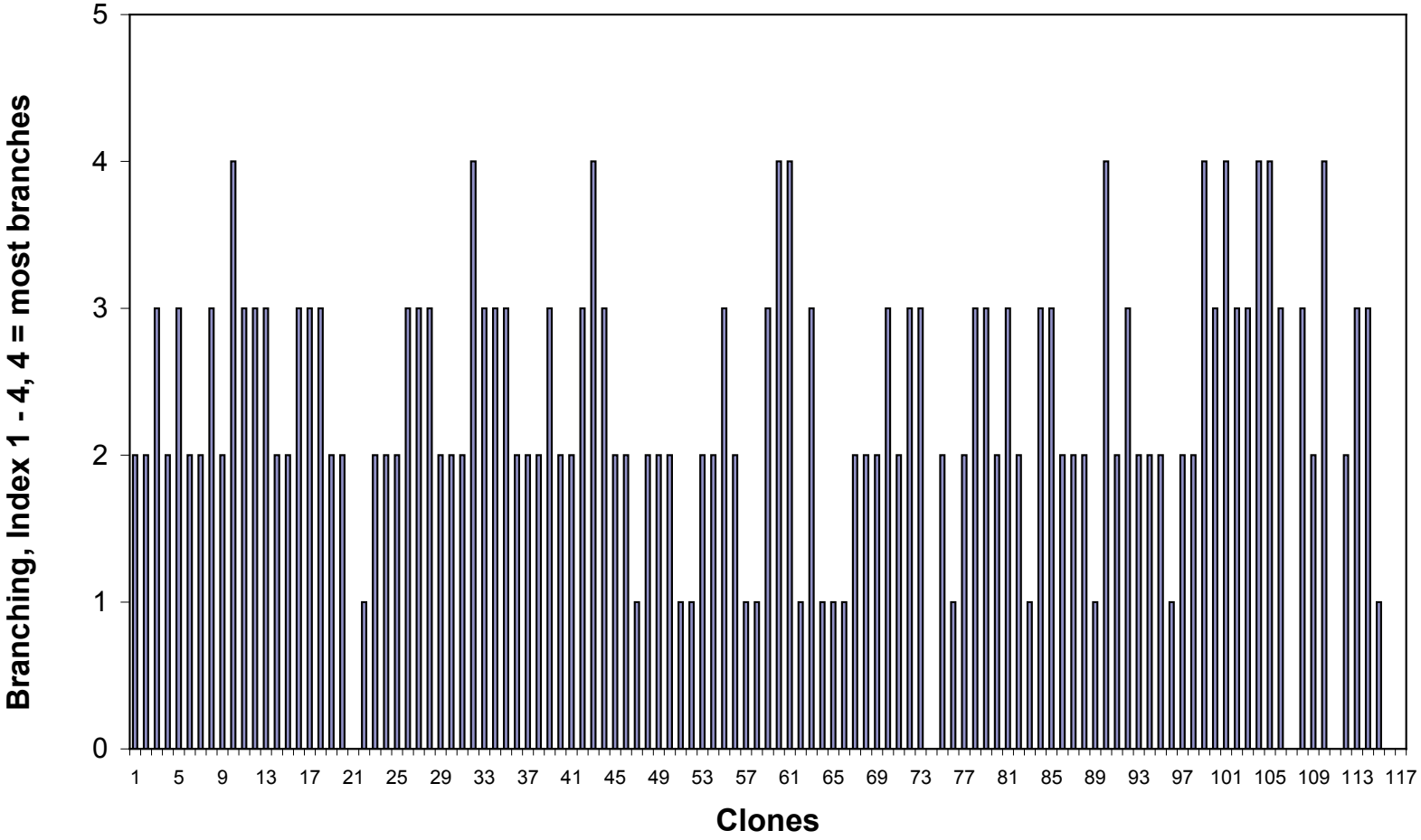
Scorching of leaves



Variation in mean growth shape of clones



Variation in mean plant health – leaf scorching on clones in greenhouse.



Variation in branching index of clones in greenhouse grown plants. (1= no or few side branches, 4 = many side branches)

Aarslev, Funen

Frederikshåb Plantage, Jutland

Conclusion – geneconservation project

The project has demonstrated different technological methods important for a possible domestication of wild growing bilberry from Denmark.

The variation between clones and locations has been preliminary shown in terms of berry size, adaptation to in vitro cultivation, propagation by seed or by softwood cuttings and preliminary variation in plant growth parameters.

Two clonal orchards established in september will provide basis for future scientific evaluation of clonal differences and potentially point to superior clones for future cultivation of wild blueberries in Denmark. (at least 3 replicates each location).

Blueberry project 2. Propagation, cultivation and berry production.

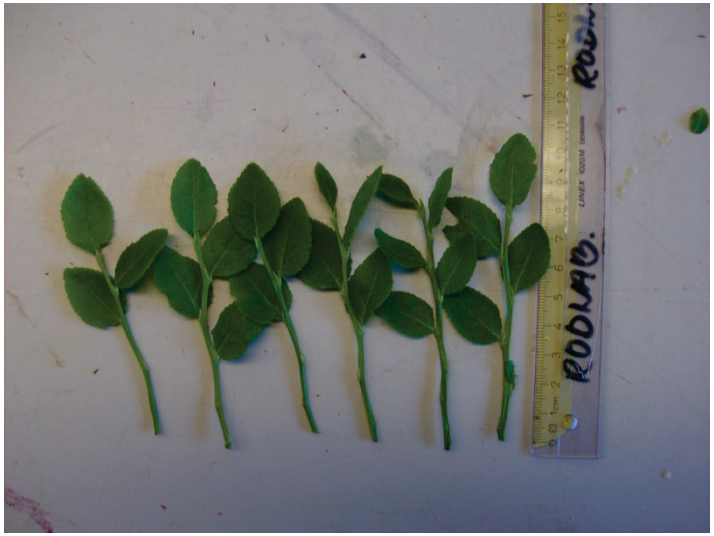
- Funded by Danish Food Agency. Participants: AU and 4 specialised growers.
- A nursery with experience in cultivating blueberries (Gl. Sunds Nursery)
- A seed company to procure seeds for future production (Levinsen & Abies)
- The largest Danish highbush blueberry grower (Halskenbjerg).
- A specialist advisor and grower of highbush blueberries. (S. Ramborg)
- 3 year project, started summer 2010.

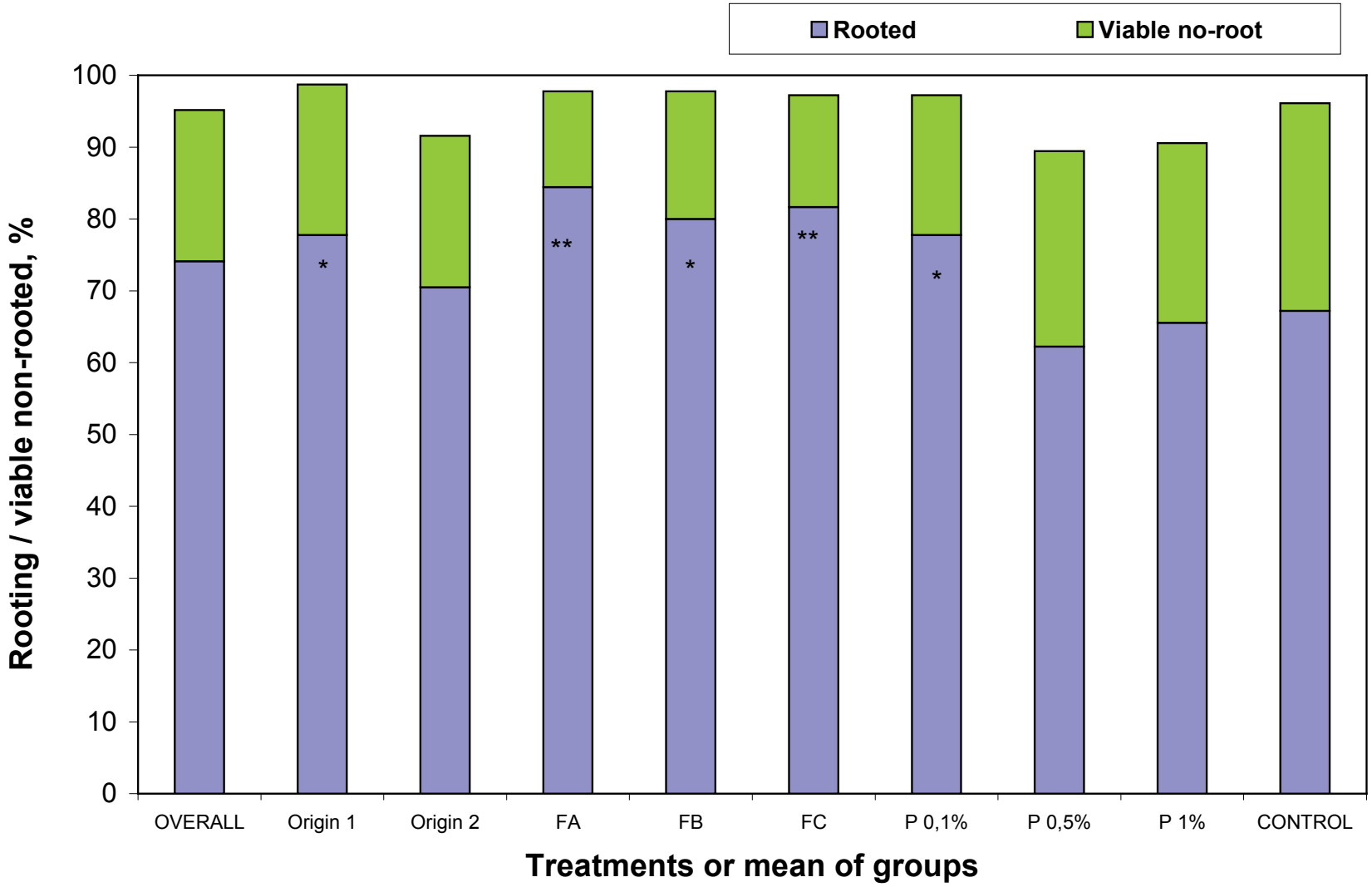
- *Ongoing*
- Propagation experiments with cuttings and seed pretreatment
- Fertiliser experiments to obtain rapid growth of propagated plants
- Ecological enginering – direct sowing of seeds in nature/semi-nature
- Establishing first berry orchard experimental systems this autumn.

Rooting experiments – softwood cuttings

- EXP 1. Effect of hormones on rooting
- Softwood cuttings directly from nature into greenhouse
- Tip cuttings taken medio July 2010
- Two origins (Stenholt and Kollemorten Krat)
- 5 replicates of 18 cuttings for each treatment
- 7 treatments
- Floramon A, B, C powder dip
- Pomoxon spray, 0,1 %, 0,5 % , 1 %
- Control
- 77 hole plugtrays, raw finegraded peatmos, pH 4, no fertiliser, rainwater irrigation,
- Greenhouse, min 20 C, ventilation 25 C, white plast tent cover 100% RH
- Daylength 20 hours.

- Recording rooting on surface of plug-media 28 October 2010





Effect of hormones and origin of cuttings on rooting succes.

- Large scale confirmation of cutting process, two origins, 500 cuttings each, stored 2 weeks in cold storage in plastic bag, dip in Floramon B, cuttings stuck late July 2010, recorded rooting 24 January 2011

- Stenholt, 85 % rooting
- Kollemorten Krat , 71 % rooting

One year old plants from cuttings in greenhouse

Exp 2. Effect of the position of the cutting on the annul shoot (top, mid, base) on rooting.

Softwood cuttings from nature, long shoots, two origins, 5 replications of 18 cuttings, stuck medio July 2010.

Rooting recorded 19 January 2011.

Rooting %	Stenholt	Kollemorten K
Top	100	95,56
Mid	100	96,67
Base	97,78	91,11

	Stenholt	Kollemorten K
Top	33,33	15,56
Mid	34,44	26,67
Base	55,56	45,56

Percentage with budbreak of all

Exp 3. Effect of cuttings from older shoot parts, 2-3 years branches, on rooting.

5 replicates of 18 cuttings, stuck mid July 2010, rooting recorded 19 January 2011.

Rooting %	Stenholt	Kollemorten K
Control	61,11	44,44
Hormone FB	65,56	54,44

Budbreak %	Stenholt	Kollemorten K
Control	50,00	30,00
Hormone FB	62,22	50,00

Budbreak of all cuttings

Exp 4. Variation in rooting of clones from different origin.

Softwood tip cuttings directly from nature into greenhouse medio July 2010 or medio September and rooting recorded 19 January 2011

Location	No of Clones	Cutting date	Bud break % cuttings	Viable % cuttings
Stenholdt	4	16 juli	47 – 91	61 - 94
Kollemorten Krat	4	16 juli	29 – 57	72 - 89
Kollemorten Krat	4	17 sep	0 – 14	94 - 100
Svanemosen	4	20 juli	15 – 66	39 - 93
Hønning Plantage	4	22 juli	37 – 63	58 - 97
Draved Skov	4	23 juli	36 – 72	75 - 97
Mols Bjerge	4	23 juli	0 – 61	72 - 89
Hårup Sande	4	23 juli	36 – 77	67 - 97
Rørbæk Sø	3	23 juli	19 – 26	78 - 94
Grene Sande	5	26 juli	22 – 79	53 -78
Tinnet Krat	5	26 juli	34 – 83	69 -94
Tinnet Krat	4	17 sep	14 – 50	91 -100
Gudenåens Udspring	4	26 juli	21 – 84	71 – 94
Musebakkerne	5	27 juli	14 – 84	39 – 89
Musebakkerne	2	17 sep	14 – 19	96 – 100
Ulvshale	4	27 juli	65 – 94	72 – 100
Legind Bjerge	5	2 aug	34 – 62	83 - 94

Fertilizer experiments

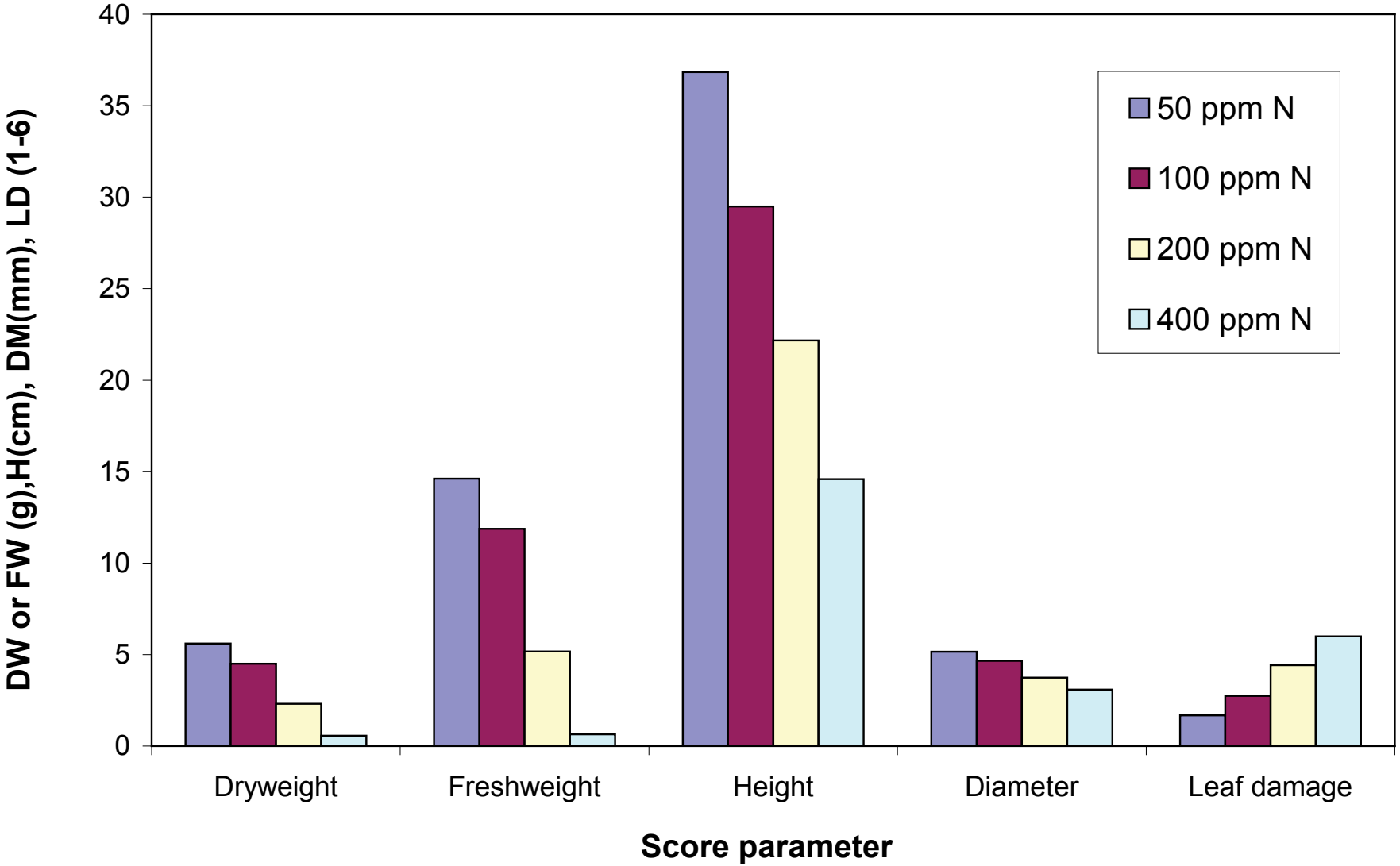
- Development of a standard liquid fertiliser composition.
- Literature review – Ingestad paper.
- Norm numbers – standard for dilution

		pH	4,5	Kultur: Blåbær gødningsforsøg						Udarbejdet af: KOD					Forsøgs nr	0					
START HER	NH4%	HCO3	EC	N	NO3	NH4	P	K	Mg	Ca	Na	Cl	SO4	Fe	Mn	B	Cu	Zn	Mo	Si	
ØNSKET (ppm)	45,0	50	2,29	400	220	180	52	200	16	16	0	0	18	2,80	1,60	0,80	0,12	0,12	0,04	0,00	
OPNÅET (ppm)	45,2	1	2,48	400	219	181	52	200	16	34	4	4	50	2,80	1,60	0,80	0,12	0,14	0,04	0,00	

Exp. 1. Fertilizer experiments – high levels

- Test effect of 50, 100, 200 and 400 ppm N fertilizer on growth of cuttings in greenhouse (EC values of 0,31, 0,62, 1,24 , 2,48). Eb-flood irrigation, fertiliser every time. 3 replicates (12 separate tables).
- Effect of growing medium with increased pore volume/rapid drainage tested within each fertilizer treatment.
- Raw peat moss, addition of 10 % or 25 % medium sized vermiculite (vol/vol) compared to control with no vermiculite.
- Non-clonal plants from two origins tested, 6 plants for each treatment replicated 3 times.
- Begin May - growth evaluated 18 August, app. 3 months.

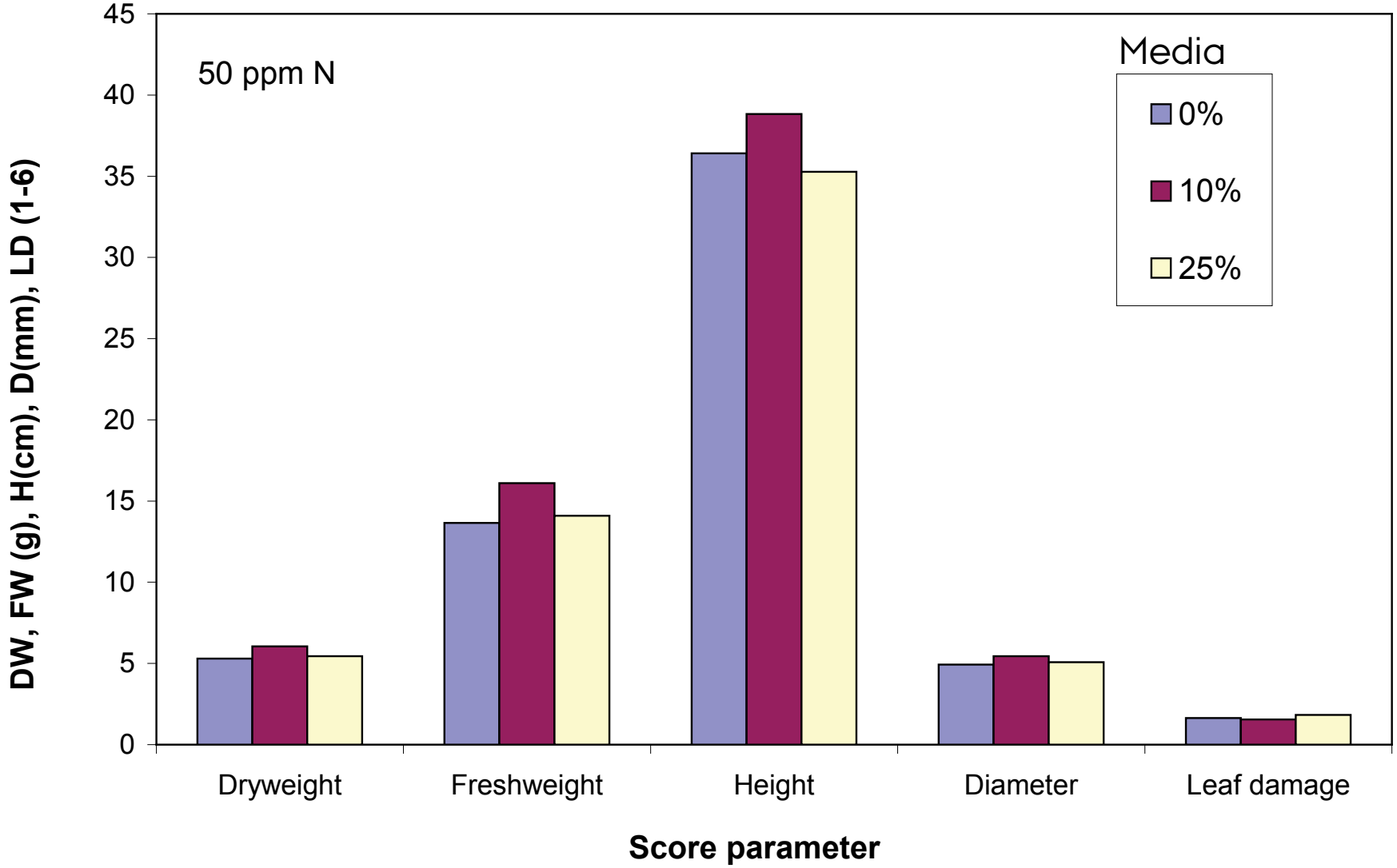
- 20 C, 20 hour daylength, plants cut back to 10 cm height.



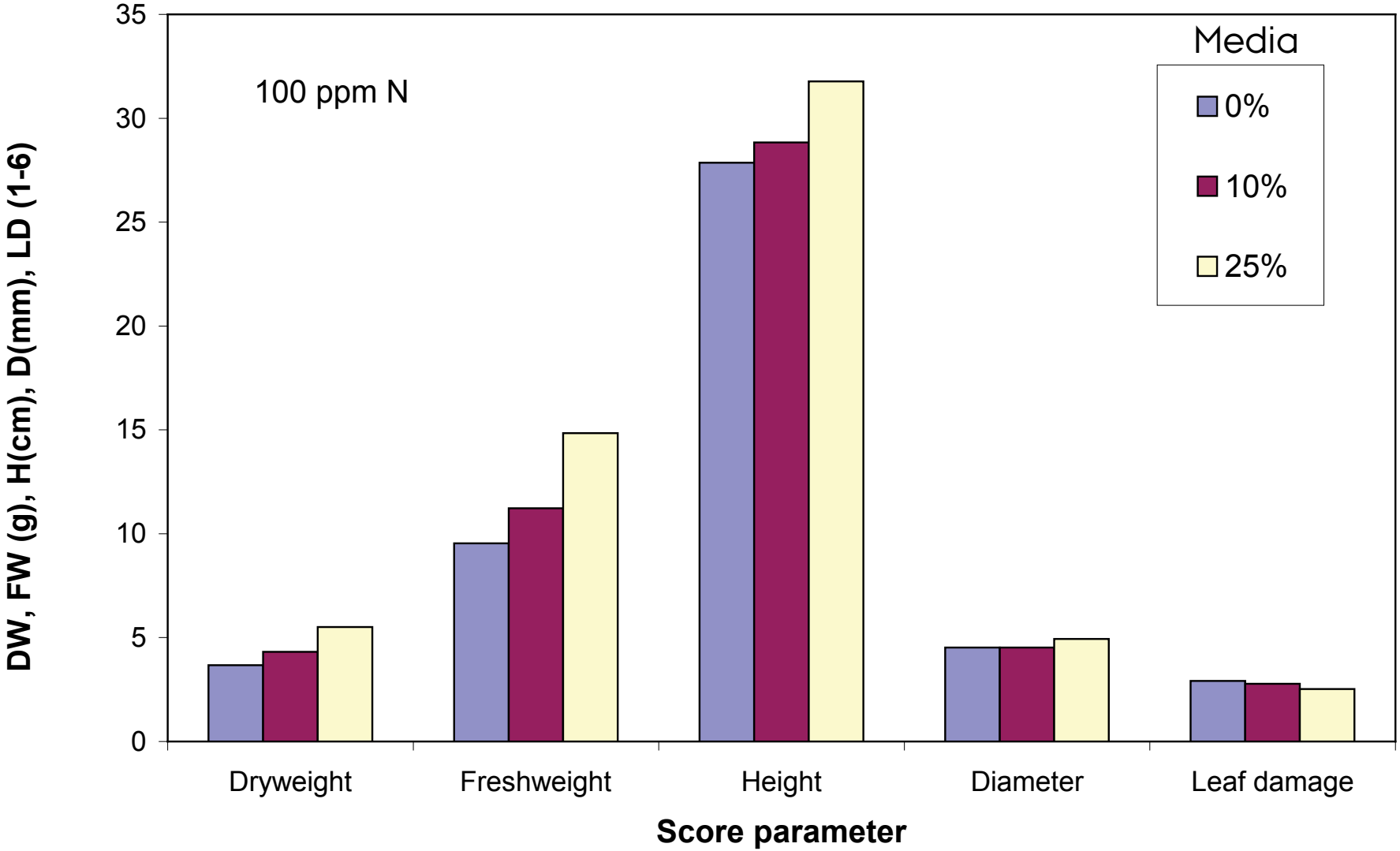
Effect of 4 levels of fertilizer on growth of plants. Data are mean of 3 media and 2 origins (108 plants /each mean).

10 % vermiculite

0 % vermiculite



Effect of addition of vermiculite to peat growth media on growth parameters. Data are mean of two origins (36 plants/each mean)



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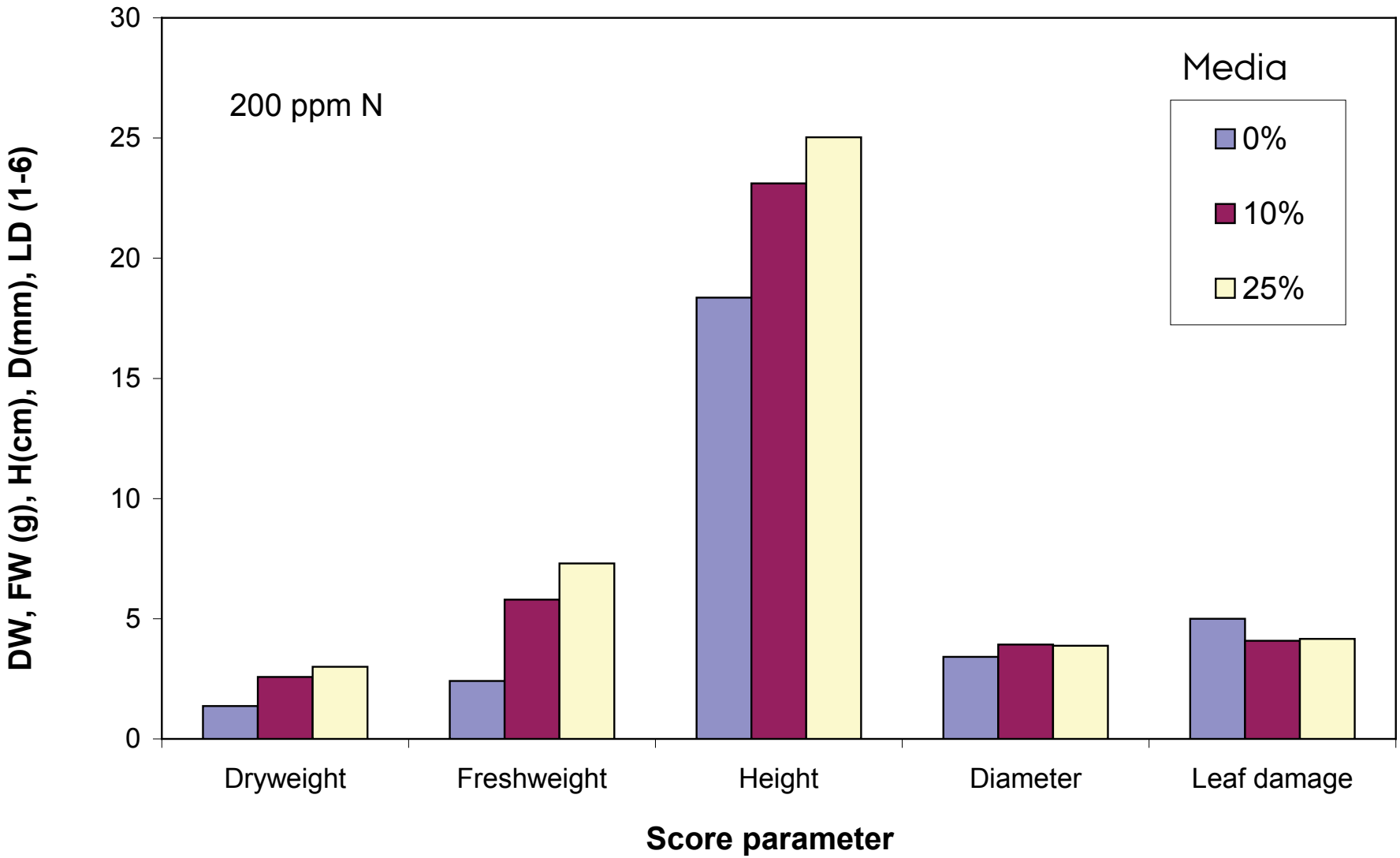


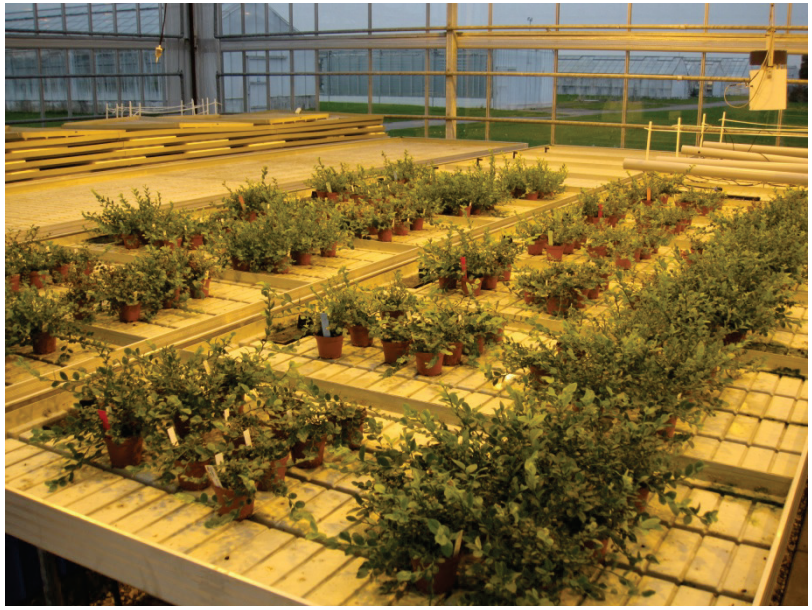
Effect of addition of vermiculite to peat growth media on growth parameters. Data are mean of two origins (36 plants/each mean)

Exp 2. Ongoing fertilizer experiment

Young seedling plants

Same fertilizer composition but lower concentration range

25, 50, 100 and 150 ppm N



Indication: 50-100 ppm N seems optimal

Flowering experiments in planning.

- Aim to induce as high flowering frequency pr shoot, synchronously and in as young a stage as possible.

- Possible topics to investigate:
- Investigate plant age effect, plant size (cultivation effect)
- Earliest flowering in cuttings versus seedlings
- Timing of induction during summer-autumn
- Vegetative – generative growth balance for induction of flowering (daylength, fertilizer, temperature)

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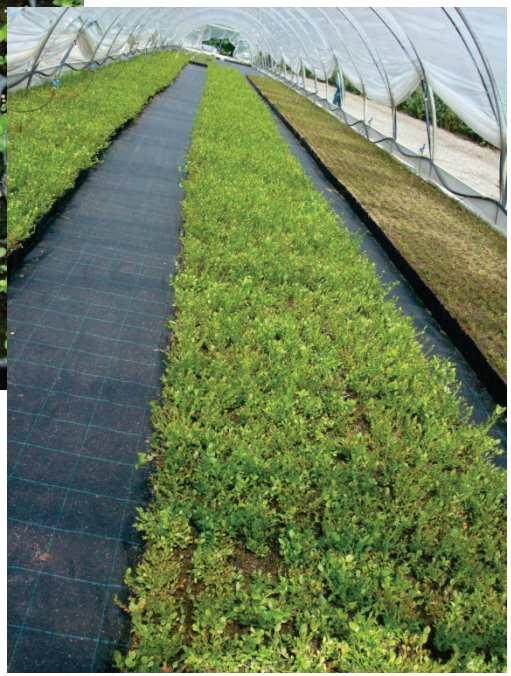
Applied experience in growing bilberries in pots at Gl. Sunds Nursery/ Ole Søndergaard.



Conclusion project 2

- Propagation by softwood cuttings taken in July or September and rooted in greenhouse in high RH is generally a succesfull method for vegetative propagation.
- Rooting hormones speed up rooting and may increase rooting percentage significantly.
- Liquid fertilizers with N values of 200 and 400 ppm N damage and kill plants after 1-3 months
- 50 ppm N is slightly better than 100 ppm.
- Addition of 10-25 % vermiculite to raw peat medium may improve growth slightly in a high nutrient stress situation

Thank you for your attention

Funded by The Danish Food Agency