

Pelleting poplar seeds – a chance to improve cultivation of seedlings?

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Outline

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Introduction



Specialty of aspen and their seeds

- pioneer tree species, suitable for poor and dry soil
- increasing demand for use in bioenergy plantations
- plenty of seed only every 3-5 years
- very small seeds, 1000 seed weight 35 – 133 mg
- without endosperm, surrounded by a thin translucent seed coat

Introduction



- only few weeks viable in a natural environment
- not dormant, may germinate within few hours with favourable conditions
- difficult harvesting, cleaning and sowing of seeds
- only one hint on former pelleting experiments



Aspensaat auf Sturmwurfflächen

Eine einfache und kostengünstige Möglichkeit zur schnellen Wiederbewaldung ?

als
Diplomarbeit der
Forstwissenschaftlichen Fakultät
der Albert-Ludwigs-Universität
vorgelegt von

Thomas Heindrichs

Freiburg, im April 1992

Material

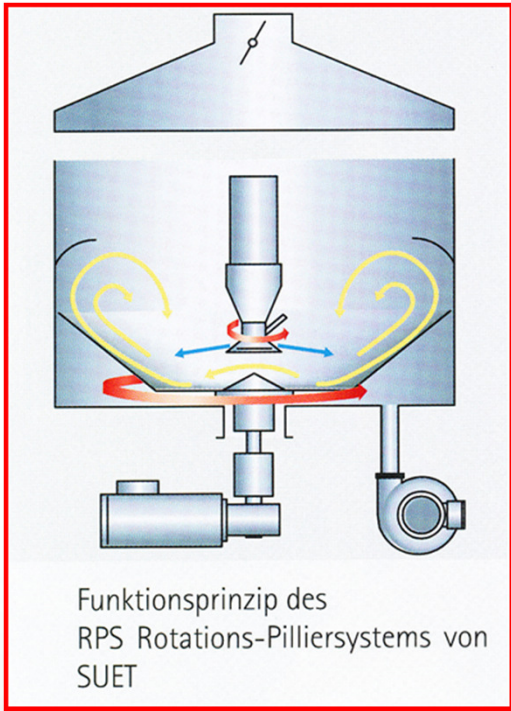
Seed supply for the project

Tree species	Origin	Year of harvest	Seed characteristics			
			weight (g)	water activity (aw)	moisture content (%)	germination (%)
<i>Populus tremula</i>	Bunk Pflanzen, Elmshorn	1990	17			56
		1993	152			86
		2004	30			74
<i>Populus tremula</i>	Waldsieversdorf	2010	75		7.0-7.39	91
		2011	126	0.381	5.62	70
<i>P. tremula x P. tremuloides</i>	Waldsieversdorf	2011	208	0.364-0.415	5.04-5.80	67-85
Hybrid poplar 'Rochester'	Waldsieversdorf	2011	53	0.468	6.35	86
		2012	2.113	0.527	7.58	80
Hybrid poplar 'Oxford'(?)	Waldsieversdorf	2011	644	0.498	6.05	88-91
<i>Populus nigra</i>	Semillas Montaraz,	2010	20			89
<i>Populus alba</i>	Spain	2010	20			83

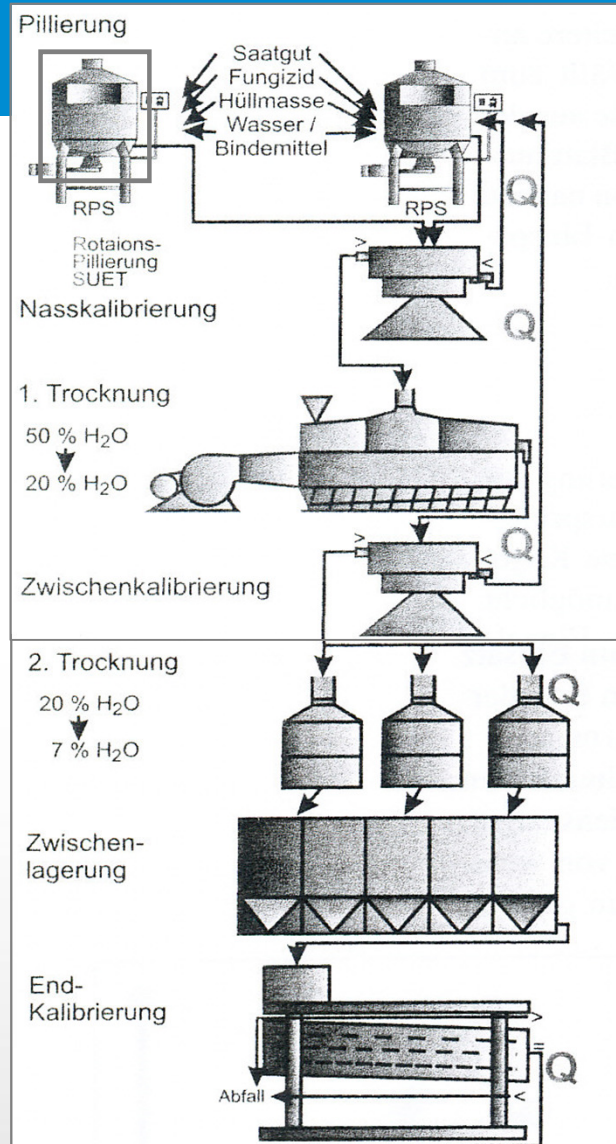
aw: Water activity, assessed with HygroPalm 23-Aw (rotronic GmbH)

Methods

Pelleting process

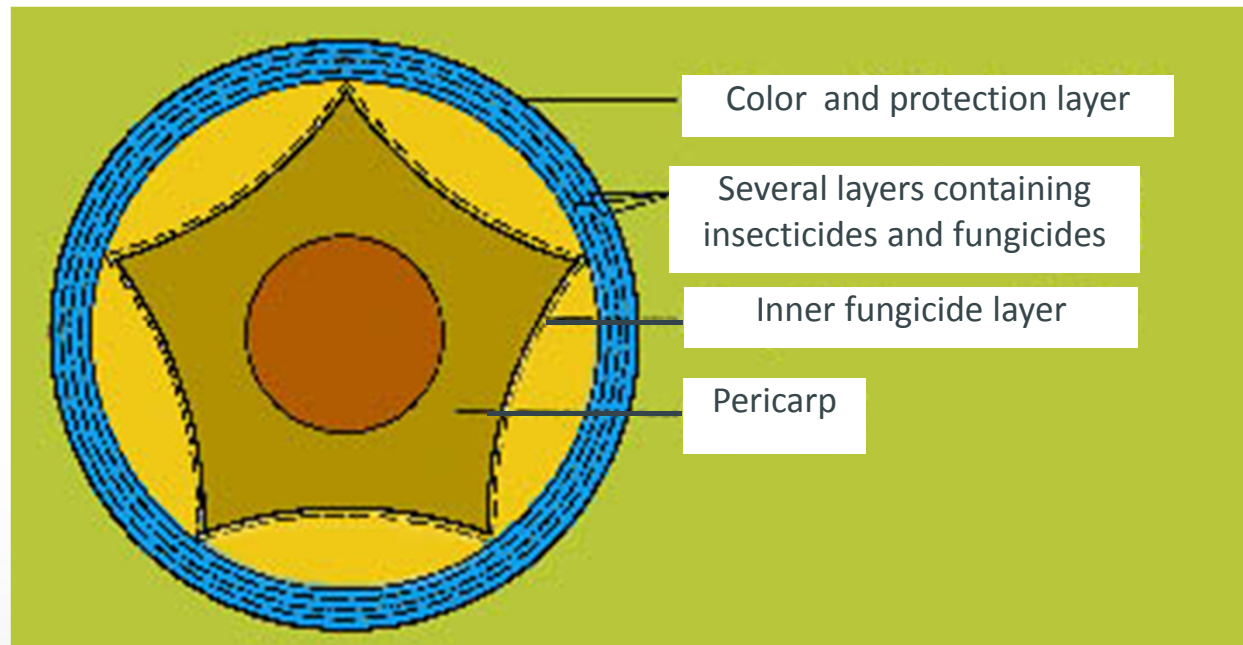


Example: Pelleting of sugar beet seed
 Cited from: Lamprecht, H.: Saatgutumhüllung,
 in Kruse, M. (2008): Handbuch Saatgutaufbereitung



Methods

Structure of a pelleted seed



Drawing modified from:



<http://www.suet.de/en/services/manufacture>

Methods

Germination test conditions

According to ISTA rules 20 / 30 °C (SUET lab); modified to 21 +/- 2 °C (Thünen lab)
4 x 100 seeds, moist filter paper

Seedling evaluation related to good growth and well developed essential organs
e.g. elongated hypocotyle, well formed cotyledons, collet hairs, main root



abnormal seedlings



normal seedling

Methods

Sowing in the soil

SUET greenhouse:

2 x 100 seeds, commercial propagation soil
3 – 4 weeks

Thünen greenhouse:

2 x 104 seeds (HerkuPak HPD 104/5R) resp.
4 x 24 seeds (Quickpot 24)
Commercial propagation soil : sand = 1 : 1
8 – 19 weeks



Plants from sowing tests with pelleted aspen seeds in different container types

Evaluation of normal vs. abnormal growth, shoot length, shoot and root dry weight, shoot/root ratio, survival percentage

Methods

Storage experiments

Experiment No.	Seed + pelleting type	Temperatures	Germination test intervals
1	aspen 2010 / pelleting with 2 levels of firmness	room temperature (21 +/-2°C) fridge (6 +/-3°C) deep freezer (-11 +/-3°C) deep freezer (-20 +/-1°C)	14 days 4 weeks 6 months 1 year
2	hybrid aspen 2011 / pelleting with 2 levels of firmness	room temperature (21 +/-2°C) fridge (6 +/-3°C) deep freezer (-20 +/-1°C)	14 days 8 weeks 6 months
3	aspen, hybrid aspen, hybrid poplars 2011 firmness/bacteria/fungicide	fridge (6 +/-3°C) deep freezer (-20 +/-1°C)	12 weeks 6 months
4	hybrid aspen, hybrid poplar 2011 3 moisture levels	fridge (6 +/-3°C) deep freezer (-20 +/-1°C)	12 weeks 6 months

Results

56 samples were pelleted until now

3 firmness levels: standard (based on SUET know-how) = variant 7
more binding material = variant 8
much more binding material = variant 9

3 calibres in aspen: 1-1.25, 1.25-1.5 and 2-2.5 mm
1 calibre in the poplar species: 1-1.25 mm or 1.5-2 mm



Results

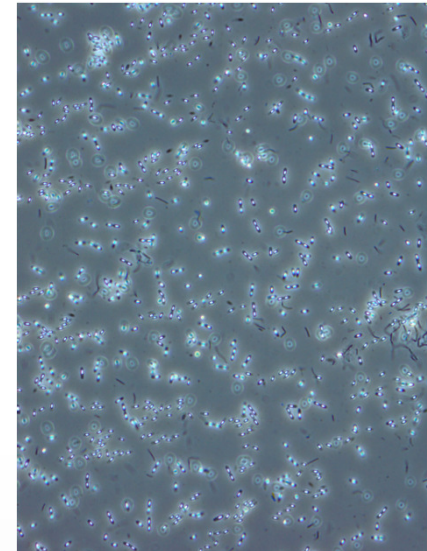
Addition of growth-promoting compounds

6 bacteria strains:

5 *Paenibacillus* strains (supplied by Dr. K. Ulrich, Thünen Institute)
Bacillus amyloliquefaciens („Rhizovital“ by ABiTEP GmbH)
Integration was successful, $10^4 - 10^7$ cfu/seed pellet

2 mycorrhiza products:

„Mykorrhiza soluble“ and „Mykorrhiza Samenimpfstoff“
(by Mushroom Research Centre MRCA GmbH, Austria)
problems due to limited technical miscibility



Spore suspension of
Paenibacillus humicus

Results

Sample type	1000 seed weight (mg)	Seed length (mm)	Seed width (mm)	Purity (%)
Aspen 2010				
control	113	1256	575	-
Standard pelleting (Var. 7)	987	1870	1210	97.5
+ binding mat. (Var. 8)	1115	1934	1213	98
Var. 7, double calibre	5826	2576	2180	98.3
Var. 8, double calibre	5920	2595	2164	95.8
Aspen 2011				
control	122	1128	582	-
Var. 8	700	1679	1052	97.3
Var. 8+ 0.3% Thiram	688	1707	1035	95.8
++ binding mat. (Var. 9)	864	1617	1068	97.3
Var. 8+Bac.amyloliquef.	976	1643	1168	97.5
Var. 8+Paenibac. P22	1185	1650	1186	99
Hybrid aspen 2011				
control	115	968	566	-
Var. 8	665	1633	1099	96.3
Var. 8+ 0.3% Thiram	611	1546	1020	97.8
Var. 9	868	1509	1093	97.3
Var. 8+Bac.amyloliquef.	924	1576	1167	98.3
Var. 8+Paenibac. P22	1028	1475	1157	98.8

Aspen seed pellet weight, calibre 1-1.25 mm: 6 – 10 x control weight
calibre 2-2.5 mm: 51 – 52 x control

Results

Sample type	1000 seed weight (mg)	Seed length (mm)	Seed width (mm)	Purity (%)
Hybrid poplar ,Rochester' 2011				
control	281	1549	769	
Var. 8	1345	1920	1201	99,3
Var. 9	1597	1951	1283	99,3
Hybrid poplar ,Rochester' 2012				
control	194	1379	650	
Var. 8	816	1722	1084	
Var. 8+Paenibac. P22	871	1738	1074	
Var. 8+Bac.amyloliquef.	816	1828	1074	
Var. 9	893	1838	1077	
Var. 9+Paenibac. P22	897	1769	1083	
Var. 9+Bac.amyloliquef.	905	1822	1084	
P. nigra				
control	623	2276	1021	
Var. 8	3410	2638	1681	
P. alba				
control	325	1695	782	
Var. 8	1261	1934	1225	

Poplar seed pellet weight, depending on the species: 4 – 6 x control weight

Results

Sample type	Germination at 21 °C Thünen lab (%)		Germination at 30/ 20°C SUET lab (%)	
	control unpelleted	pelleted	control unpelleted	pelleted
Aspen 2010				
Standard pelleting (Var. 7)	91	86	96	90
+ binding mat. (Var. 8)		81		89
Var. 7, double calibre		2		9
Var. 8, double calibre		5		5
Aspen 2011				
Var. 8	73	62	77	76
Var. 8+ 0.3% Thiram		61		58
++ binding mat. (Var. 9)		68		65
Var. 8+Bac.amyloliquef.	61	66	53	71
Var. 8+Paenibac. P22		62		71
Aspen 1993				
Var. 8	86	85	92	88
Var. 8+Paenibac. 119		85		90
Var. 8+Paenibac. 120		82		86
Var. 8+Paenibac. 454		78		85
Var. 8+Paenibac. Rob10		89		85
Var. 8+Paenibac. P22		84		87
Var. 8+Bac.amyloliquef.		80		84
Hybrid aspen 2011				
Var. 8	85	65	99	80
Var. 8+ 0.3% Thiram		80		79
Var. 9		61		81
Var. 8+Bac.amyloliquef.	77	65	88	87
Var. 8+Paenibac. P22		71		88

Aspen germination tests



Results

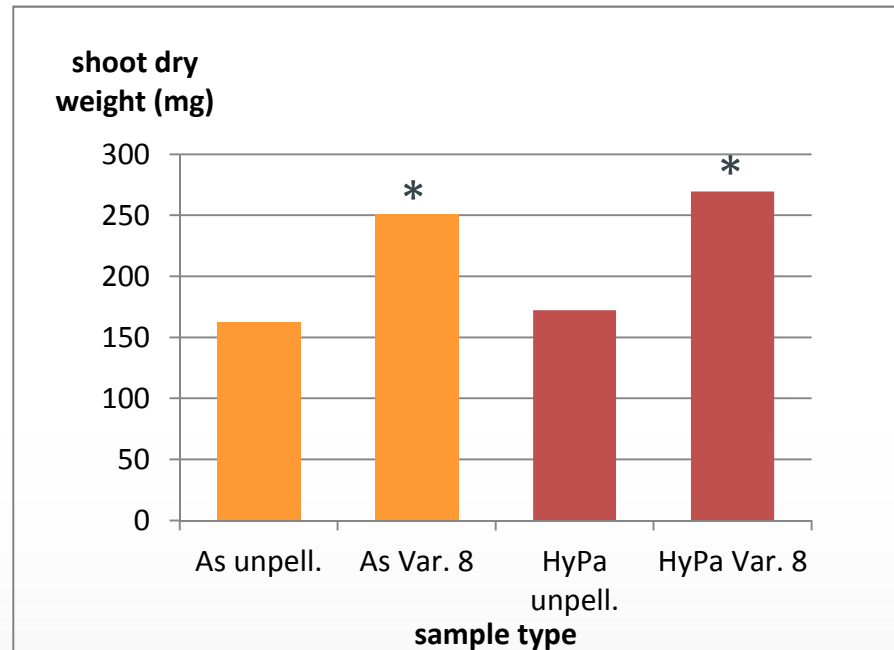
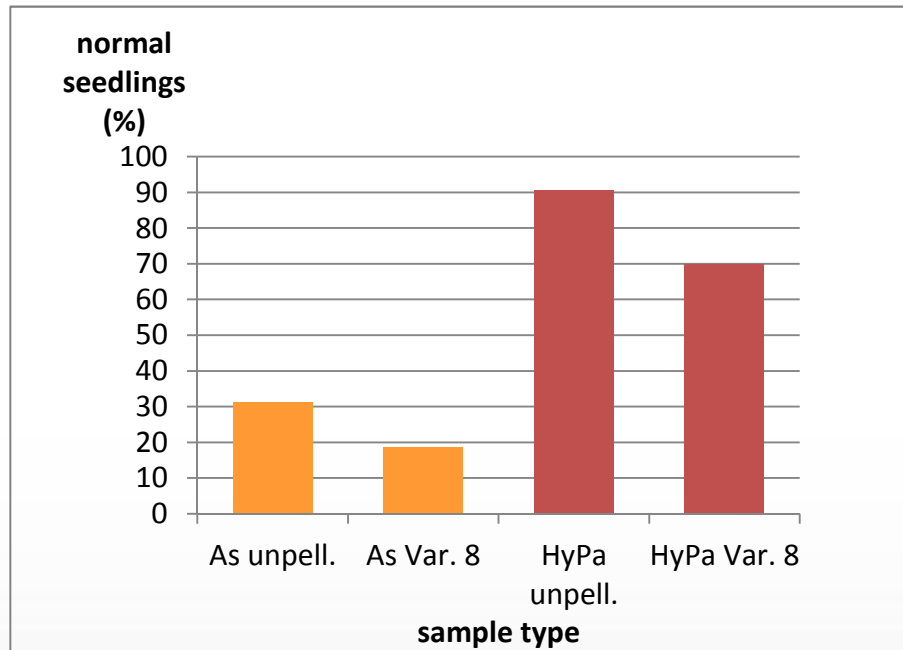
Germination tests – other poplar seeds

Sample type	Germination at 21 °C Thünen lab (%)		Germination at 30/ 20°C SUET lab (%)	
	control unpelleted	pelleted	control unpelleted	pelleted
Hybrid poplar ‚Rochester‘ 2011				
Var. 8	90	95	92	95
Var. 9		91		96
Hybrid poplar ‚Rochester‘ 2012				
Var. 8	84	69	81	75
Var. 8+Paenibac. P22		63		67
Var. 8+Bac.amyloliquef.		18		23
Var. 9		65		78
Var. 9+Paenibac. P22		66		74
Var. 9+Bac.amyloliquef.		29		32
P. nigra				
Var. 8	43*	49	83	55
P. alba				
Var. 8	2**	7	10	8

(* , **: germination test with 100 resp. 200 seeds only)

Results

Effect of aspen seed pelleting on plant survival in the greenhouse



*: significant difference to the unpelleted control

Aspen: seed harvest 2011
Hybrid poplar: 'Rochester' 2012

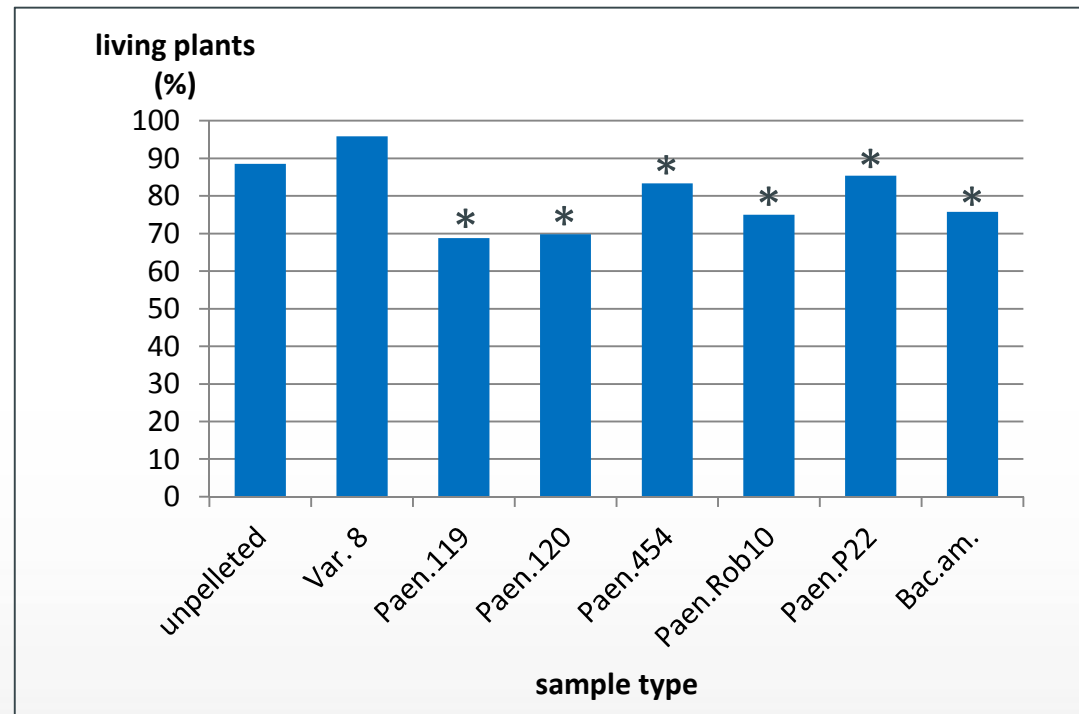
cultivation period 16 resp. 19 weeks
beginning in July resp. Sept. 2012

Results

Effect of aspen seed pelleting on plant survival in the greenhouse



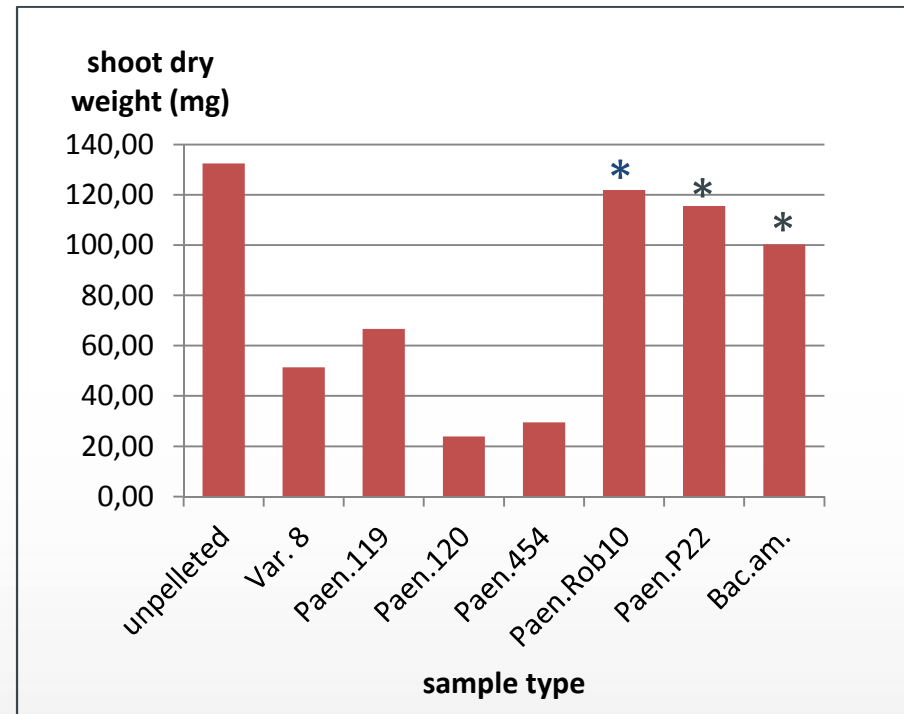
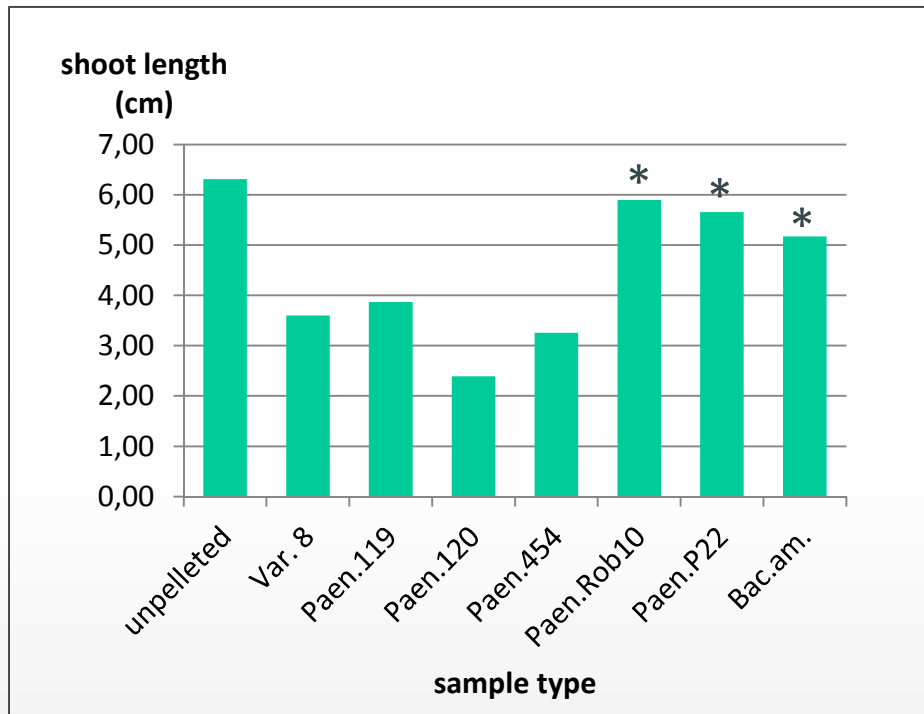
Aspen seeds: Bunk 1993,
all pelleted with var.8
cultivation period 15 weeks
beginning at October, 25th 2012



*: significant difference to var.8 without additives

Results

Effect of bacteria added to aspen seed pellets

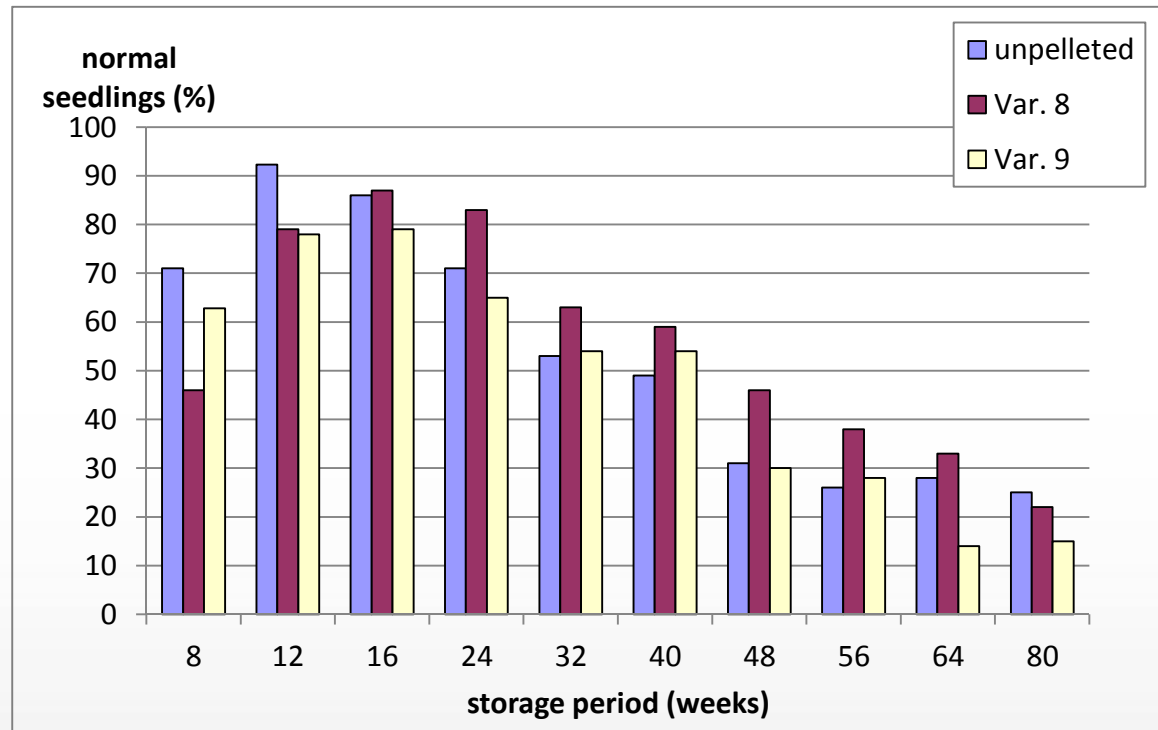


Aspen seeds: Bunk 1993, all pelleted with var.8
Cultivation period 15 weeks, beginning at October, 25th 2012
*: significant difference to var.8 without additives

Results

Storage of hybrid aspen in the fridge at + 6°C

Storage in sealed plastic bags,
one additional sample of each variant
with vacuum for a final control



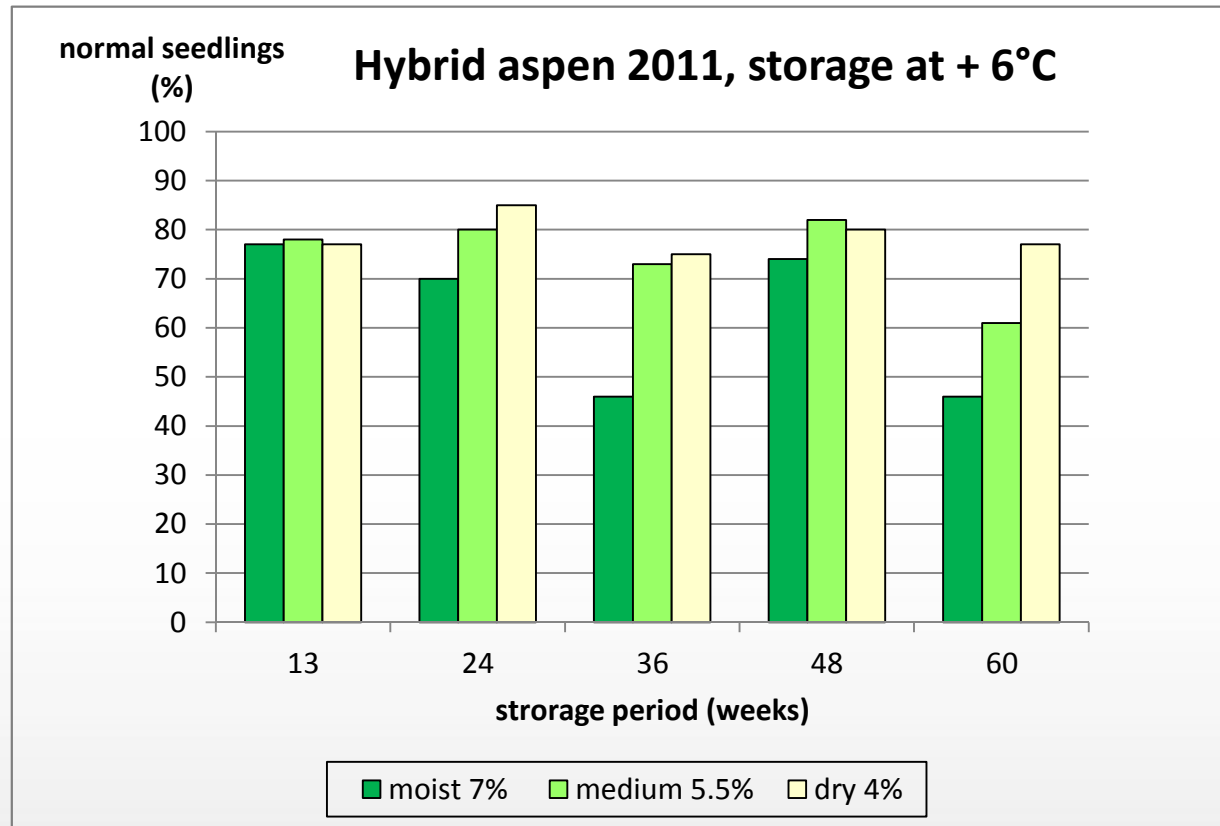
Results

Storage in the deep freezer at -20°C

Variant	% normal seedlings			% of the initial value
	initial value	after 6 months	after 12 months	
Aspen 2011 unpelleted	73	77	76	104
Var.8	62	72	70	113
Var.9	68	71	66	97
Var.8 + Bac. am.	66	62	64	97
Var.8 + Paen. P22	62	50	64	103
Var.8/F	61	69	65	107
Hybrid Aspen 2011 unpelleted	85	88	89	105
Var.8 + Bac. am.	65	45	47	72
Var.8 + Paen. P22	71	63	54	76
Var.8/F	80	83	85	106
Hybrid poplar 'Oxford' 2011 unpelleted	92	95	94	102
Var.8	85	83	82	96
Var.9	90	92	91	101
Hybrid poplar 'Rochester' 2011 unpelleted	90	96	96	107
Var.8	95	94	93	98
Var.9	91	90	92	101

Results

Storage experiment with different seed moisture



Results

Sowing suitability

First tests were made:

- Thünen Institute, Waldsiedersdorf (container; nursery bed)
- Thünen Institute, Großhansdorf (container)
- nursery of Bunk Pflanzen, Elmshorn (nursery bed)
- Agrimedia GmbH Gartenbaubedarf, Eisenberg (container sowing device „Lehners Sägerät“)



Positive response, but repetition of sowing tests is necessary.

Problems in the nursery with extreme weather conditions (e.g. strong rainfall) and weed control

Conclusions

- Pelleting of aspen and other poplar seeds results in improved suitability for sowing (higher seed weight and calibre)
- At the best, slight reduction of germination percentage is to be expected after pelleting aspen and other poplar seeds but, excellent seed quality is the pre-condition
- In some cases, reduced germination percentage of seed pellets is accompanied by increased shoot biomass development
- Growth enhancement after addition of *Paenibacillus* strains must be verified
- Mycorrhiza products integration into aspen seed pellets was not successful
- Pelleted seeds have the same suitability for storage like pure aspen seeds, provided the seed moisture content is optimal (5-6%, storage at -20°C) and seeds have a high quality

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Thank you for your attention!