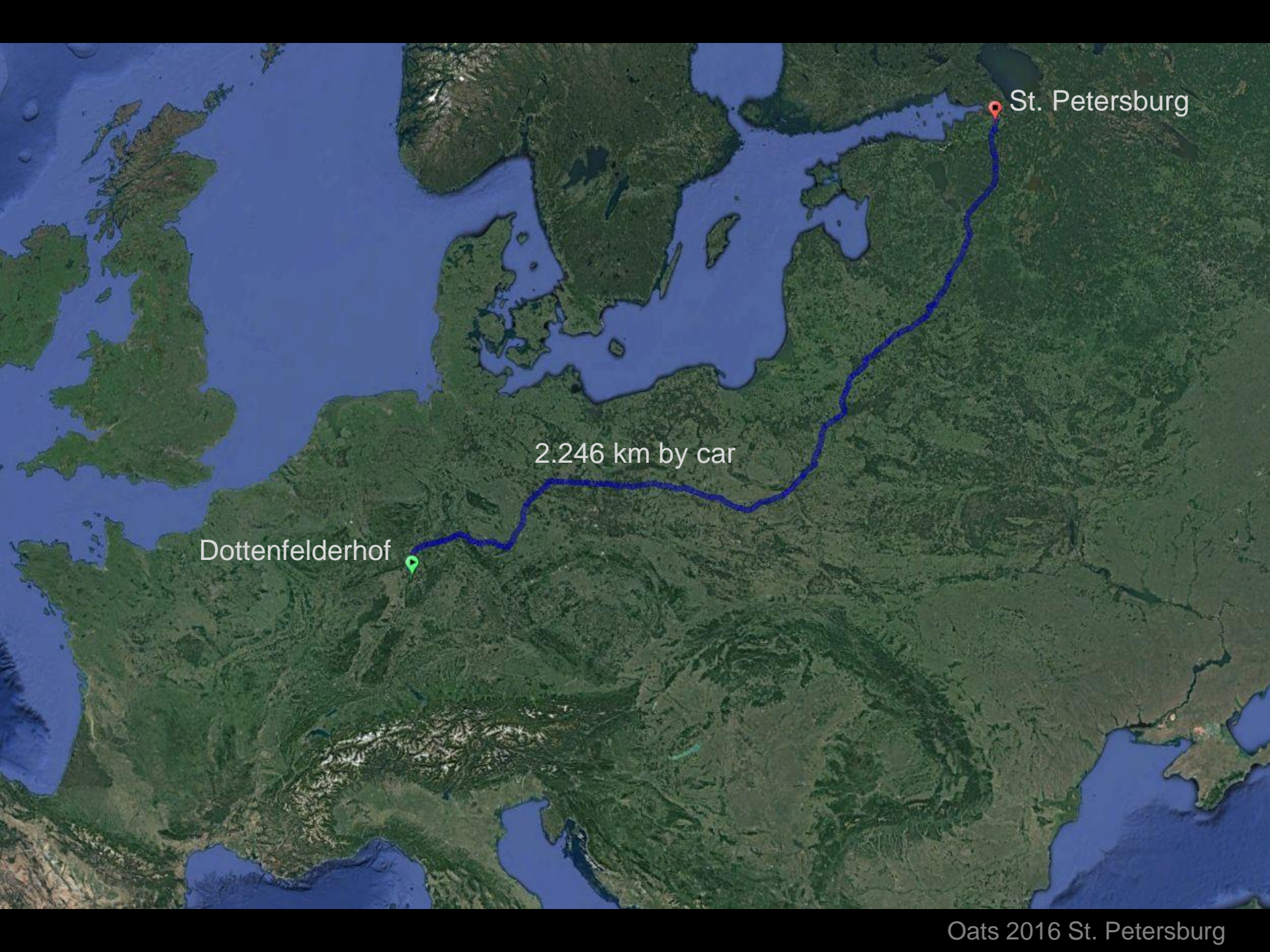


On farm organic oat breeding

10th International Oat Conference 11 - 15 July 2016 St. Petersburg, Russia

Ben Schmehe, Hartmut Spieß, Sabine Martis, Lilla Szabo, Stefan Klause, Anjana Pregitzer, Lina Perez

1. Description of the breeding site Dottenfelderhof
2. Organic Breeding scheme of oats at FZD
3. Loose smut of oats (*Ustilago avenae*) – appearance, life cycle and role in organic farming
4. Inoculation method
5. Results
6. Summary and open questions



Dottenfelderhof

2.246 km by car

St. Petersburg

Dottenfelderhof



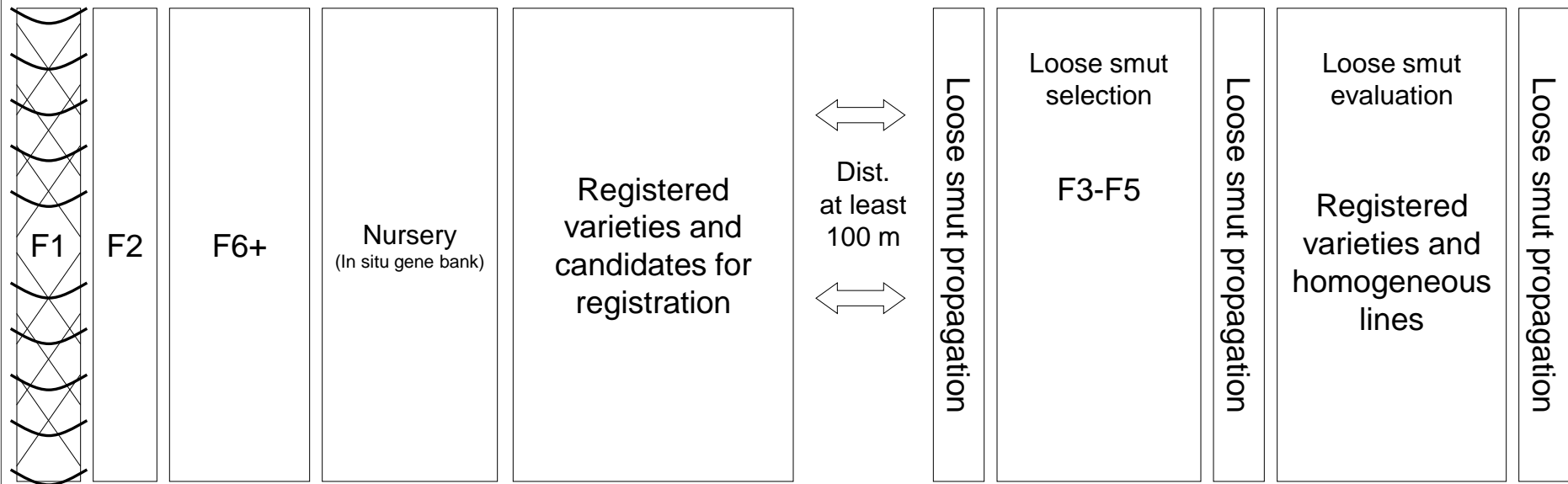
Breeding goals summer and winter oat

- high yield and yield stability
- lodging resistance
- high hectoliter weight (55 kg/hl)
- hullability
- medium to high kernel weight
- low hull weight
- good weed competition (ground cover)
- winter hardiness (winter oat)
- good nutritional quality for human and animal
- good plant health, disease resistance especially loose smut

Pedigree selection

Performance test

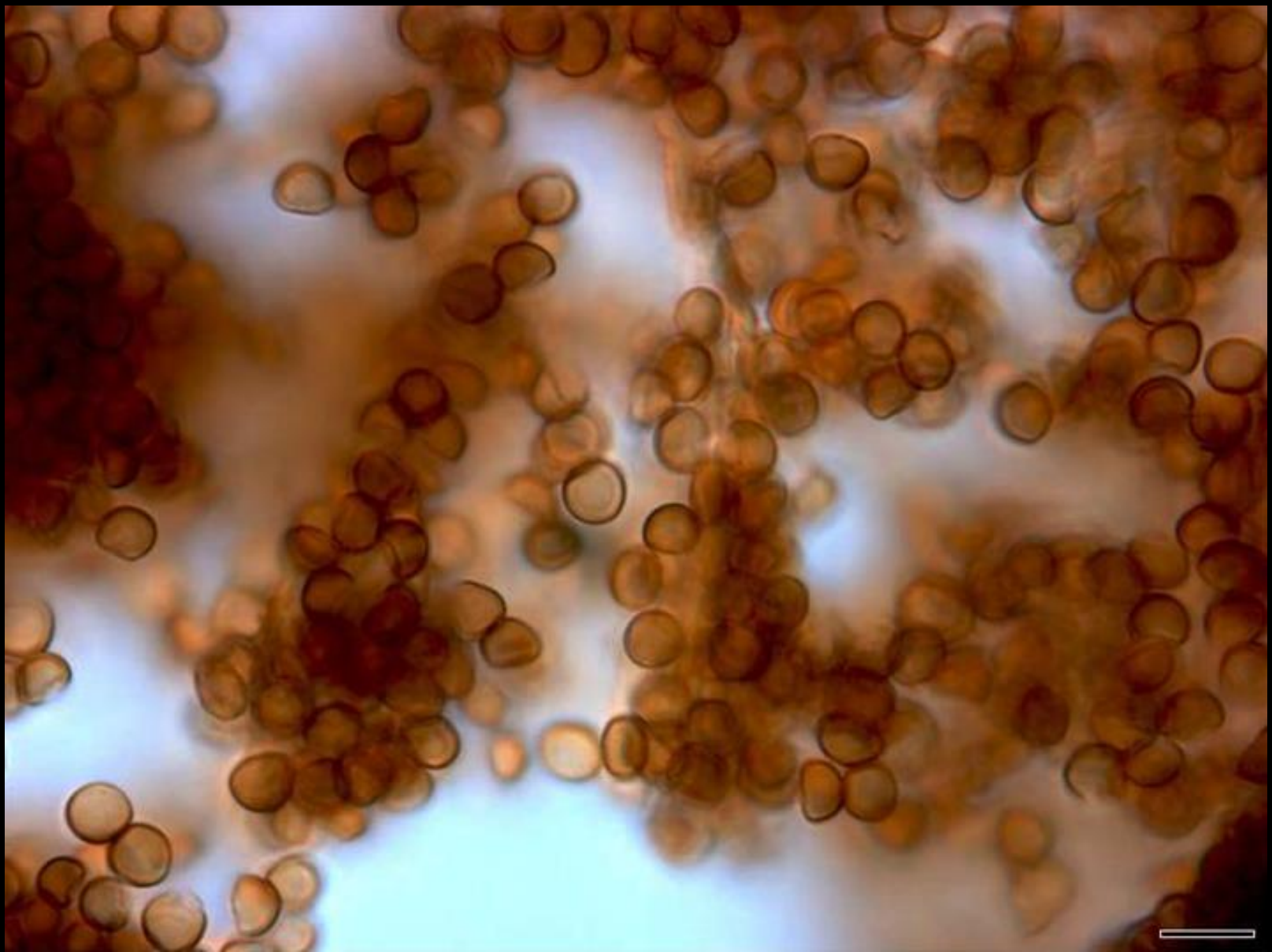
Loose smut selection and evaluation
Ustilago avenae (Ua)



Oats 2016 St. Petersburg

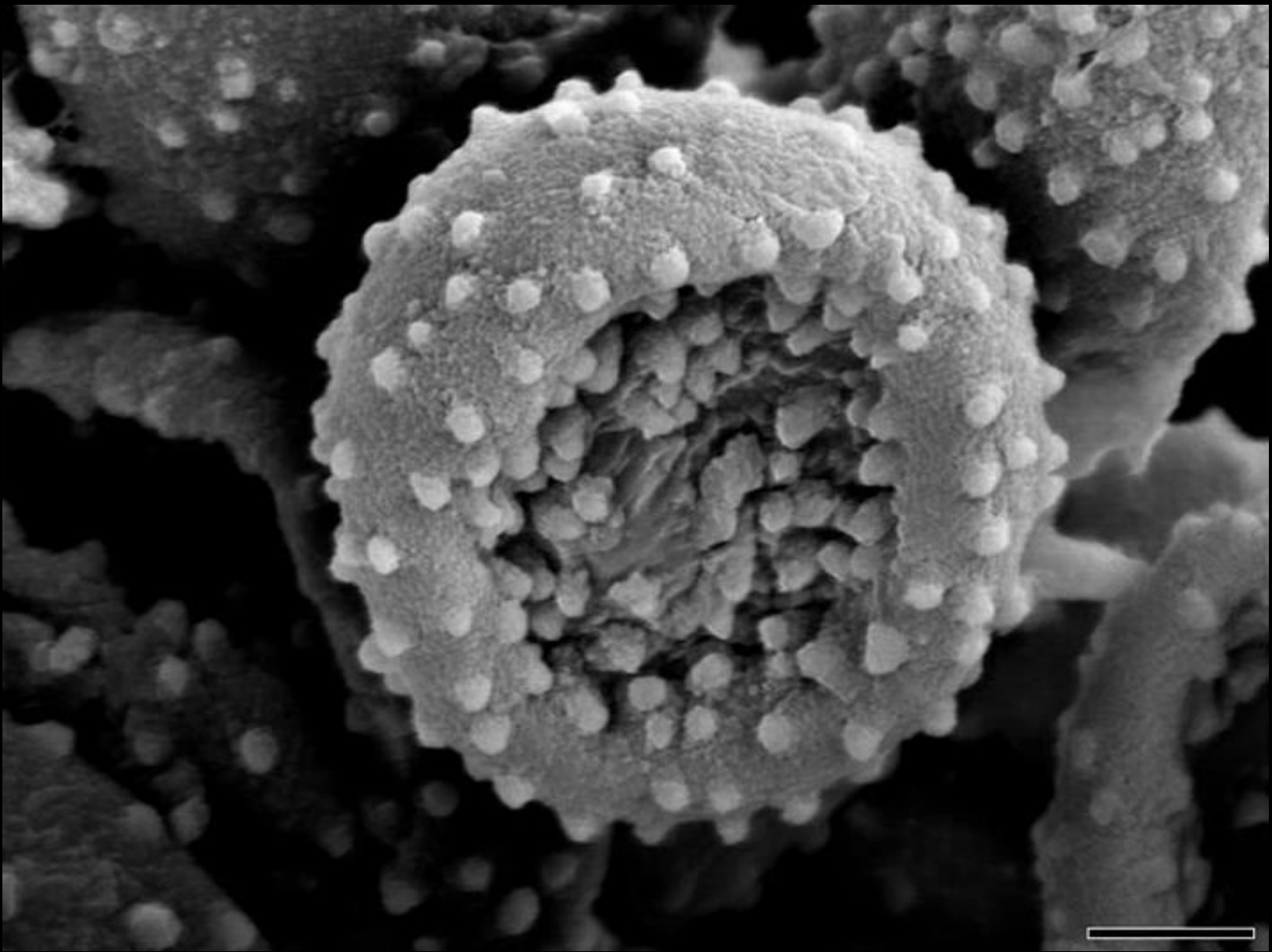
Loose smut (*Ustilago avenae*)





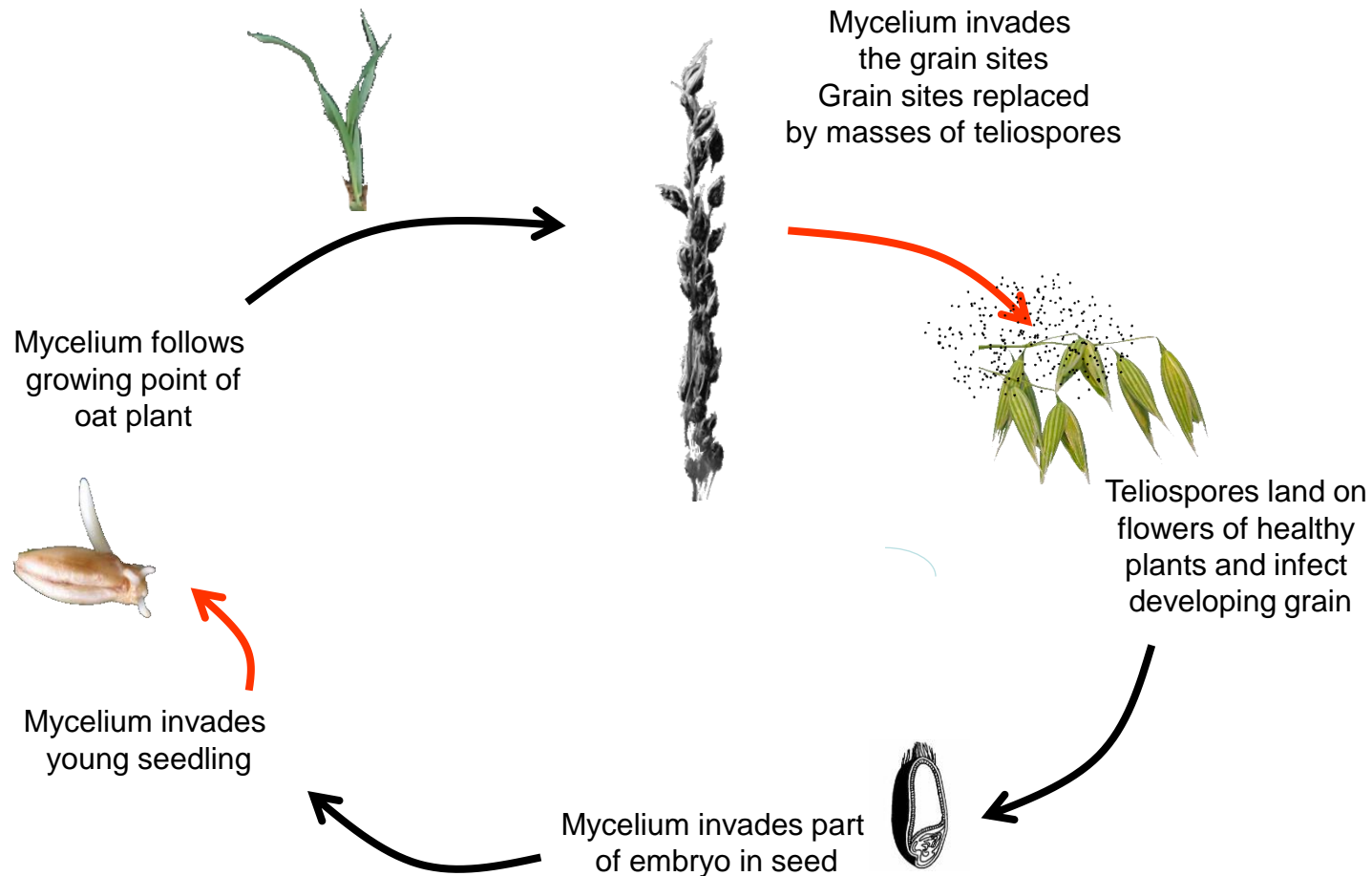
Caption: *Ustilago avenae* on *Avena sativa* - BRIP 1531b. Scale bar = 10 μm

Source: Roger Shivas DEEDI



Caption: *Ustilago avenae* on *Avena sativa* - BRIP 44545. Scale bar = 1 μ m
Source: Desley Tree DEEDI

Life cycle of loose smut (*Ustilago avenae*)



Source: modified from <https://cereals.ahdb.org.uk/cereal-disease-encyclopedia/diseases/loose-smut.aspx>

Loose smut in organic farming and seed production

- As directed by EU-regulation Nr. 1452/2003, the use of organically produced seed is obligatory for organic production of oats.
- Denial of seed multiplications for further purchase:
 - > 3 bunted plants per 150 m² (basic seed)
 - > 5 bunted plants per 150 m² (certified seed)
- Agronomic measures to prevent infestation and seed treatments approved in organic farming are limited.
- Resistance not required for registration of new varieties.
- Leads to yield loss.
- Spores have toxic effects if oat is used as green fodder.



Method ‚Reed‘: Reed und Faris (1924)

Partial vacuum -800 hPa
5 g spores / liter water



Method: Nielsen (1976), Menzies et al. (2009)

Details loose smut evaluation

Variety
ox - Aragon (check)
Galaxy (check)
Cavallo (check until 2012)
Check mean
Oberon (reference)
HSH 461-11
HSH 395-12
ox - Dominik
ox - Flocke
ox - Ivory
ox - Max
ox - Poseidon
ox - Scorpion
ox - Symphony
ox - Typhon
ox - Prokop (new 2016)

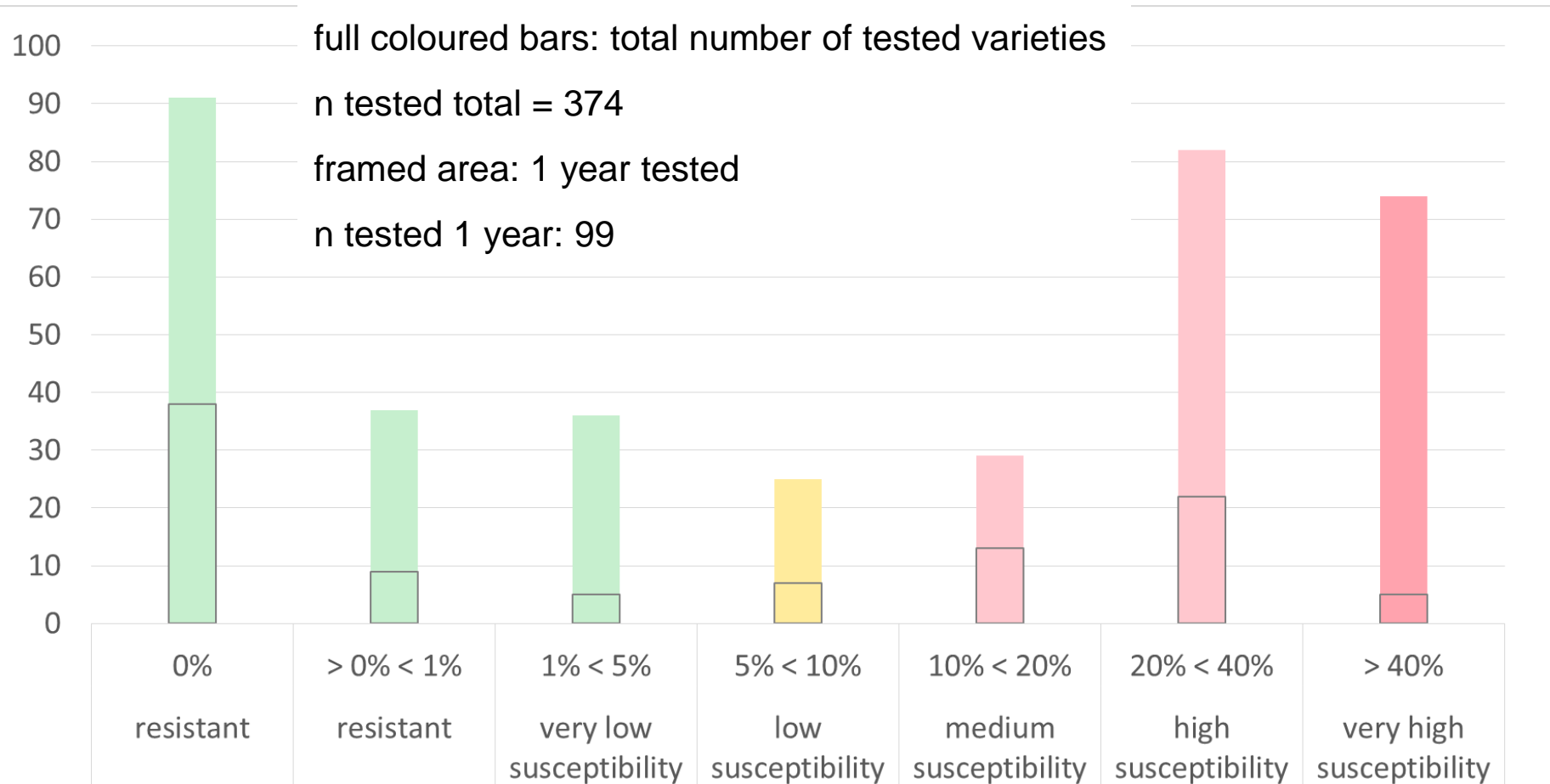
n years	Max Ua [%]
6	83
5	77
4	62
	74
4	0,2
4	3,4
3	0,2
4	42
3	74
4	36
5	57
2	24
4	58
3	25
4	50
0	-

- ox: varieties available on organicXseeds germany
- 2009 until 2015 total 374 evaluated varieties / genetic resources
- more than 1.450 datasets (by end of 2015)

Classes of resistance to loose smut

All varieties / genetic resources

Evaluation Dottenfelderhof 2009-2015



Classes of resistance to loose smut Registered oat varieties

Evaluation Dottenfelderhof 2009-2015

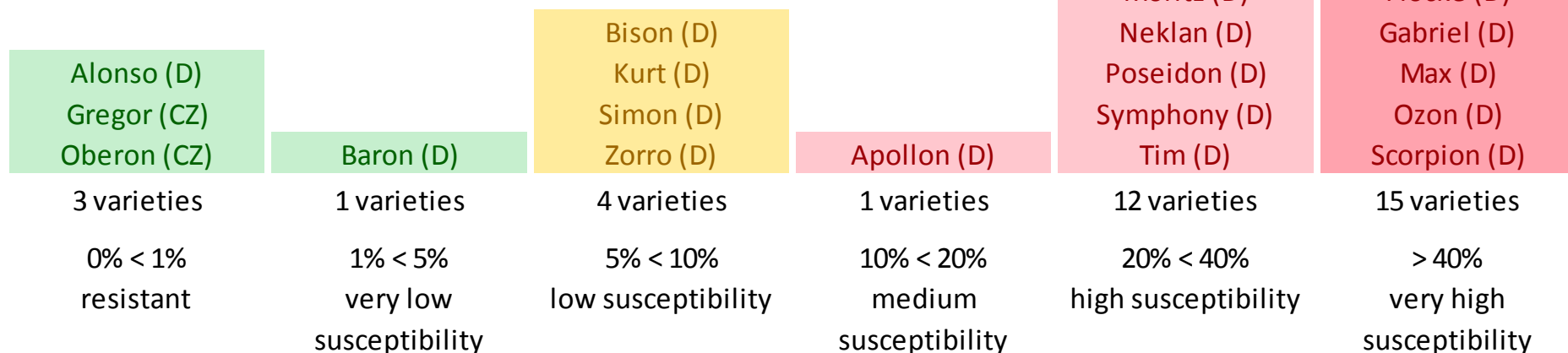
n=36

(D) – Germany

(A) – Austria

(CZ) – Czech Republic

not tested so far: Earl, Prokop, Spartan, Yukon



Differential varieties of oats

C.I. No.	Variety	Avenae races															Kolleri races							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	"576"	1	2	3	4	5	6	7
<u>Differential varieties:</u>																								
2143	Anthony	95	77	78	71	95	60	72	95	44	68	95	0	0	28	0	84	5,1	Anthony	45				
4599	Atlantic	0	0	3	0	0	3	4	0	0	0	0	7	1	91	85	0	16,9	Atlantic	100				
1878	Black Diamond	84	37	58	39	74	22	43	51	26	0	0	24	0	23	34	9	0,96	Black Diamond	5				
1877	Black Mesdag	0	0	0	64	0	0	0	0	0	0	0	0	0	0	0	0		Black Mesdag	0				
2965	Camas	0	88	0	0	0	0	12	0	0	0	0	0	0	0	0	0		Camas	0				
6701	Clintland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0	Clintland	0				
708	Fulghum	0	0	0	0	3	0	0	0	30	0	0	23	0	4	18	3		Fulghum	0				
1898	Gothland	0	0	39	0	95	28	45	0	33	18	30	0	0	0	15	67	0	Gothland	10				
1876	Monarch	0	0	90	93	0	54	65	0	0	0	0	0	72	0	12	0	0	Monarch	0				
560	Victory	81	60	22	48	74	12	13	80	0	7	47	0	0	0	0	48	6,9	Victory	5				

HOLTON and MURPHY (1966): Reactions of oat varieties to races of loose and covered smut. Washington, Agricultural Research Service, U.S. Dept. of Agriculture, Nr.34-83, S. 9.

Resistance nursery loose smut 2016

Variety / gen. res.	n	Max Ua (%)	Variety / gen. res.	n	Max Ua (%)	Variety / gen. res.	n	Max Ua (%)
	years			years			years	
Alonso	3	0,4	Gregor	2	0,3	Jaak	3	0,5
Assiniboia AC	2	0	Grin Noir	3	0,3	Jay	3	0
Avesta	4	0,5	HSH 178-3	1	0	Oberon	4	0,2
AzuNek	3	0	HSH 2815	2	0,5	Orrin CDC	3	0
Azur	4	0,3	HSH 335-12	3	0	Pinnacle	1	0
Bia	3	0	HSH 338-12	3	0	Rigodon AC	3	0,5
Black Mesdag	3	1	HSH 3555	2	0	Rozmar	3	0
Boxer	4	0	HSH 367-12	2	0,4	Sirene	3	0,1
Caravelle	3	0,2	HSH 381-12	2	0,6	Spurs	3	0
Clintland 60	3	0,6	HSH 395-12	3	0,2	Starter	3	0
Coach	3	0,1	HSH 461-12	1	0	Stewart AC	3	0
Ebene	3	0	HSH 486 HSH	1	0	SW Betania	4	0,6
Excel	3	0,1	HSH 493-12	3	0	Sylva	2	0
Feltwell	3	0,6	HSH NeISkr	1	0			
Florian	3	0	HSH SWBetIvo	1	0			

- total 43 varieties, only varieties with <1% smutted panicles maximum
- 14 FZD lines
- 3 varieties currently available (Oberon, Pinnacle, Rozmar)
- 26 old varieties available through genebanks

Varieties with natural infection spotted

Variety	n years inoc.	Max Ua [%]	n years nat. inf.	Variety	n years inoc.	Max Ua [%]	n years nat. inf.
Aragon	6	83	1	GK Pillango	2	49	1
Galaxy	5	77	1	Erbgraf	3	46	2
Flocke	3	75	1	Alf	2	45	1
President	4	74	1	Panther IPK	2	44	1
Auron	3	74	1	Sang	2	43	1
Panther	3	67	1	Flämingsfit	2	38	1
Seldon	1	59	3	Moholt	1	32	1
Scorpion	4	58	1	Vok	2	30	1
Obelisk	2	57	1	Klaus	2	28	1
Max	5	57	1	Neklan	3	28	1
Flämingstip	3	54	1	Cavaliere	1	27	3
Lehenhof	3	51	1	KWS Contender	4	26	1
Erbgraf IPK	2	50	1	Apollon	1	19	1

Resistance of crossings and parents

Crossing	n years	<i>Ua</i> max crossing [%]	<i>Ua</i> max mother [%]	<i>Ua</i> max father [%]
Neklan × Azur	3	0,2	27,5	0,3
Azur × Neklan	3	0	0,3	27,5
Boxer × Expander	3	0	0	36,4
Chantilly × Flämingsfit	1	0	6,0	37,8
Erbgraf × Flämingstip	2	0,6	50,3	53,6
(Erbgraf x Neklan) × Azur	3	0	50,5	0,3
(Flämingsvita x 90/10) x Neklan) × Azur	2	0,4	51,3	0,3
(Flämingstip × Coach) × IL 2815	2	0,5	0,04	18,1
(Flämingstip × Coach) × IL 3555	2	0	0,04	26,8
Monarch × Skrzat	1	0	25,1	2
Nelson × SW Betania	3	0	36,8	0,6
Nelson × Skrzat	1	0	36,8	2
SW Betania × Ivory	1	0	0,6	36

- 13 crossings, only crossings with <1% smutted panicles maximum

Summary and open questions

- ✓ Exchange of germplasm between breeders and genebanks is important for breeding progress
- ✓ In case of loose smut an active resistance breeding programme for organic varieties is necessary.
- ✓ Even crossings of two highly susceptible lines can be resistant, but the chance is low
- ✓ Development of resistance nursery as a pool for breeding activities
- ✓ 2 resistant oat varieties adapted to conditions of organic farming in the process of registration
- ? Connection between artificial and natural resistance levels needs to be further investigated
- ? The role of cleistogamy and morphologic resistance

Acknowledgements

- Team at FZD
- Mahle-Stiftung
- Zukunftsstiftung Landwirtschaft
- Organizing committee of Oats 2016

GLS *Treuhand*
Zukunftsstiftung
Landwirtschaft

MAHLE ■ **STIFTUNG**
GESELLSCHAFT MIT BESCHRÄNKTER HAFTUNG

A wide-angle photograph of a large agricultural field, likely a grain field, with golden-brown stalks in the foreground and middle ground. The field stretches to a flat horizon line. In the background, there is a line of green trees and a tall, silver communication tower on the right side. The sky is filled with large, white and grey clouds.

Thank you