Willow and Poplar Diseases in Short Rotation Forestry"

NEW THREATS

Pajand Nejad and Mauritz Ramstedt
Swedish University of Agricultural Sciences – SLU - Sweden

New habitat for pathogens and predators

First priority
leaf rust;
Melampsora spp.

- 2nd: Insects
- 3rd: grazing
- Bacteria – not considered as a problem for willows

Grazing – but also a source of wildlife for hunting!

Willow rust

- Alternate host: willow ⇄ larch
- Host multiplied by cuttings – clonal host
- Ideal system for a pathogen for adaption and selection

Rust effects

- Production loss : > 40% lower yield
- Dieback 60% if attacked after coppice
- Early defoliation → disturbed dormancy → winter dieback

Specificity - pathotypes

the rust population, both on Willow and Poplar, consists of a variety of different types with a variation of virulence on different clones

Table 2. Pathotypes found in Sweden 1991-96

	Pathotype		TESTCLONES								
f. sp.	No.	code	1 Mull	2 Q83	3 Stip	4 B. H.	5 -149	6 Calod	7 Korso	8 Him.	9 -139
	1	0.0.0									
LD	2	0.0.4									+
LR	3	0.3.0						+	+		
	4	0.3.2					+	+	+		
	5	0.3.4						+	+		+
	6	0.7.0						+	+	+	
	7	0.7.2					+	+	+	+	
	8	0.7.4						+	+	+	+
	9	1.7.0	+					+	+	+	
	10	4.1.6			+		+	+			+
	11	4.3.0			+			+	+		
	12	4.7.0			+			+	+	+	
	13	4.7.2			+		+	+	+	+	
	14	4.7.4			+			+	+	+	+
LET	15	5.0.0	+		+						
	16	5.0.1	+		+	+					
	17	5.0.2	+		+		+				
	18	5.0.3	+		+	+	+				
	19	5.0.7	+		+	+	+				+
	20	5.1.2	+		+		+	+			
	21	5.1.3	+		+	+	+	+			
	22	5.1.6	+		+		+	+			+
	23	5.1.7	+		+	+	+	+			+
	24	5.4.3	+		+		+			+	
	25	6.1.0		+	+			+			
	26	6.1.6		+	+		+	+			+
	27	7.0.2	+	+	+		+				
	28	7.0.3	+	+	+	+	+				
	29	7.0.7	+	+	+	+	+				+
	30	7.1.1	+	+	+	+		+			
	31	7.1.3	+	+	+	+	+	+			
	32	7.1.5	+	+	+	+		+			+
	33	7.1.6	+	+	+		+	+			+
	34	7.1.7	+	+	+	+	+	+			+
	35	7.4.2	+	+	+		+			+	
	36	7.4.3	+	+	+	+	+			+	
	37	7.5.3	+	+	+	+	+	+		+	
virulence factor			1	2	3	7	8	4	5	6	9

Genetic diversity – variation of the pathogen

- **Population structure concerning pathogenicity on national and international level (Sweden, UK, Chile, France)**
- **Separate populations or common worldwide?**

Genotype mapping can show:

Long distance dispersal of spores?

Global population of rust –spreads easily over long distances

- Within-plantation variation of the rust virulence is higher than between plantations
- High similarity of rust between different geographic regions → rust spreads easily over long distances
- Mapping of 89 rust isolates from Sweden, UK / Northern Ireland, France, and Chile show no clustering according to geographical origins of isolates → Same population in all countries
- Large Geen-pool in China, rust should be mapped

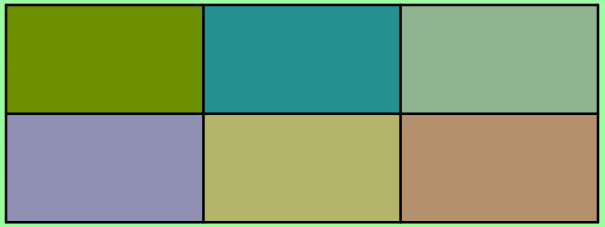
(Pathotyping: M. Ramstedt, AFLP-mapping: S. Hurtado, B. Samils, SLU)

Clonal mixtures to minimize rust adaption

Plant 5–8 different clones randomly mixed

- Lower initial rust
- Slower development
- Lower disease level in end of season
- Higher production than same clones in monoplots

Different clones planted in rows or smaller plots



Problems with mixtures

- **Can the pathogen adapt to a multivirulent state and how does that affect aggressiveness?**
- **Does rust pathotypes differ on a certain clone in a mix or when cultivated as a monoclone**

Trials carried out to study this in Northern Ireland by *Alistair McCracken et al.*

Summary – *Melampsora* rust

- Rust produce a high amount of spores, many cycles each season. Fast selection – new varieties of the pathogen.
- Poplar & Willows clones, earlier resistant now heavily attacked by rust
- Genetic mapping ●⟶ common global population
- Distant rust varieties must be regarded in resistance breeding
- After many years, still lower rust in mixtures, no negative selection seen yet.

Control

- Need to know origin and direction of spore dispersal.
- Resistance breeding – some 300 - 500 willow species available worldwide
- Biological Control – mycoparasites (*Sphaerellopsis filum*)
- Clonal mixtures / multiclonal plantations
- Fungicide – high cost, practically difficult – not an option.

Bacterial diseases

most serious threat

- Specific Poplar problem
  Xanthomonas populi
- Belgium, The Netherlands, France
- Willows – no similar symptoms noticed, weak and atypic

Poplar trials in Halland (southern Sweden)

- Dieback with necrotic bark
- Old trees dead in one year

- Young trees OK
- Frost damage ??
- More reminding on bacteria

Dieback in Halland 1991-94

- Bacteria isolated from necrotic parts
- Even found in willows with weak necrosis at the same trial
- Identified as

  - *Pseudomonas syringae, Erwinia spp., Xanthomonas spp*
- More willow samples collected in Uppland

  weak symptoms frequently found, also on commersial cuttings

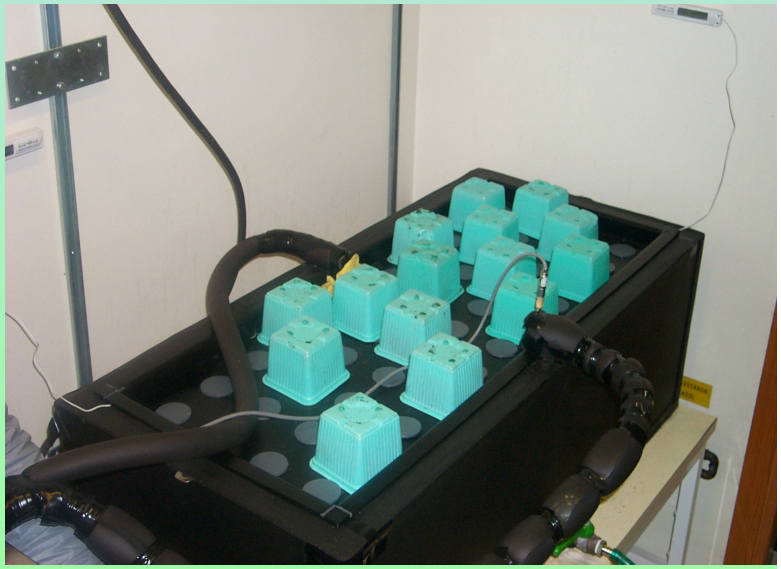
(Mauritz Ramstedt, H. von Fircks, B. Åström)

Ice Nucleation Active bacteria wellknown threat to many agricultural crops (Induce freezing in plants)

- Known from annual crops, vegetables, fruit trees (flowers).

- We tested bacteria for Ice nucleation activity:

  - POSITIVE

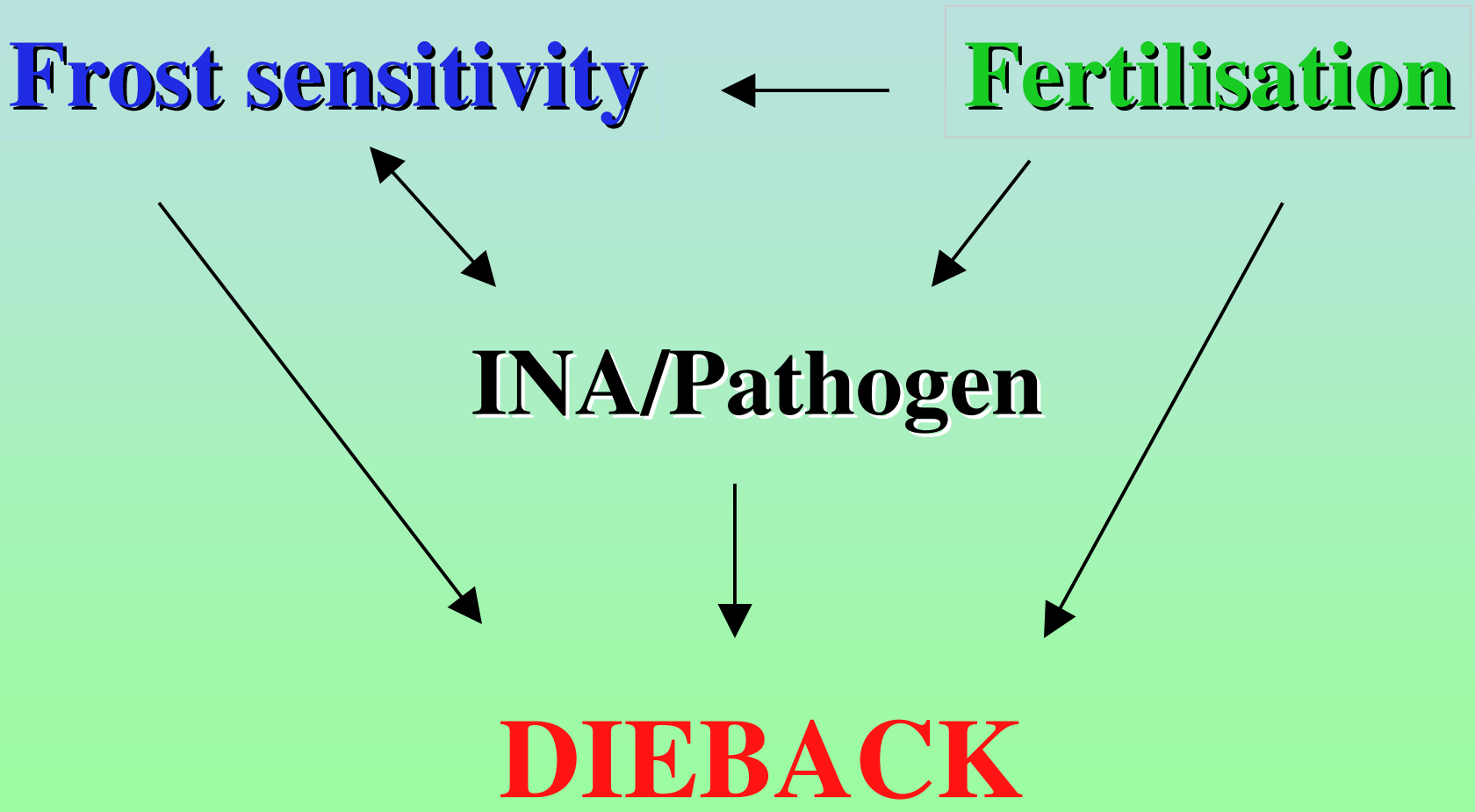


Presence of INA bacteria

- Initiate early freezing in the tissues
- Predispose plants for disease
- Aggravate frost-damage; plants are damaged at temperatures from which they normally will recover

Freezing at -3°C + bacteria

Freezing at -3°C


Frost sensitivity
Fertilisation
INA/Pathogen
DIEBACK

General assessments and collections of endo- and epiphytically growing bacteria

- 14-20 clones of Willows
- Several sites in Sweden and Estonia
- Symptoms of presence found in most plantations
- Approx 300 bacterial isolates first test
- Dieback were associated with: *Erwinia spp., Pseudomonas syringae, Sphingomonas / P. fluorescens* and *Xanthomonas spp, Bacillus* spp., *Erwinia rhapontici*, *Frigoribacterium* sp., *Pedobacter* sp., *Pseudomonas fluorescens*, *P. grimontii*, *P. graminis*, *P. trivialis* and *Sphingomonas/ Pseudomonas fluorescens*, non-fluorescent *P. fluorescens* (biotype A, C, G), *Xanthomonas spp* i.e. commonly appearing bacteria in nature – NOT specific willow pathogens

(Pajand Nejad et al.)

Symptoms appearance in *Salix* plants

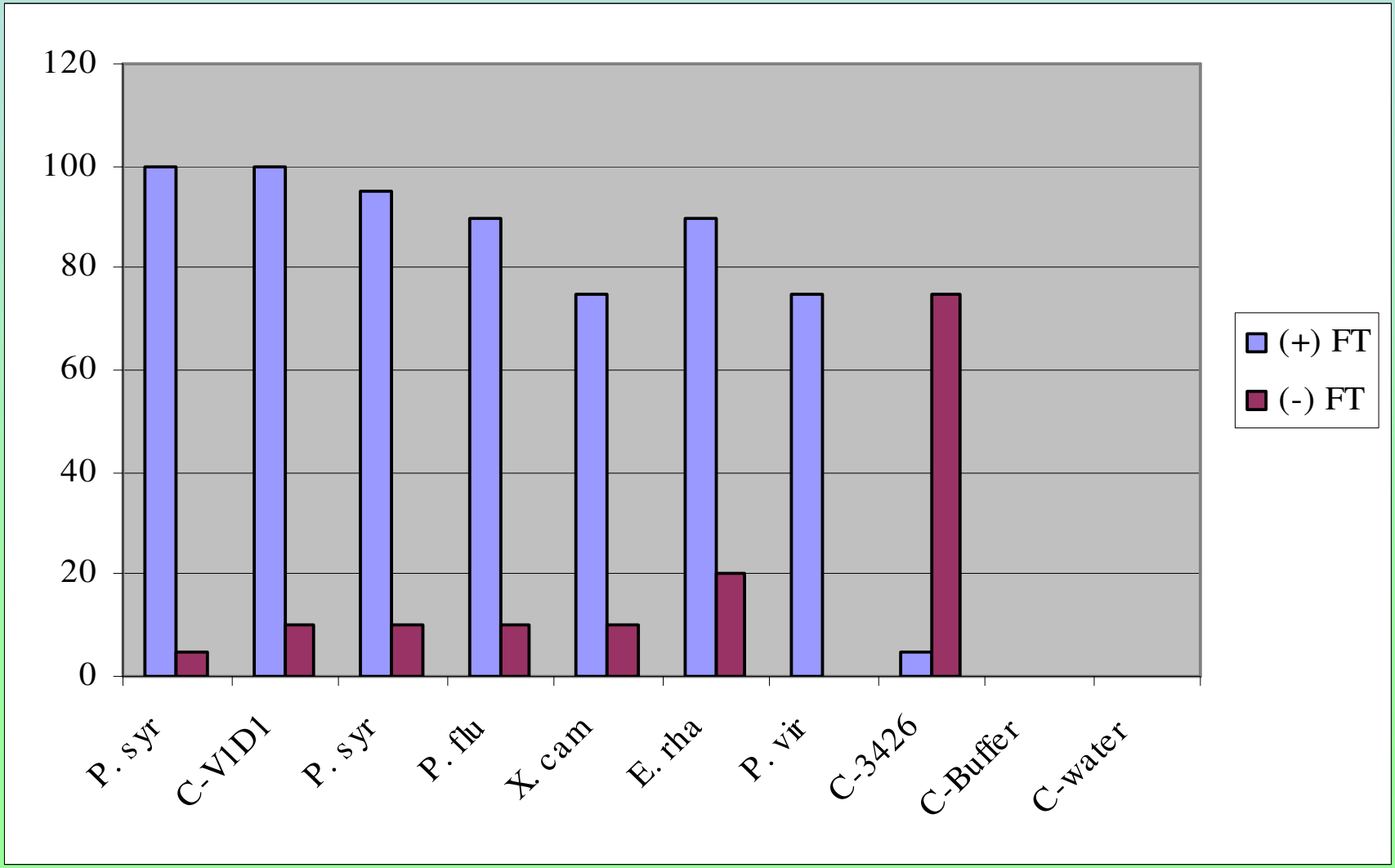
- Bacteria alone — No symptoms
- Freezing alone — No symptoms
- Bacteria + freezing — Necrotic bark / tissues

only freezing – 3 °C

freezing + bacteria

freezing + bacteria

Disease development with and without freezing



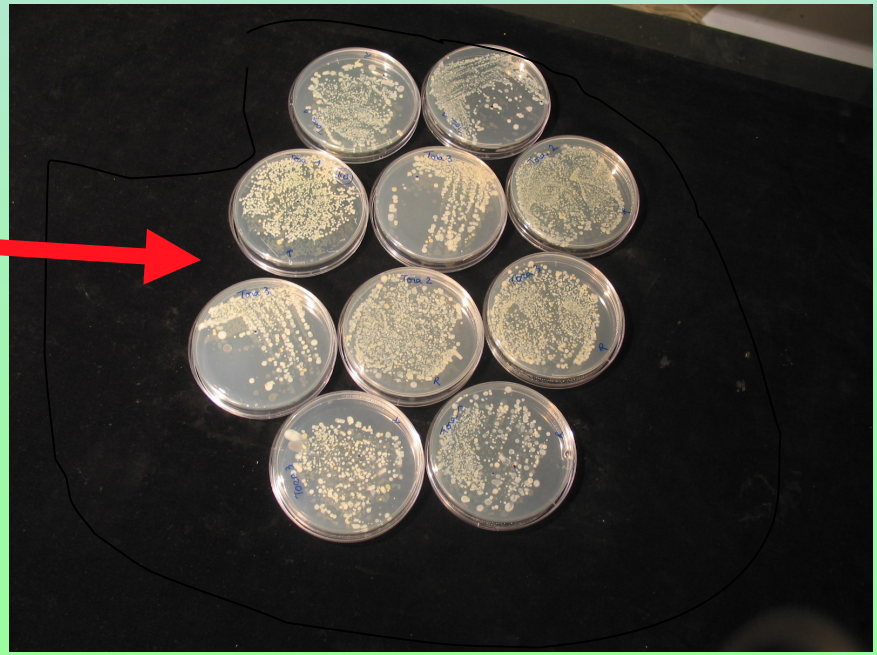
CONCLUSIONS

- Ubiquitous bacteria that found a new pathogenic niche
- Supposed frost damage → often infections by bacteria
- Breeding specifically for frost hardiness will miss the important part → bacterial resistance
- Electrolyte leakage → favours bacterial growth – large variation among clones.
- Epiphytic colonisation – large variation among clones.

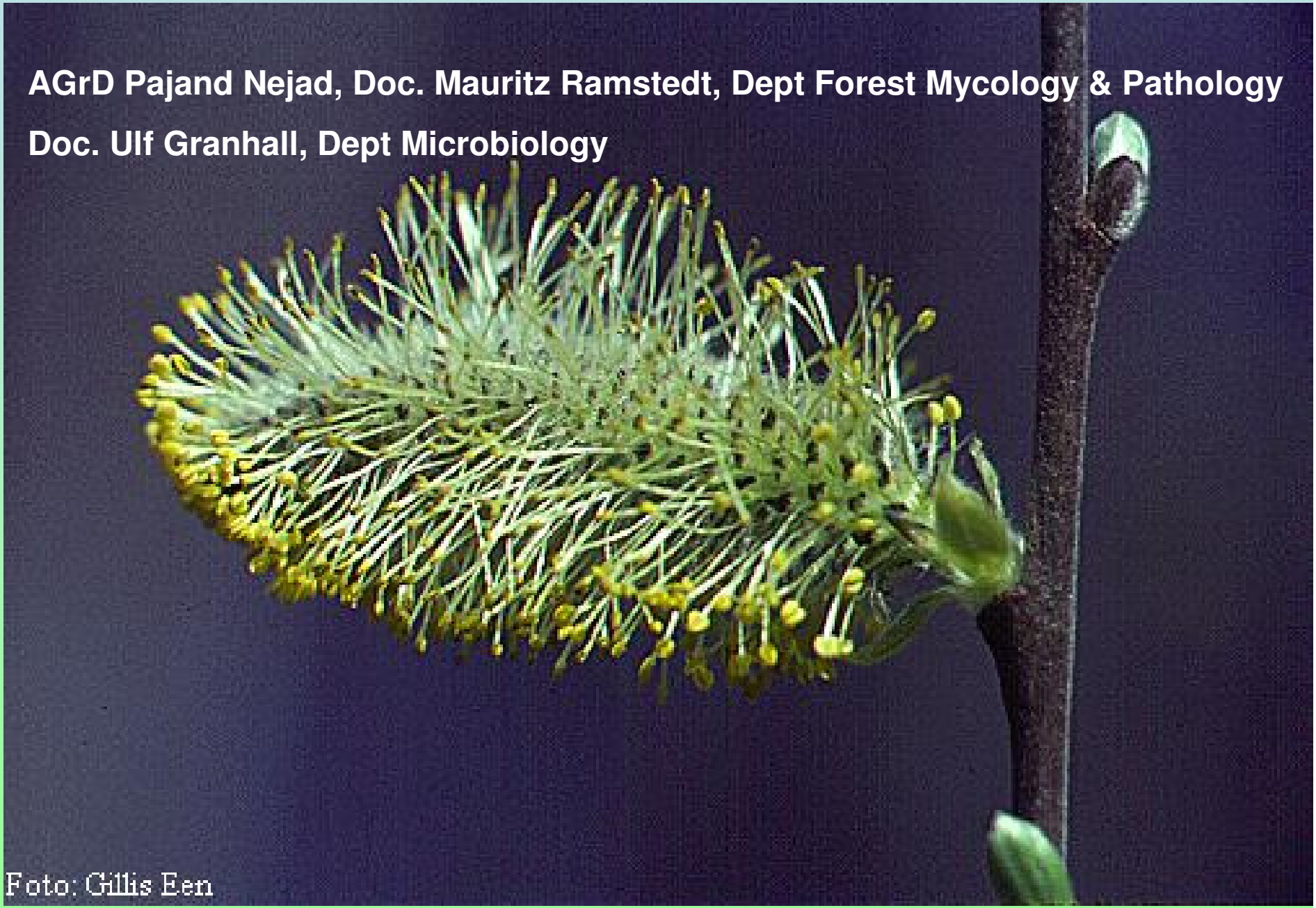
Control

- QTL-studies on correlation frost hardiness AND bacterial resistance
- *Quorum Sensing* interference manipulate INA
- Choose willows with
  - low leakage
  - lower epiphytic bacterial population
  - favour mixtures and multiclone plantations
- Not too dense plantations
- Avoid frost exposed sites

Disease free clones



New commercial clones inoculated with INA bacteria from field

AGrD Pajand Nejad, Doc. Mauritz Ramstedt, Dept Forest Mycology & Pathology

Doc. Ulf Granhall, Dept Microbiology