Spatial and temporal dynamics of Olive Quick Decline Syndrome in olive orchards in Puglia, Southern Italy

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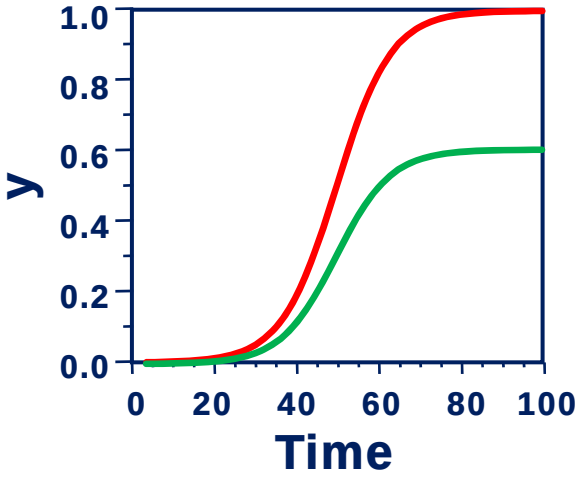
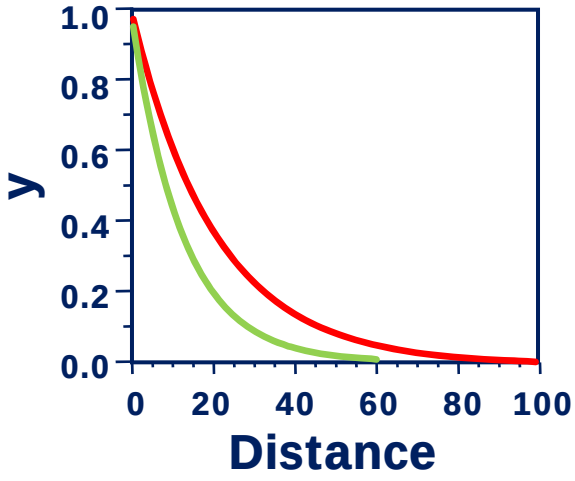
Temporal and spatial dynamic of epidemics

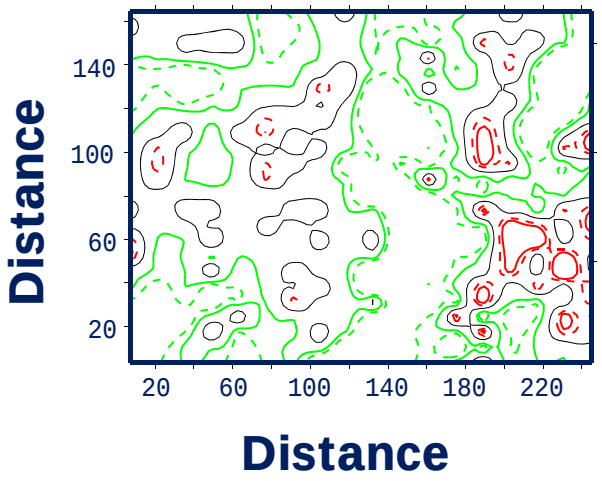
✓ Epidemic

Change in the intensity of the disease in a population of the host in time and/or space

Jurgen Kranz







Disease progress curve (Time)	Disease gradient (Distance)	Spatial distribution pattern (Space)

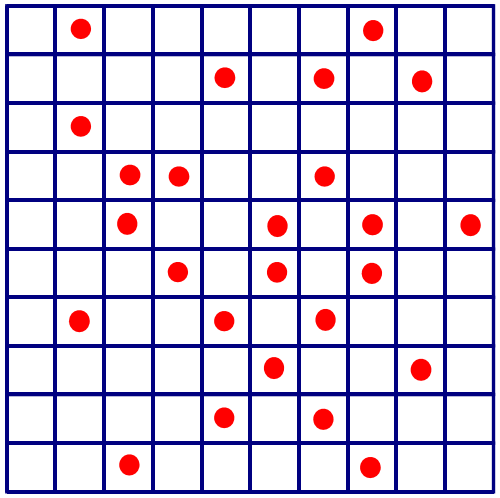
Adaptaded from: van Maanen, A. & Xu, X.-M. 2003. European Journal of Plant Pathol. 109: 669-682

Spatial patterns of plant diseases

"Everything is related to everything else, but near things are more related than distant things"

Tobler (1970), Tobler's Law of Geography

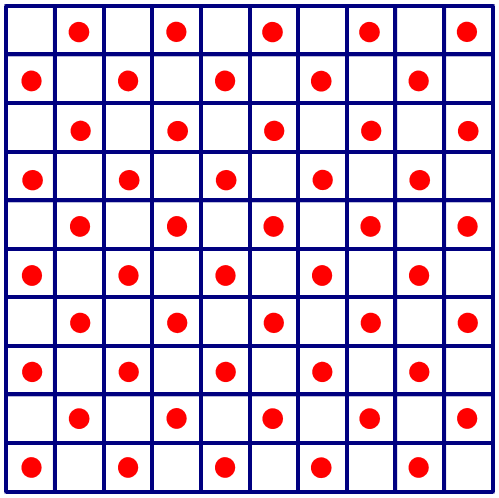
- **Three basic spatial patterns**



Random

Variance < Mean

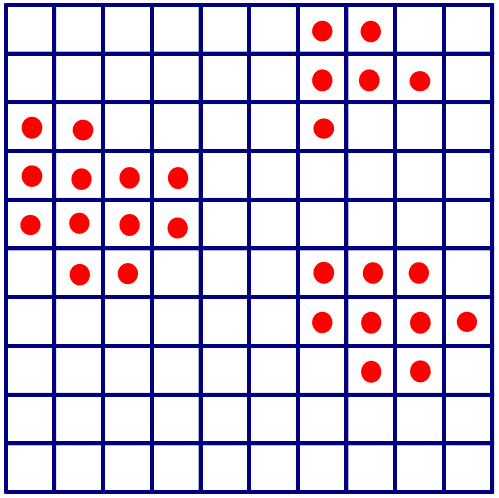
$\sigma^2 < \mu$



Regular

Variance = Mean

$\sigma^2 = \mu$



Clustered

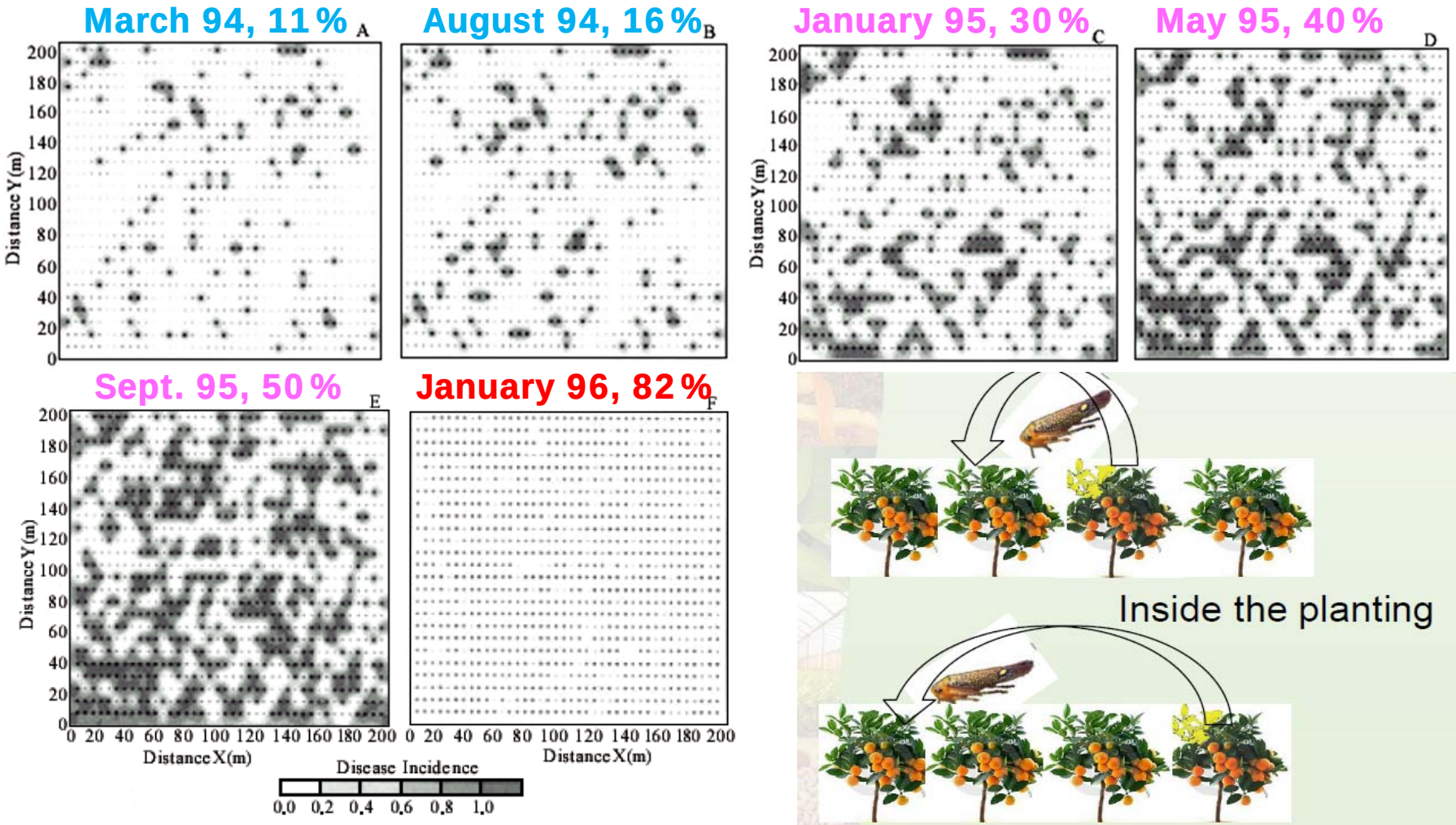
Variance > Mean

$\sigma^2 > \mu$

Diseases caused by *Xylella fastidiosa:* CVC -Citrus

➢ Citrus variegated clorosis: Spatio-temporal dynamics

Sweet orange "Valencia", São Paulo, Brazil

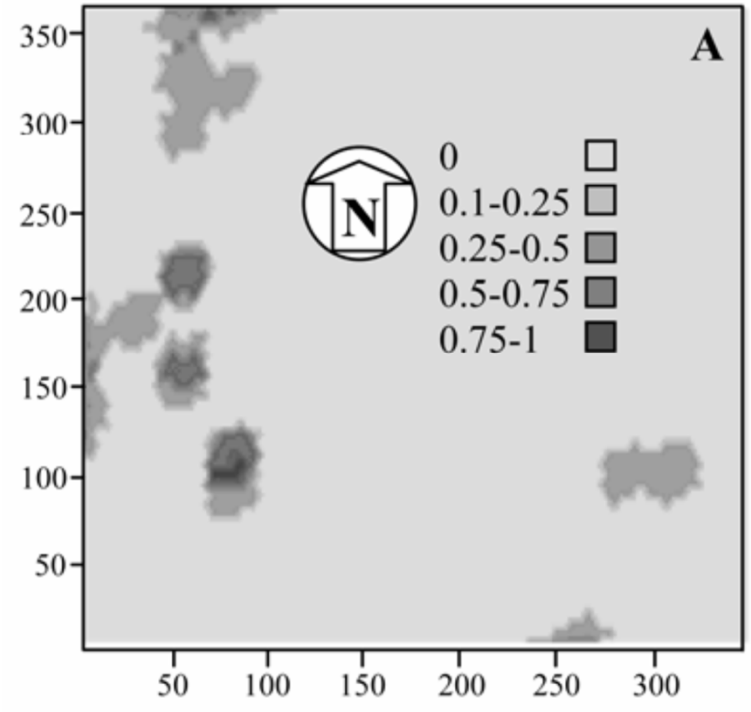


Source: Roberto et al., 2002. Fitopatologia Brasileira 27:599-604

Diseases caused by *Xylella fastidiosa:* Almond leaf scorch

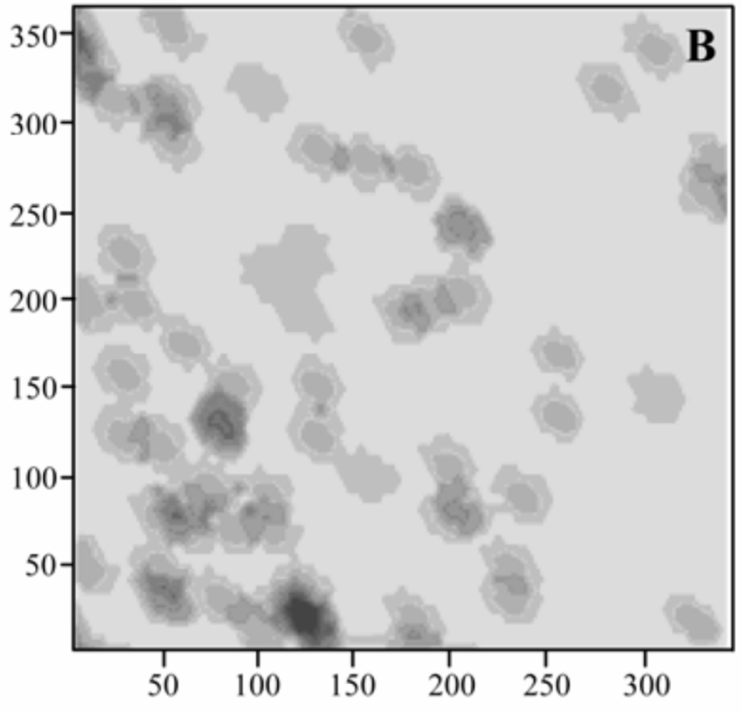
- **San Joaquin Valey, California, USA: *X. fastidiosa* genotypes**

***X. fastidiosa* Genotype G**



Clustered pattern

***X. fastidiosa* Genotype A**



Random pattern

- **Both genotypes are present in the same filed but showing differential spatial patterns**

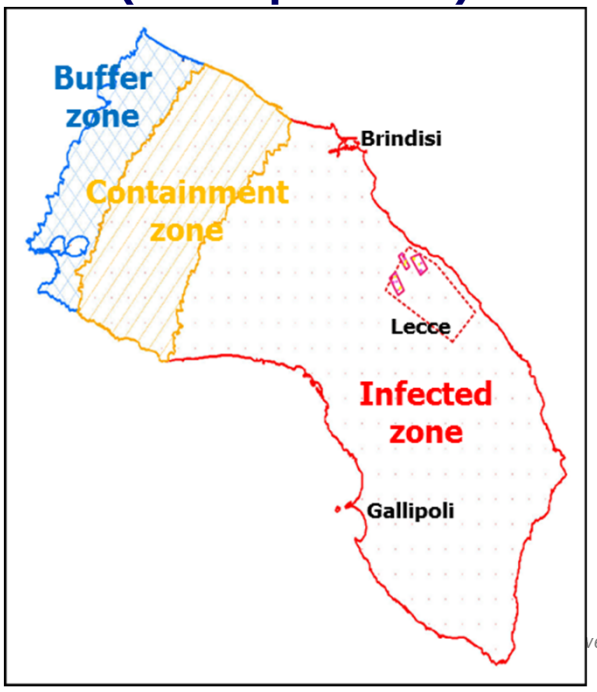
Source: Groves et al., 2005. Plant Disease 89:581-589

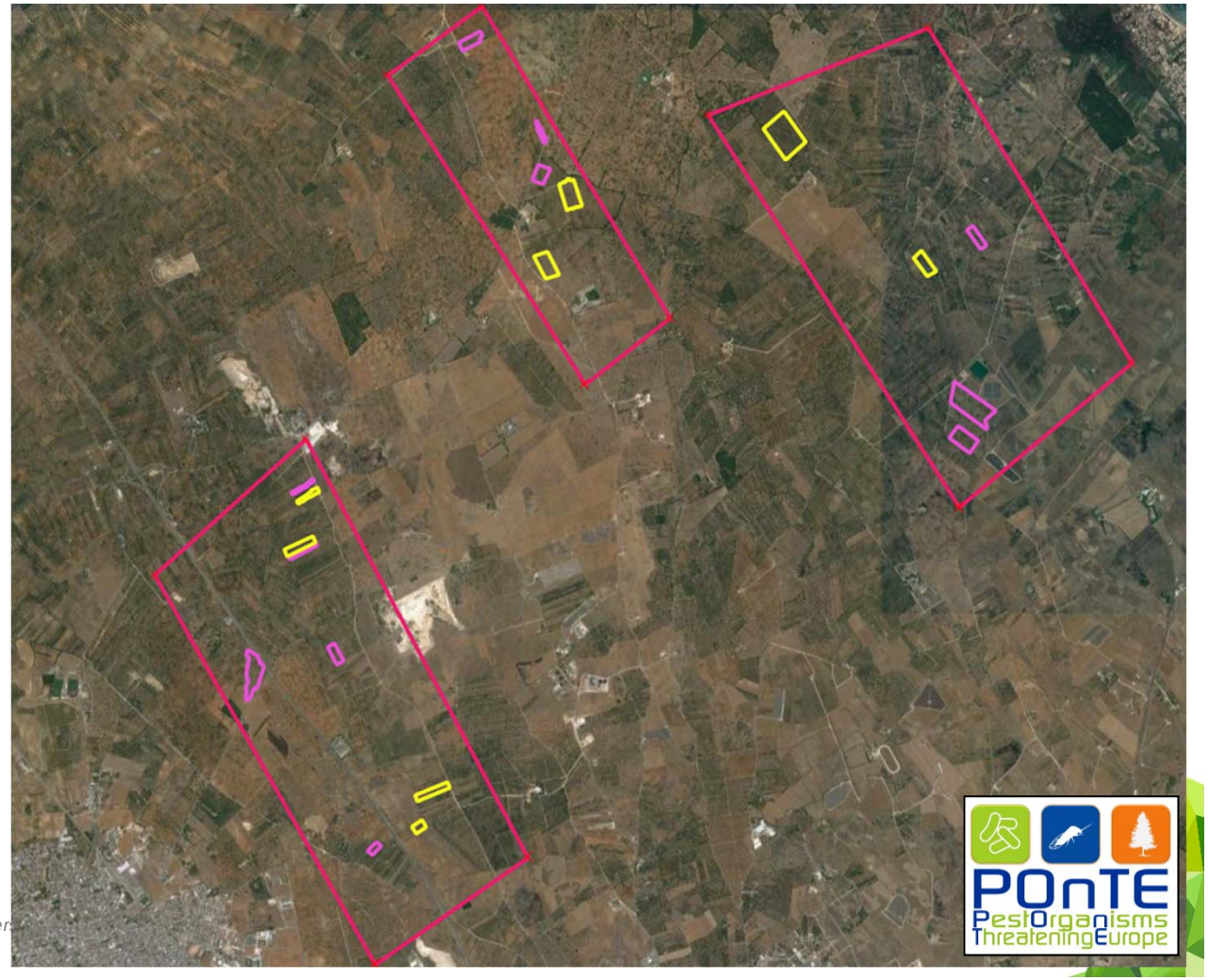
Field surveillance systems for vector and disease monitoring

Assessment of the spatio-temporal dynamics of *Xf* infections

Field assessments in the Salento region, 2016-2017

Location of study areas (Lecce province)





Field surveillance systems for vector and disease monitoring

Assessment of the spatio-temporal dynamics of *Xf* infections

Field assessments in the Salento region, 2016-2017

Olive Quick Decline Symdrom: Disease progression

No symptoms=0

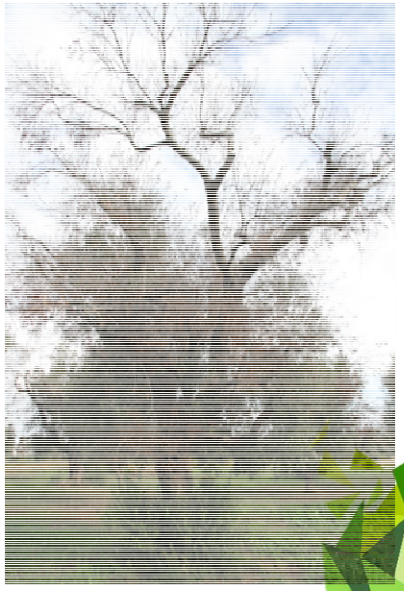
Severity=1

Severity=2

Severity=3

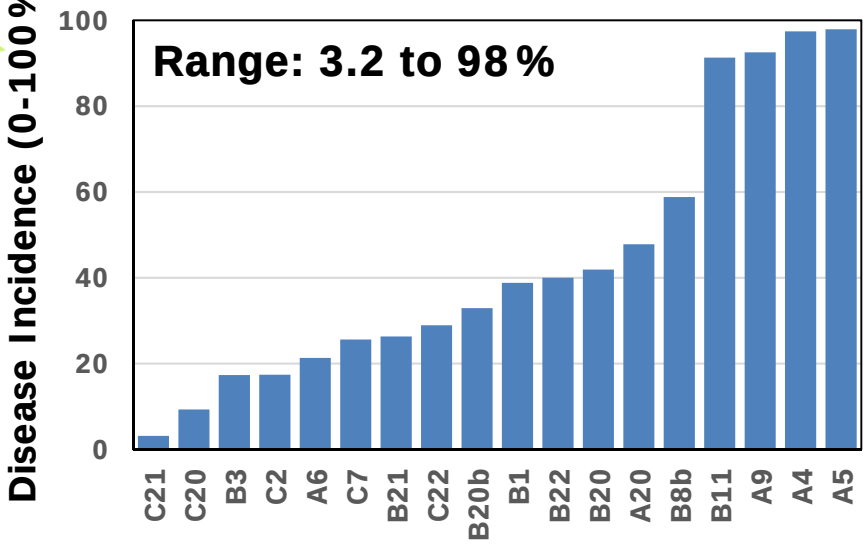
Severity=4

Severity=5

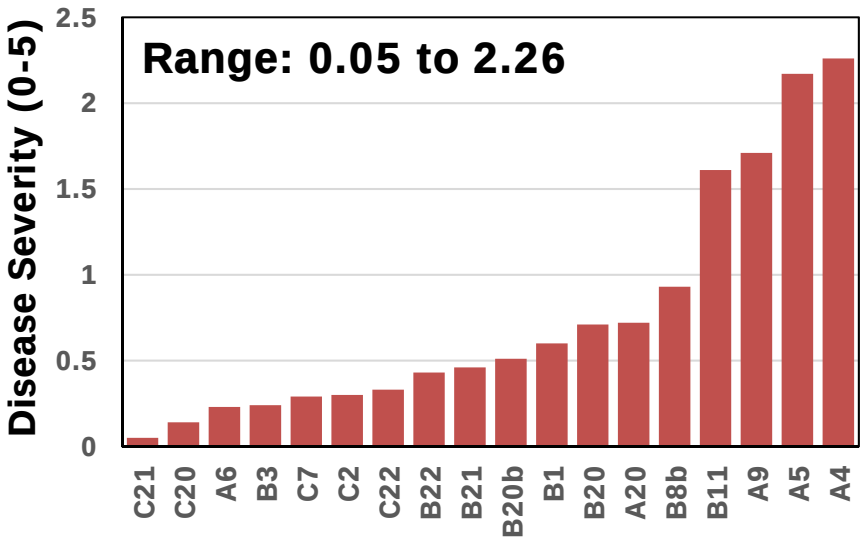


Spatial pattern of OQD symptomatic plants in Apulia, 2016-2017: Initial values for Disease Incidence, Severity & plot size

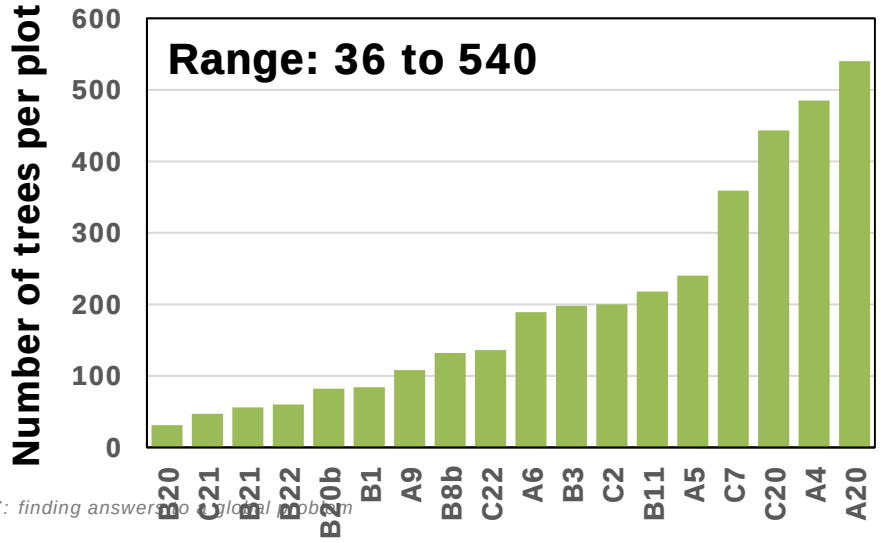
Disease Incidence



Disease Severity

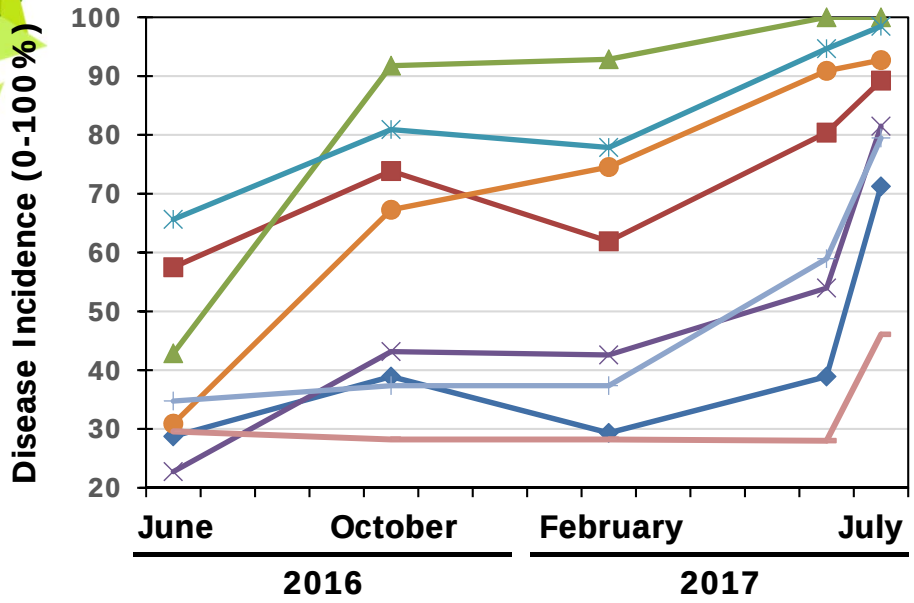


Number of trees per plot

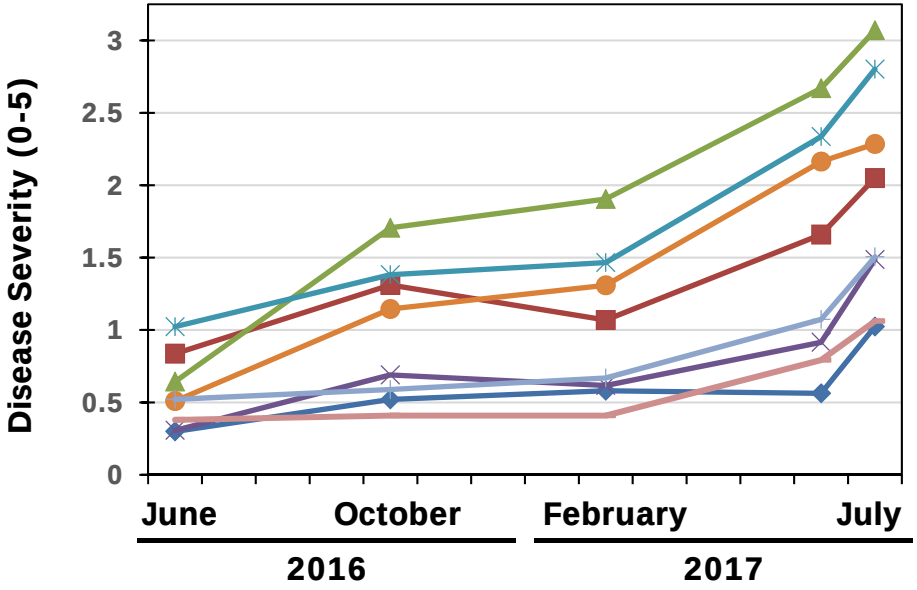


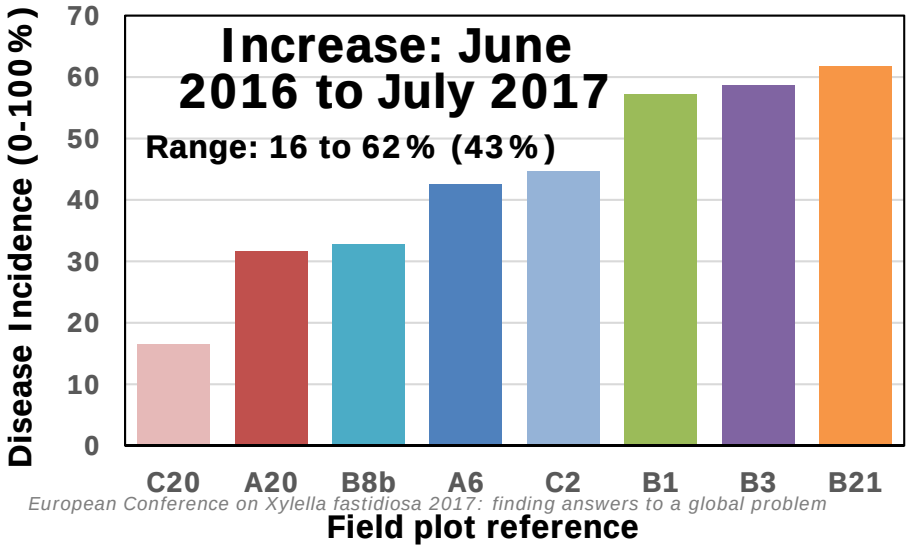
Temporal dynamics of OQD symptomatic plants in Apulia, Italy: June 2016 – July 2017

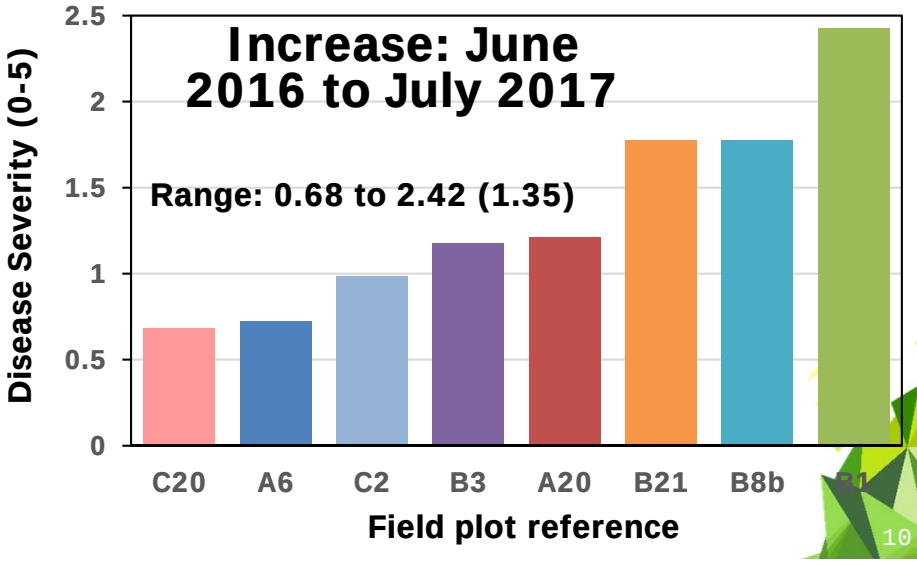
Disease Incidence (0-100%)



Disease Severity (0-5)



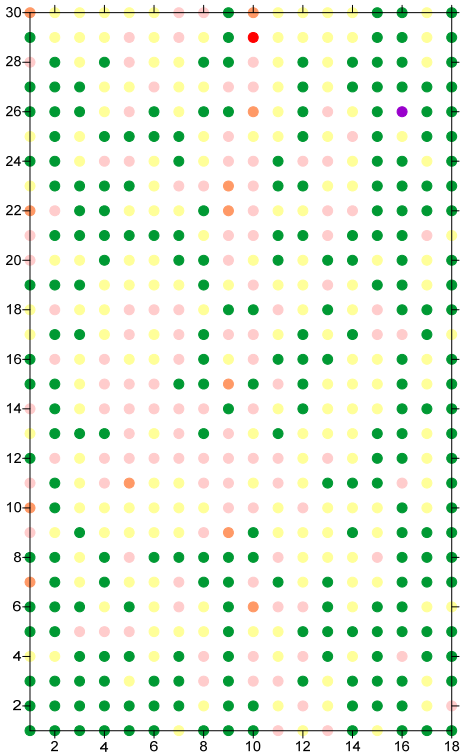




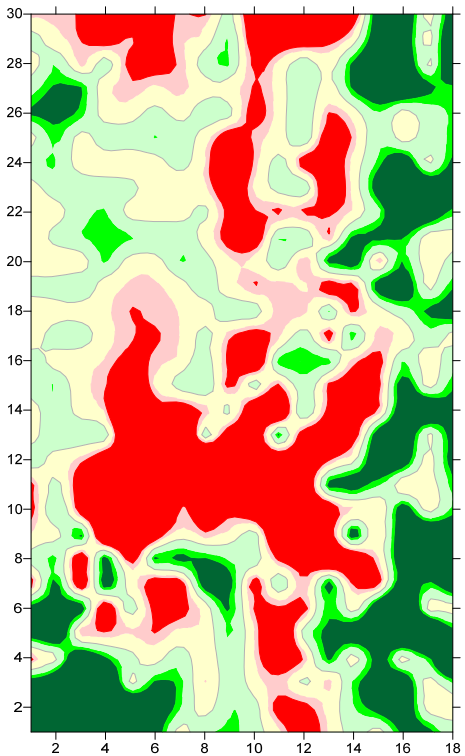
Spatial pattern: SADIE analysis

SADIE: *Spatial Analysis by Distance IndicEs*

Incidence / Severity



SADIE



Perry et al. 1999.
Ecol. Lett. 2:106-113

Index of aggregation (Ia)

Ia*; *Probability

Patches (*Vi*) **Gaps (*Vj*)**

Clusters

No. Area No. Area

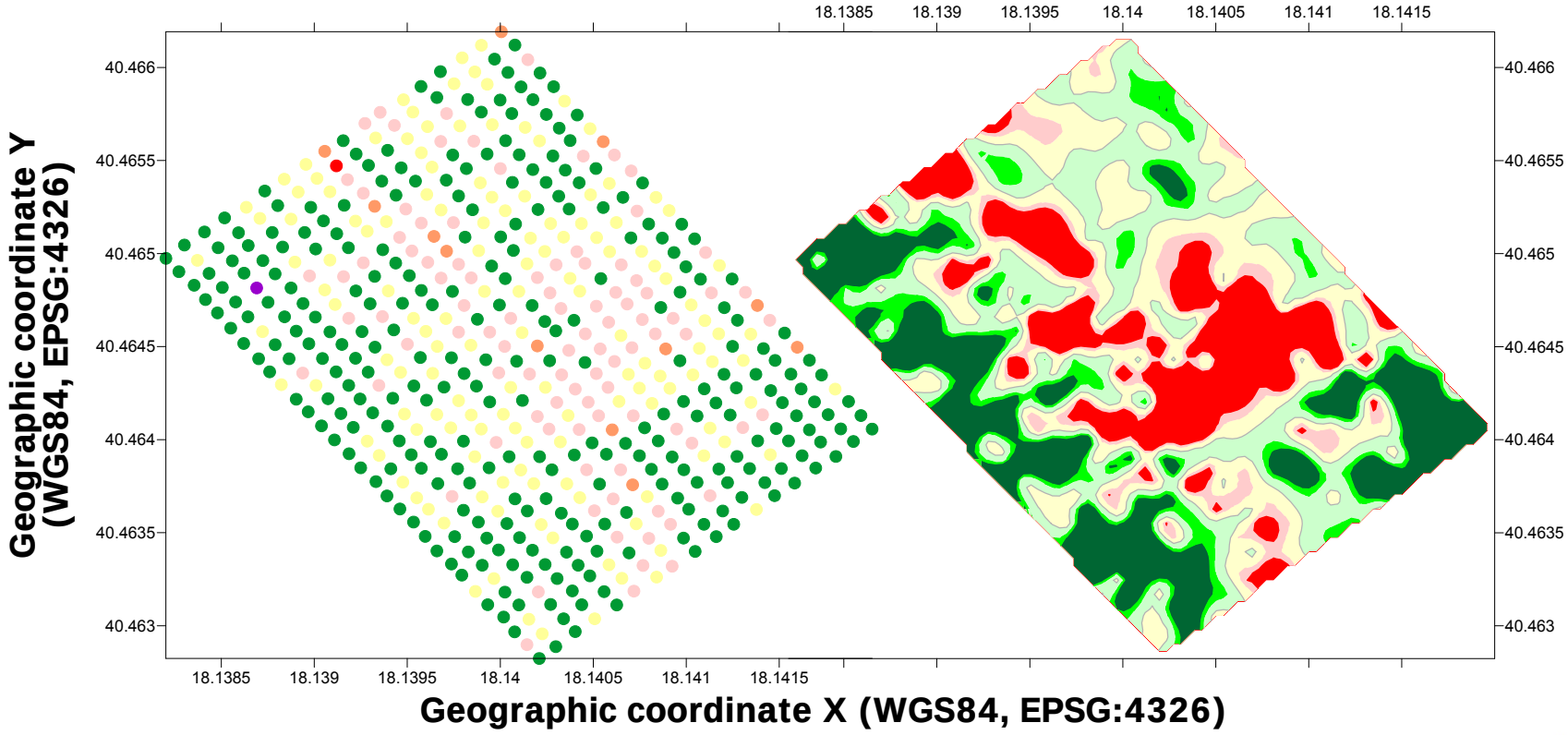
- To determine the spatial distribution of diseased plants
- Classify plants in foci: 'donors' (Patches) and 'receivers' (Gaps)
- Quantify the number and area of disease foci
- Spatio-temporal association test

Spatial pattern of OQD symptomatic plants in Puglia, Italy, 2016: Disease Incidence and Severity

Cv. Cellina

Incidence=47.8%, Severity=0.72, 540 trees
(*Ia*=1.91, *Pa*<0.001*): AGGREGATED

Disease severity | **SADIE analysis**



Disease severity (0-5)

No Symptoms → High Severity

SADIE Index of aggregation (*Ia*)

Gaps (*Vi*) **Patches (*Vi*)**

No Symptoms → High Severity

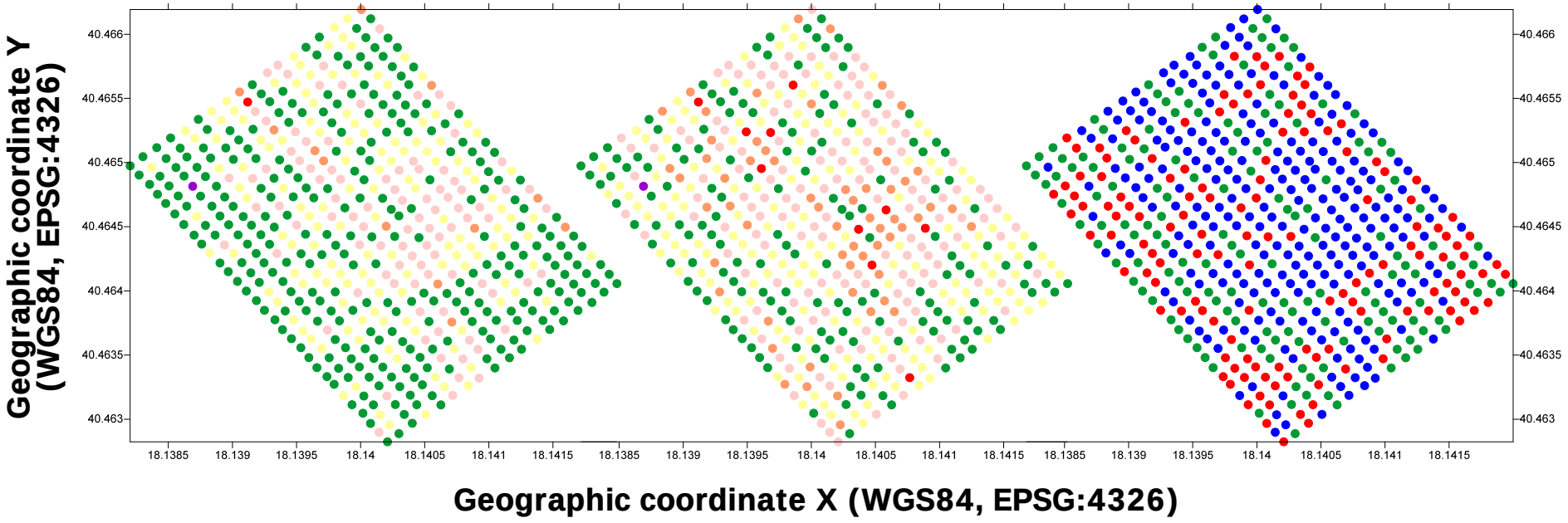
Spatial pattern of OQD symptomatic plants in Puglia, Italy, 2016: Disease Incidence and Severity

Cv. Cellina

JULY:
Inc=47.8%, Sev=0.72

OCTOBER:
Inc=73.9%, Sev=1.32

JULY vs OCTOBER:
Incidence: +26.1%
Severity: +0.60



Disease severity (0-5)

No Symptoms → High Severity

Change in Disease Incidence

- No Symptoms
- Symptomatic in July
- New Symptomatic in October

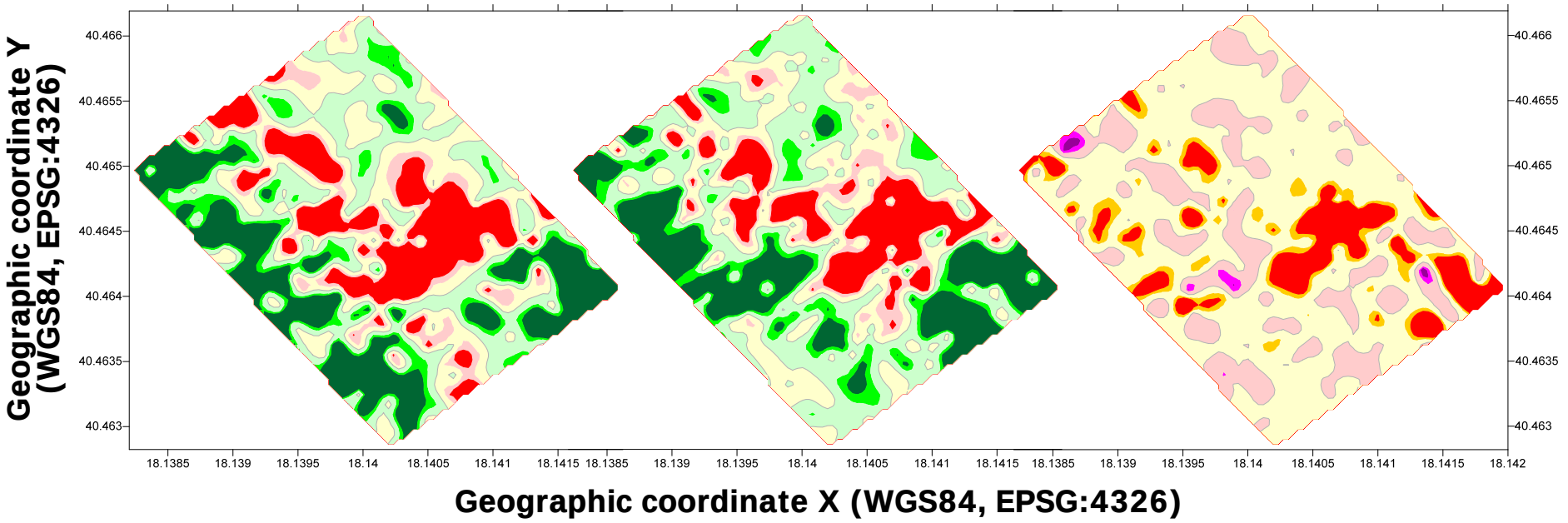
Spatial pattern of OQD symptomatic plants in Puglia, Italy, 2016: Disease Incidence and Severity

Cv. Cellina

JULY:
Inc=47.8%, Sev=0.72
Ia=1.91, *Pa*<0.001*
AGGREGATED

OCTOBER:
Inc=73.9%, Sev=1.32
Ia=1.74, *Pa*=0.001*
AGGREGATED

INDEX OF ASSOCIATION JULY vs OCTOBER
Xa=0.48, *Pa*<0.001*
ASSOCIATION

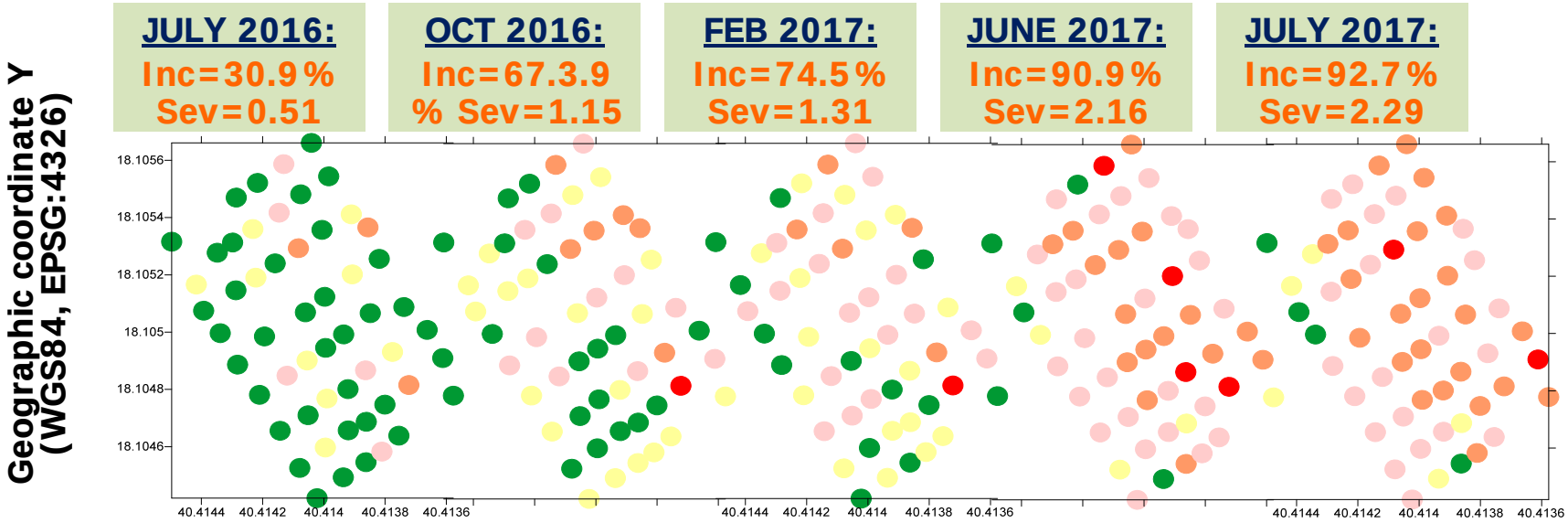


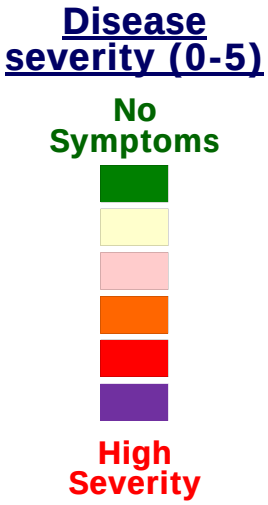
SADIE Index of aggregation (*Ia*)
Patches (*Vi*) Gaps (*Vj*)
High Sev → No Symptoms

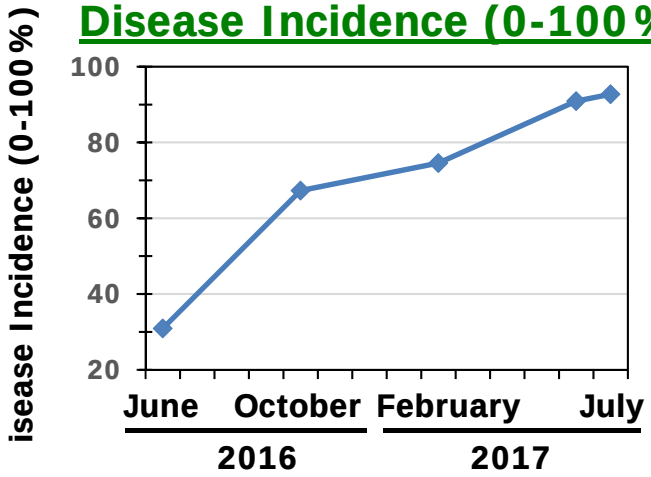
SADIE Index of association (*Xa*)
Association Disassociation

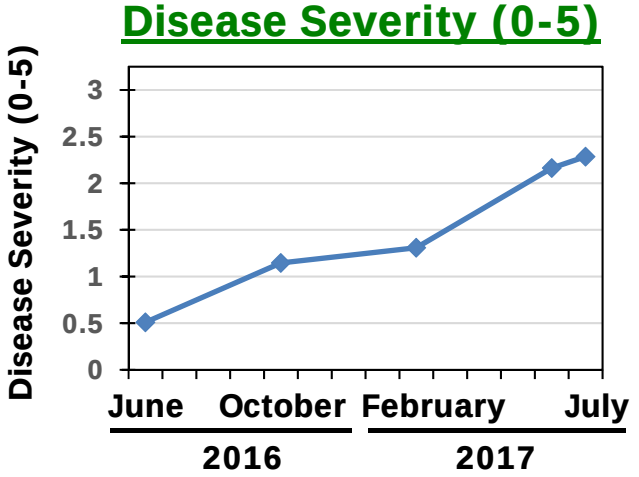
Spatial pattern of OQD symptomatic plants in Apulia, Italy, June 2016 to July 2017: Incidence & Severity

Cv. Ogliarola









Spatial pattern of OQD symptomatic plants in Apulia, Italy, June 2016 to July 2017: Incidence & Severity

Cv. Ogliarola

JULY 2016: Inc=30.9% Sev=0.51

OCT 2016: Inc=67.3.9 % Sev=1.15

FEB 2017: Inc=74.5% Sev=1.31

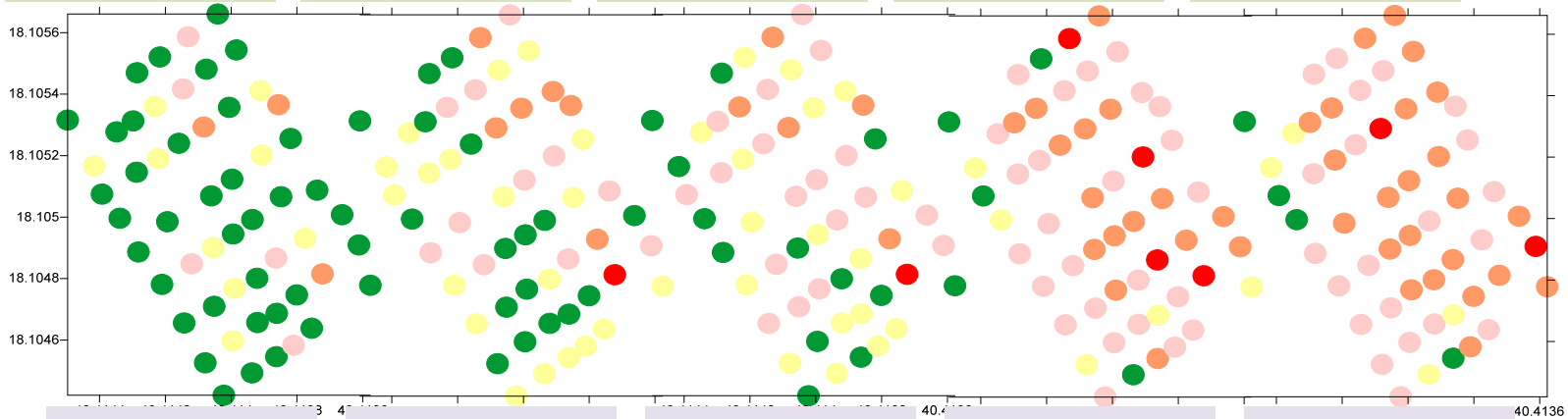
JUNE 2017: Inc=90.9% Sev=2.16

JULY 2017: Inc=92.7% Sev=2.29

Disease severity (0-5)

No Symptoms

High Severity



JULY 2016: Ia=1.05

OCT 2016: Ia=1.56*

FEB 2017: Ia=1.65*

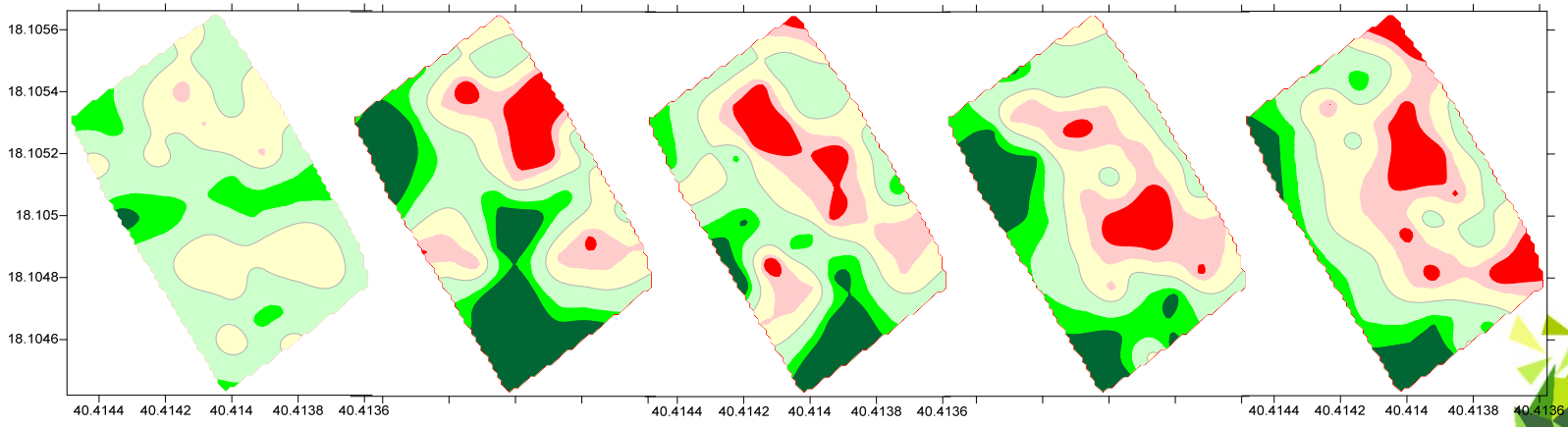
JUNE 2017: Ia=1.26

JULY 2017: Ia=1.44*

SADIE Index of aggregation (*Ia*)

Patches (*Vi*)

Gaps (*Vj*)



Geographic coordinate X (WGS84, EPSG:4326)

Spatial pattern of OQD symptomatic plants in Apulia, Italy, June 2016 to July 2017: Incidence & Severity

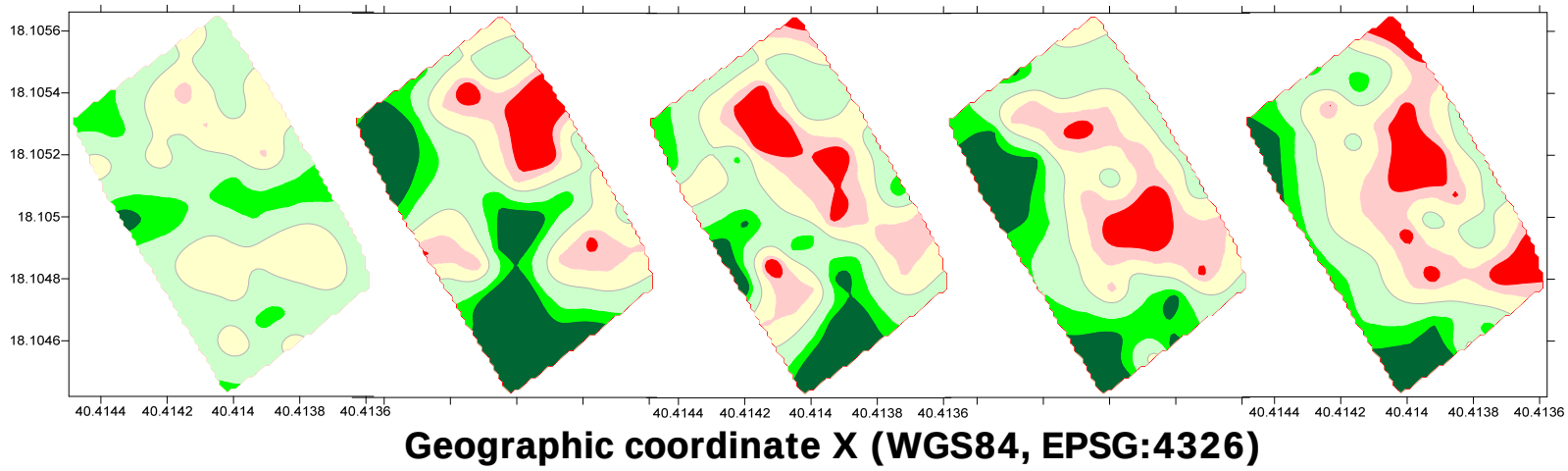
Cv. Ogliarola

SADIE Index of aggregation (*Ia*)

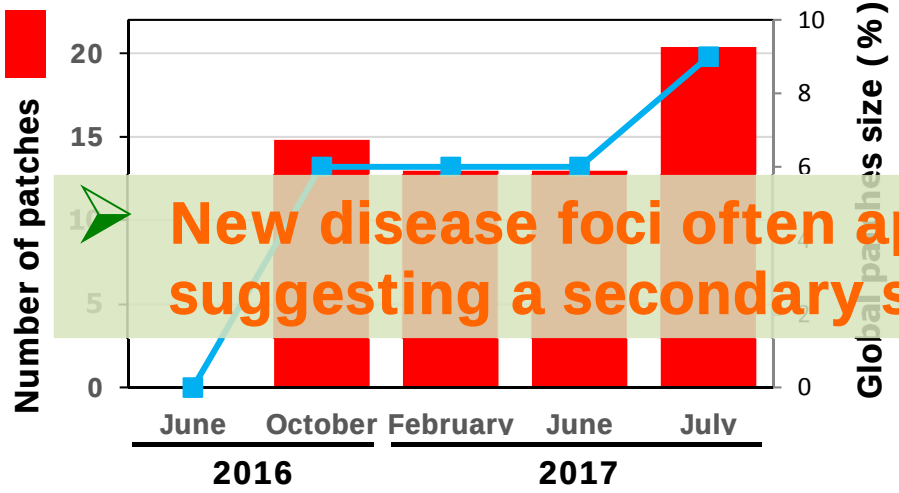
Patches (*Vi*)

Gaps (*Vj*)

JULY 2016:	OCT 2016:	FEB 2017:	JUNE 2017:	JULY 2017:
Ia=1.05	Ia=1.56*	Ia=1.65*	Ia=1.26	Ia=1.44*



Number and size of patch cluster



Spatio-temporal Association test

	Jun. 16	Oct. 16	Feb. 17	Jun. 17
Oct. 16	0.3909			
Feb. 17	0.2597	0.3562		
Jun. 17	0.2643	0.3150	0.5289	
July 17	0.2413	0.4494	0.4378	0.6265

Spatial association at $P<0.025$

New disease foci often appears close to previous foci suggesting a secondary spread by vectors

CSIC
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Instituto de Agricultura Sostenible IAS

IPSP

Università degli Studi di Bari Aldo Moro
Dipartimento di Scienze del Suolo della Pianta e degli Alimenti

POnTE
Pest Organisms Threatening Europe

- The initial disease foci determine the spatial pattern
- New disease foci often appears close to previous foci suggesting a secondary spread by vectors
- Aggregated spatial pattern: as expected for a vector-borne transmitted disease