Van éénjarige modellen naar meerjarige problemen

Gert HJ Kema – Wageningen Universiteit – Laboratorium voor Fytopathologie

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Instituut voor Plantenziektenkundig Onderzoek
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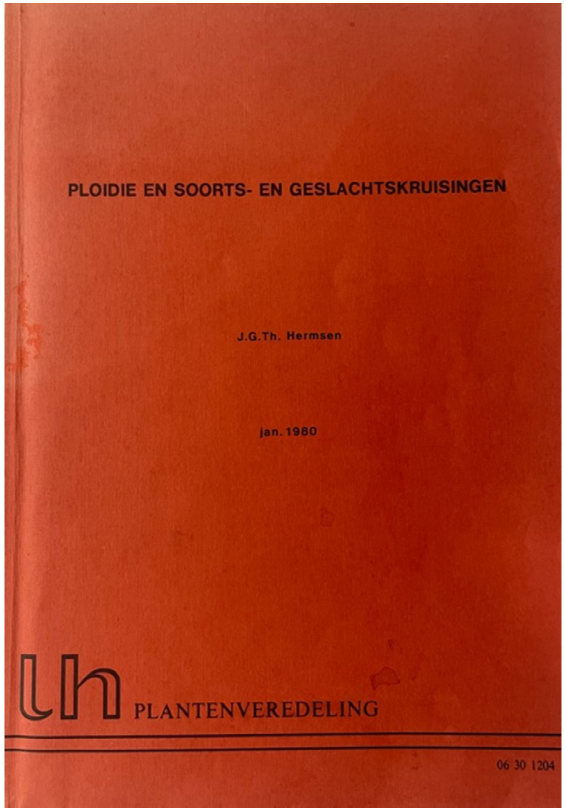
Het belang van wilde tarwe- en grassoorten voor de ziekteresistentieveredeling, in het bijzonder met betrekking tot roestziekten



PLOIDIE EN SOORTS- EN GESLACHTSKRUISINGEN

J.G.Th. Hermsen

jan. 1980

lh PLANTENVEREDELING

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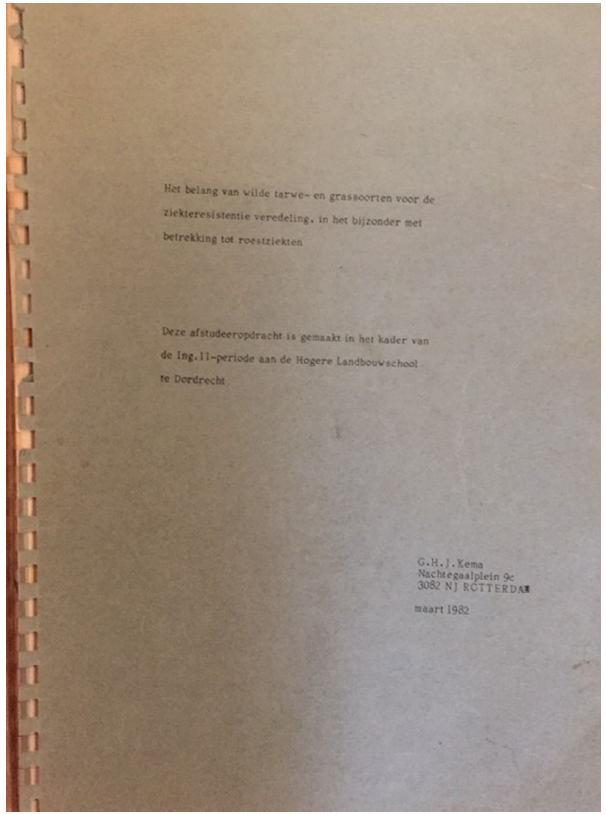

Het belang van wilde tarwe- en grassoorten voor de ziekteresistentie veredeling, in het bijzonder met betrekking tot roestziekten

Deze afstudeeropdracht is gemaakt in het kader van de Ing.II-periode aan de Hogere Landbouwschool te Dordrecht

G.H.J.Kema
Nachtegaalplein 9c
3082 NJ ROTTERDAM

maart 1982

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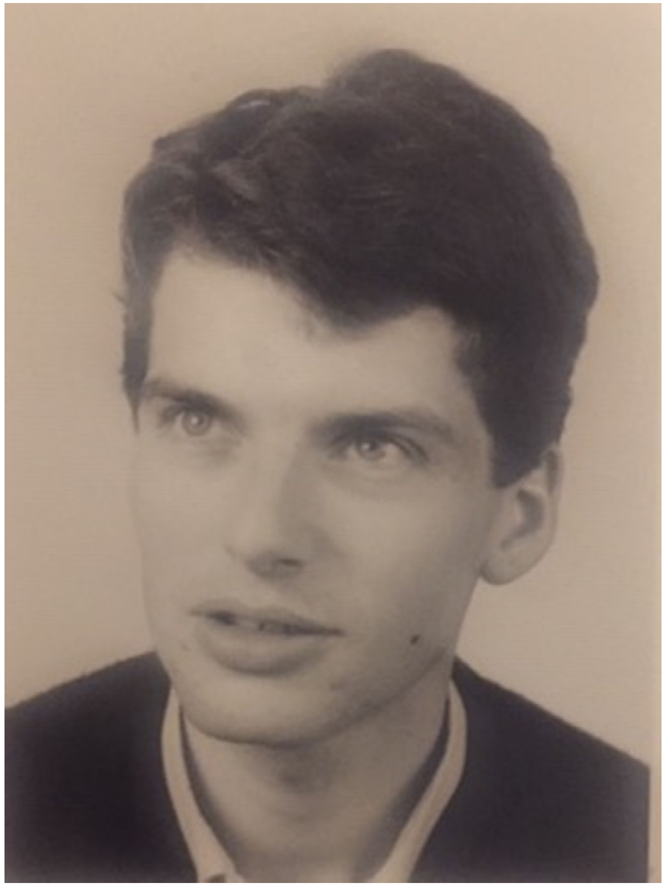
Puccinia striiformis



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THE FERTILE CRESCENT AND RISE OF AGRICULTURE
Black Sea
PONTIC mts.
CAUCASUS mts.
Caspian Sea
ELBURZ mts.
ZAGROS mts.
KUH RUD mts.
Kavir Desert
ANATOLIA
Halys r.
Lake Tuz
10300 BCE
EMMER WHEAT
RYE
EINKORN WHEAT
SHEEP
9000 BCE
CATTLE
6500 BCE
PIGS
8500 BCE
Lake Van
GOATS
9000 BCE
SHEEP
9000 BCE
Lake Urmia
11900 BCE
EINKORN WHEAT
CATTLE
8000 BCE
Khabur r.
Tigris r.
BARLEY
LENTILS
11500 BCE
11000 BCE
SHEEP
9000 BCE
GOATS
9000 BCE
GOATS
7500 BCE
13000 BCE
11500 BCE
MESOPOTAMIA
Euphrates r.
10600 BCE
Cyprus
LENTILS
23000 BCE
11500 BCE
11700 BCE
11300 BCE
LENTILS
PEAS
MEDITERRANEAN SEA
Levant Coast
BARLEY
EMMER WHEAT
CATTLE
6500 BCE
GOATS
7500 BCE
Jordan r.
Syrian Desert
Nile Delta
Dead Sea
BARLEY
EMMER WHEAT
SINAI
Negev Desert
modern coastline
An Nafud Desert
Persian Gulf
Red Sea
Nile r.
natural distribution of wild cereals
Fertile Crescent
wild cereal
evidence of animal domestication
11700 BCE evidence of consumption of wild cereals
11300 BCE evidence of domestication of cereals
WORLD HISTORY ENCYCLOPEDIA

Triticum monococcum (AA, 2n=14)

Triticum dicoccoïdes **(AABB, 2n=28)**

Aegilops squarrosa (DD, 2n=14)

Euphytica **63**: 207–217, 1992.
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Resistance in spelt wheat to yellow rust

I. Formal analysis and variation for gliadin patterns

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Received 21 February 1992; accepted 15 July 1992

Key words: electrophoresis, gliadin patterns, spelt wheat, stripe rust, *Triticum aestivum* ssp. *spelta*, *Puccinia striiformis*, yellow rust

Summary

Seven spelt wheat accessions of different origin were hybridized with the susceptible bread wheat cultivar Taichung 29 in order to study the genetics of their resistance to yellow rust (*Puccinia striiformis* Westend. f. sp. *tritici*). One Iranian and five European accessions were found to carry *Yr5* of *Triticum aestivum* ssp. *spelta* var. *album*, whereas a factor for resistance in the Iranian accession 415 was confirmed to be genetically distinct from *Yr5*. The alleles for resistance in each of the accessions studied showed a monogenic dominant mode of inheritance. Twenty-eight spelt wheat accessions, including those studied for their resistance to yellow rust, were subjected to polyacrylamide-gel-electrophoresis to study variation for gliadin storage protein patterns. Thirteen distinct patterns were revealed, implying the presence of duplicates within the studied spelt wheat collection.

Introduction

Spelt wheat, *Triticum aestivum* (L.) Thell. ssp. *spelta* (L.) Thell. (Kimber & Sears, 1983) or *T. spelta* L. (Kimber & Sears, 1987), was an important cereal crop in Europe until the early nineteen-thirties (a.o. Flaksberger, 1930), and continues to be cultivated in the Ardennes and on high, isolated plateaus of the Swiss Alps, where its former importance is recognized in village names like 'Dinkelbühl' (Dinkel = spelt wheat). The distinguished the observed resistance in spelt wheat to *Pythium aristoporum* Vanterpool, *Fusarium* spp. and other soil fungi, probably associated with its adherent glumes, resulted in higher plant numbers per unit area than that of bread wheat (*T. aestivum* L.) (Kuckuck, 1964; Riesen et al., 1986).

High levels of resistance to several fungal pathogens, including yellow rust (*Puccinia striiformis* Westend. f. sp. *tritici*), in spelt wheat have been described in the 19th century (Kühn, 1858; Eriksson & Henning, 1896). The latter authors recognized

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Resistance in spelt wheat to yellow rust

II. Monosomic analysis of the Iranian accession 415

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Received 21 February; accepted 15 July 1992

Key words: monosomic analysis, *Puccinia striiformis*, spelt wheat, stripe rust, *Triticum aestivum* ssp. *spelta*

Summary

A factor for resistance to yellow rust in the Iranian spelt wheat accession 415 was found to be located on chromosome 1B, utilizing a monosomic series of *T. spelta* var. *saharense*. Ditelosomic stocks of cv. Chinese Spring, were employed to verify the identity of the critical chromosome. The factor for resistance is most probably identical with the *Yr10* allele which is also located on chromosome 1B. Moreover, the response of cv. Moro which carries *Yr10* and accession 415 to 22 yellow rust races, representing a wide pathogenicity spectrum, was identical.

Introduction

In a previous study, several accessions of spelt wheat, *T. aestivum* (L.) Thell. ssp. *spelta* (L.) Thell. (Kimber & Sears, 1983) or *T. spelta* L. (Kimber & Sears, 1987), were found to carry a common allele for resistance to yellow rust (*Puccinia striiformis* Westend. f. sp. *tritici*) (Kema, 1992^a). This allele was originally discovered in *T. spelta* var. *album* and designated *Yr5* (Macer, 1963). Interestingly, it was shown to occur also in some Iranian accessions (Kema, 1992^a), which had been collected by Kuckuck & Schiemann (1957), whilst other

Materials and methods

The Iranian spelt wheat accession 415 was crossed as the pollen parent with a monosomic series of the universal suscept *T. spelta* var. *saharense* (El-Bedewy, 1981; El-Bedewy et al., 1982). Monosomic F_1 plants were selected cytologically and subsequently cultivated in a greenhouse with additional illumination provided by high pressure sodium lamps, to produce an F_2 generation. All ears were bagged prior to flowering in order to preclude cross fertilization. Seedlings of the F_2 populations were analyzed for resistance to yellow rust, utilizing a

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Resistance in spelt wheat to yellow rust

III. Phylogenetical considerations

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Received 21 February 1992; accepted 15 July 1992

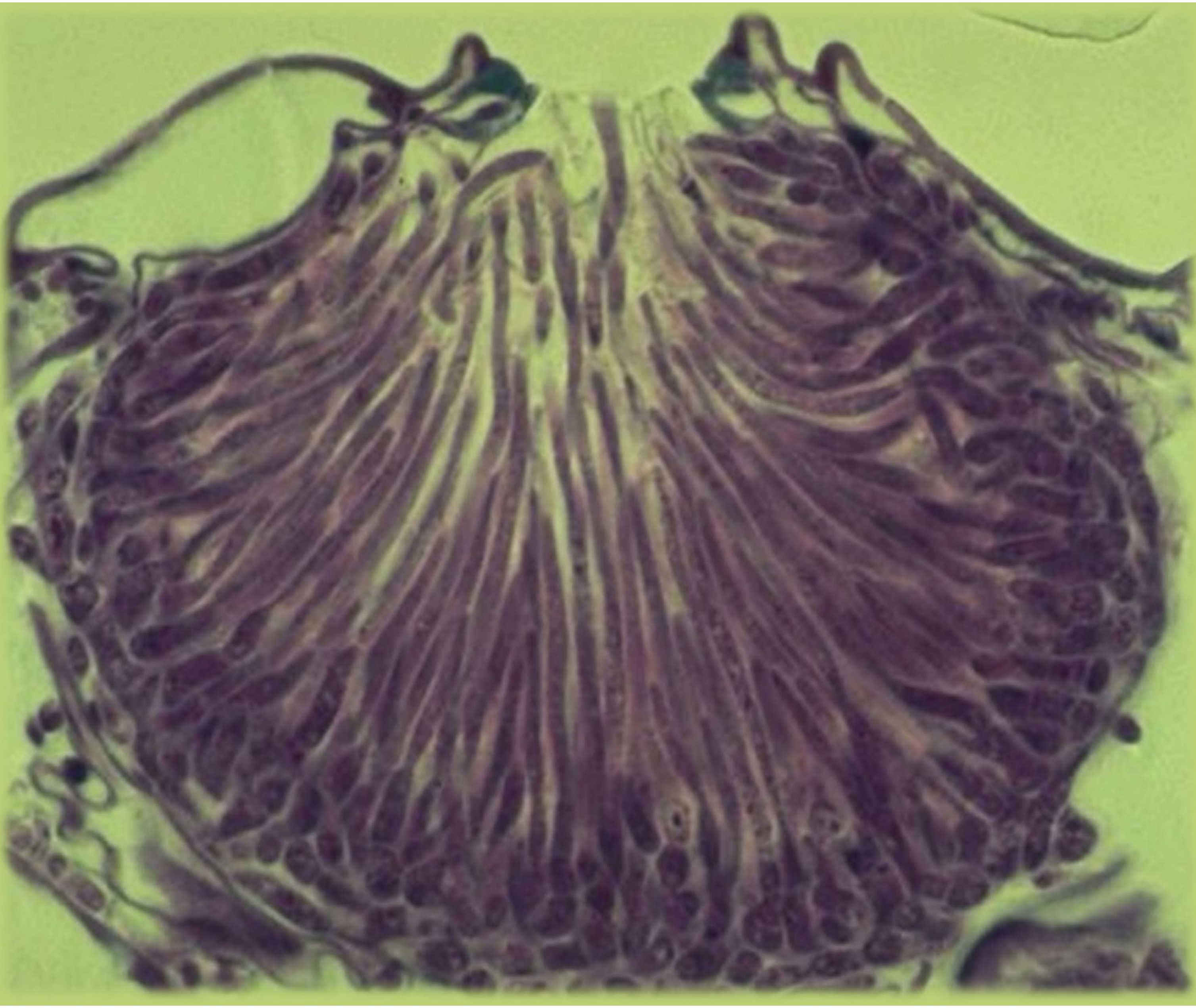
Key words: phylogeny, *Puccinia striiformis*, resistance, spelt wheat, stripe rust, *Triticum aestivum* ssp. *spelta*, yellow rust

Summary

Theories on the origin and dissemination of spelt wheat (*Triticum aestivum ssp. spelta*) are evaluated. Recent information on resistance to yellow rust (*Puccinia striiformis* Westend. f. sp. *tritici*) and variation for gliadin patterns in spelt wheat accessions originating from Iran and Europe is superimposed on literature reports concerning the origin, status and dissemination of spelt wheat. The data support the theory on the origin of spelt wheat in the Near East. An alternative European site of origin, albeit improbable, cannot be excluded.

Introduction

Spelt wheat, *Triticum aestivum* (L.) Thell. ssp. *spelta* (L.) Thell. (Kimber & Sears, 1983) or *T. spelta* L. (Kimber & Sears, 1987), is a primitive hexaploid wheat with a brittle rachis and adherent glumes, long spike internodes and non-spherical seeds, which are controlled by the pleiotropic spelt factor (*Q*/*q*), and factors for ear compactness (*C*/*c*) and seed form (S_1/s_1), respectively. Therefore, its genotype has been designated as $qqccS_1S_1$ (McIntosh, 1983). During evolutionary processes mutations materialized, eventually resulting in bread wheat (*T. aestivum* L., $QQCCS_1S_1$). The question most popular (a.o. Harlan, 1981). The area of cultivation of the crop has been confined to Europe. According to Gradmann (1909; cited by Harlan, 1981) the acreage of spelt wheat exceeded bread wheat in the first decade of this century. In 1930 it was still a major constituent (40%) of the Middle-European wheat growing area, ranging from the North-West Alps, where its former importance is recognized in village names like 'Dinkelbühl' ('Dinkel' is the German word for spelt wheat), and parts of Austria up to the Black Forest in Germany and North-East France, where its cultivation is already known for some 900 years (Flaksberger, 1930). According to Zeven & de Wet (1982) the



Specificiteit

TABLE 4. Adjusted pycnidia (*P*) response matrix of experiment 1; 24 host accessions and 50 *Mycosphaerella graminicola* isolates, arranged according to the clusters of Figure 2[v]

	Cultivars[x]																							
	D	D	D	D	B	B	B	B	B	B	T	B	B	B	B	B	B	B	B	B	B	B	B	B
EC[w]	Vo	Et	Ca	In	KZ	KU	K7	Co	To	Ia	Be	BL	Ar	Bo	KK	Ve	Ob	T29	La	Ce	Ge	Sh	KT	Ol
TK5[y]	53	50	41	40	−2[z]	−2	−2	−2	−1	−2	−2	−2	−2	−2	−2	11	−2	0	−2	−2	−2	−2	0	−1
NL5	1	1	1	1	8	4	3	1	2	1	1	1	4	5	1	5	8	25	11	9	1	2	30	6
NL1	−1	−1	−1	0	8	0	0	−1	2	−1	−1	0	7	3	−1	7	10	21	20	14	−1	12	20	18
BU2	1	1	1	1	8	5	8	12	20	6	1	4	5	1	1	25	15	23	21	23	35	21	27	17
ET11	0	0	1	3	0	0	0	2	4	0	0	0	10	0	0	1	26	34	32	17	36	25	27	14
NL4	−2	−2	0	−2	−2	6	8	−2	−2	−1	−2	−2	5	−1	−1	−2	32	17	17	5	16	3	45	0
NL6	0	0	0	7	14	22	26	1	21	2	0	5	7	11	1	0	44	14	20	24	35	15	35	9
NL3	−1	−1	−1	0	2	0	0	−1	0	1	−1	−1	25	−1	−1	−1	38	4	1	32	48	0	18	0
ET10	20	9	10	21	0	1	0	14	53	19	1	9	0	0	2	59	38	57	39	34	64	55	9	1
ET9	4	2	1	5	21	26	39	28	35	8	1	5	1	1	19	2	9	14	40	41	54	55	14	2
ET5	2	2	12	11	1	2	1	9	21	13	1	4	1	1	6	1	2	4	39	21	52	52	7	2
KE7	3	4	3	3	14	8	21	21	21	4	3	5	3	5	4	3	7	11	23	30	34	29	29	26
KE3	5	4	4	5	11	7	9	17	20	5	4	4	4	4	4	4	14	8	34	28	45	28	27	27
KE1	2	3	2	4	4	3	9	16	9	2	2	6	2	6	2	2	6	7	29	18	32	27	36	20
KE6	1	0	1	1	12	5	10	14	15	0	0	8	0	0	7	0	21	6	33	35	12	34	33	33
UR4	0	−1	0	0	19	11	14	12	15	0	0	1	0	0	1	0	11	16	33	32	43	37	46	33
KE4	0	0	3	0	19	10	23	20	34	0	0	4	0	1	3	0	18	14	35	31	36	36	37	45
KE8	0	0	1	1	4	11	16	22	36	0	0	5	10	2	1	0	10	22	50	40	40	47	44	35
KE5	−1	−1	−1	−1	16	12	42	19	27	1	−1	1	1	2	−1	0	20	13	43	28	39	43	64	30
ET6	10	0	5	14	23	28	39	31	32	1	0	4	0	22	4	1	14	38	41	37	39	43	38	32
UG1	0	0	0	0	19	25	44	30	36	2	0	0	0	0	6	0	9	27	36	35	38	51	34	25
RW1	0	−1	0	15	31	37	40	25	43	0	0	0	0	1	2	1	17	39	34	43	34	47	63	32
TK8	1	2	9	16	23	28	42	12	51	5	1	8	4	7	7	1	41	38	53	22	38	44	73	1
TK2	1	1	1	1	1	6	8	19	16	4	1	2	1	2	1	4	3	37	40	21	36	40	33	29
BU1	−1	−4	−1	−4	19	9	10	31	33	0	−1	0	−1	7	−1	18	10	38	43	43	49	47	42	35
ET7	1	0	10	12	10	24	14	30	24	7	−1	0	11	16	0	40	4	28	51	30	39	47	40	37
ET4	0	1	7	4	11	19	36	2	26	5	0	3	2	9	3	28	51	45	34	14	29	45	37	25
ET1	0	−1	1	6	14	14	39	9	22	8	0	1	9	7	1	45	43	52	43	25	41	43	44	30
ET3[y]	10	0	2	8	11	13	24	6	29	1	0	0	6	16	9	21	51	40	51	25	46	50	58	19
ET2	0	0	4	4	19	21	26	12	16	17	0	1	4	20	22	30	39	40	54	44	43	57	52	23
TK10	0	0	3	1	14	12	47	17	14	4	0	0	0	0	30	35	53	40	22	31	58	33	0	0
NL2	−3	0	1	6	42	25	44	6	28	1	0	5	30	27	8	45	54	55	14	31	9	43	61	45
TK7	1	1	2	14	22	19	31	5	16	1	1	26	1	2	3	15	16	41	54	42	37	36	52	30
KE2	0	0	0	0	31	22	39	2	18	0	0	10	7	7	7	12	37	36	47	38	46	42	42	41
ET8	0	3	1	1	10	19	21	1	16	2	1	1	1	20	22	12	23	25	40	39	34	26	34	29
AR5	7	0	0	7	8	38	30	4	3	2	1	15	0	38	20	1	20	40	41	35	26	48	35	43
AR2	2	2	2	2	10	32	41	3	12	6	4	12	3	29	35	7	37	46	64	56	53	60	54	54
TK3	1	0	1	21	1	1	1	12	20	8	2	19	26	9	1	1	34	66	55	43	54	47	72	29
TK4	4	4	5	28	4	4	4	19	31	17	3	33	23	9	3	6	38	62	69	59	67	53	66	33
AR3	−1	−1	0	−1	−1	−1	−1	0	0	16	−1	10	27	1	−1	40	24	58	57	54	65	52	64	51
AR4	2	2	2	2	2	2	2	8	10	28	2	9	24	18	2	41	22	48	44	54	68	54	57	48
TK9	0	0	0	1	0	0	0	1	5	2	0	0	7	1	0	22	20	57	54	47	57	52	57	29
AR6	−2	−2	−2	−1	−2	−1	1	0	0	14	−2	4	6	−1	−2	16	27	12	30	36	43	42	44	27
UR2	3	6	3	8	3	3	3	5	3	12	3	4	24	8	3	13	42	41	32	41	50	50	47	30
TK1	3	1	14	16	11	8	7	11	37	9	2	13	31	2	2	32	46	33	54	57	50	49	51	33
TK6	2	2	5	4	2	2	2	14	12	10	2	6	3	9	2	28	33	44	22	15	52	51	61	54
AR1	4	3	3	3	4	4	3	4	4	4	3	15	5	25	3	7	12	23	26	34	45	43	39	38
UR1	0	0	0	4	0	0	0	0	1	0	0	3	0	18	0	0	0	26	30	36	45	48	61	47
UR5	−3	−3	−3	5	−3	−3	−3	14	5	−3	−3	0	−3	15	−3	16	20	25	21	39	34	48	60	45
UR3	2	1	1	13	1	1	1	8	11	1	6	25	2	20	1	8	22	45	45	52	43	66	62	44

[v] $LSD_{0.01} = 20$, $LSD_{0.05} = 15$.
[w] Experimental codes for isolates according to Table 2.
[x] Experimental codes for cultivars according to Table 1; B = bread wheat, D = durum wheat, and T = triticale.
[y] Durum wheat-derived isolates.
[z] Negative values are because of block adjustments.

Kema et al., Phytopathol. 1996[a,b]
Kema & van Silfhout, Phytopathol. 1997

IPO323

<u>Septoria</u> <u>tritici</u> No. 323x

vindplaats: W. Brabant, boer Claassen
oogst : 6-5-1981
waarnemer: Daamen
gewas : tarwe
ras : Arminda wt
plantdeel : blad
datum isol: 7-5-'81, W. Veenbaas, isol.nr. 810507/1
det. : IPO

10 <u>vriesdroogbuisjes</u> dd. 20-5-1981
contrôle 1e buisje: zeer goede spor., geen bact.
12/1.'82 1 b. van Ingrid Vos, over 9 buisjes. open op 26-1-'82 gebruikt voor de schudcultuur. Wel roze/grijs van kleur, stug. maakt aparte zwarte en roze kolonies.
15-5-'86 5 vriesdroogbuisjes. Contrôle: heel mooi.

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Kema et al., Curr. Genet. 1996

nature genetics
LETTERS
https://doi.org/10.1038/s41588-018-0052-9

Stress and sexual reproduction affect the dynamics of the wheat pathogen effector AvrStb6 and strobilurin resistance

Gerrit H. J. Kema[1,2,9]*, Amir Mirzadi Gohari[1,7,9], Lamia Aouini[1,9], Hesham A. Y. Gibriel[2,9], Sarah B. Ware[1,8], Frank van den Bosch[3], Robbie Manning-Smith[3], Vasthi Alonso-Chavez[3], Joe Helps[3], Sarrah Ben M'Barek[4], Rahim Mehrabi[5], Caucasella Diaz-Trujillo[1,2], Elham Zamani[6], Henk J. Schouten[1], Theo A. J. van der Lee[1], Cees Waalwijk[1], Maarten A. de Waard[2], Pierre J. G. M. de Wit[2], Els C. P. Verstappen[1], Bart P. H. J. Thomma[2], Harold J. G. Meijer[1] and Michael F. Seidl[2]

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RESEARCH ARTICLE

Finished Genome of the Fungal Wheat Pathogen *Mycosphaerella graminicola* Reveals Dispensome Structure, Chromosome Plasticity, and Stealth Pathogenesis

Stephen B. Goodwin, Sarrah Ben M'Barek, Braham Dhillon, Alexander H. J. Wittenberg, Charles F. Crane, James K. Hane, Andrew J. Foster, Theo A. J. Van der Lee, Jane Grimwood, Andrea Aerts, John Antoniw, Andy Bailey, Burt Bluhm, Judith Bowler, Jim Bristow, Ate van der Burgt, Blondy Canto-Canché, Alice C. L. Churchill, Laura Conde-Ferràez, Hans J. Cools, Pedro M. Coutinho, Michael Csukai, Paramvir Dehal, Pierre De Wit, Bruno Donzelli, Henri C. van de Geest, Roeland C. H. J. van Ham, Kim E. Hammond-Kosack, Bernard Henrissat, Andrzej Kilian, Adilson K. Kobayashi, Edda Koopmann, Yiannis Kourmpetis, Arnold Kuzniar, Erika Lindquist, Vincent Lombard, Chris Maliepaard, Natalia Martins, Rahim Mehrabi, Jan P. H. Nap, Alisa Ponomarenko, Jason J. Rudd, Asaf Salamov, Jeremy Schmutz, Henk J. Schouten, Harris Shapiro, Ioannis Stergiopoulos, Stefano F. F. Torriani, Hank Tu, Ronald P. de Vries, Cees Waalwijk, Sarah B. Ware, Ad Wiebenga, Lute-Harm Zwiers, Richard P. Oliver, Igor V. Grigoriev, Gert H. J. Kema [view less]

#1000 - 2023

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A thousand-genome panel retraces the global spread and adaptation of a major fungal crop pathogen

Alice Feurtey, Cécile Lorrain, Megan C. McDonald, Andrew Milgate, Peter S. Solomon, Rachael Warren, Guido Puccetti, Gabriel Scalliet, Stefano F. F. Torriani, Lilian Gout, Thierry C. Marcel, Frédéric Suffert, Julien Alassimone, Anna Lipzen, Yuko Yoshinaga, Christopher Daum, Kerrie Barry, Igor V. Grigoriev, Stephen B. Goodwin, Anne Genissel, Michael F. Seidl, Eva H. Stukenbrock, Marc-Henri Lebrun, Gert H. J. Kema, Bruce A. McDonald & Daniel Croll

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Els Verstappen

Sarah B Ware
2006

Rahim Mehrabi
2006

Sarrah Ben M'Barek
2011

Mahmod Ghaffary
2011

Amir Mirzadi
2015

Lamia Aouini
2017

Hisham Gibriel
2019

De *Zymoseptoria tritici* collectie

Wereldwijd ~ 3,000 isolaten

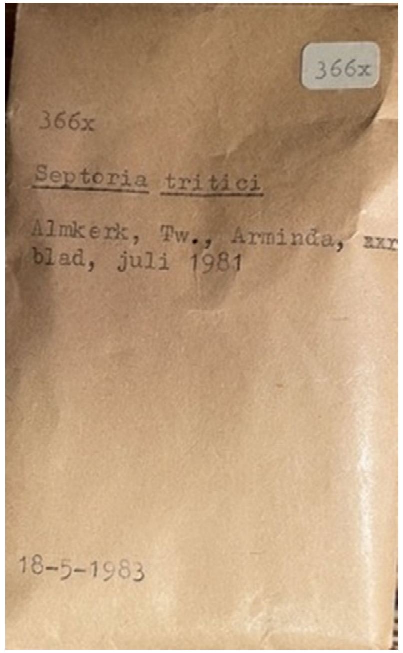
Nakomelingen ~ 4,400 isolaten

“Historische” collectie (1972-1984)

85 isolaten

GMOs ~ 200 isolaten

Anders ~ 10 isolaten



Gevriesdroogd

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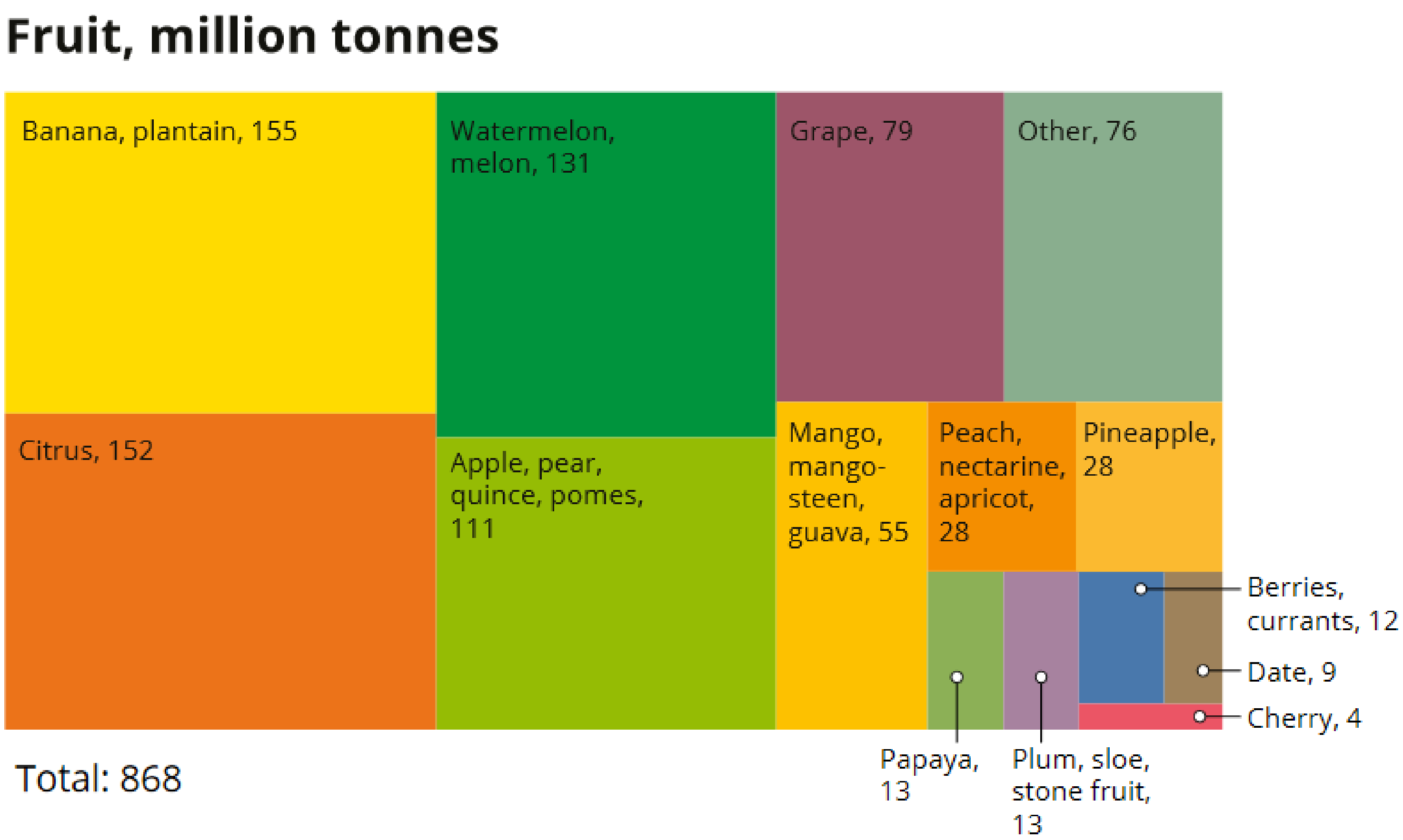
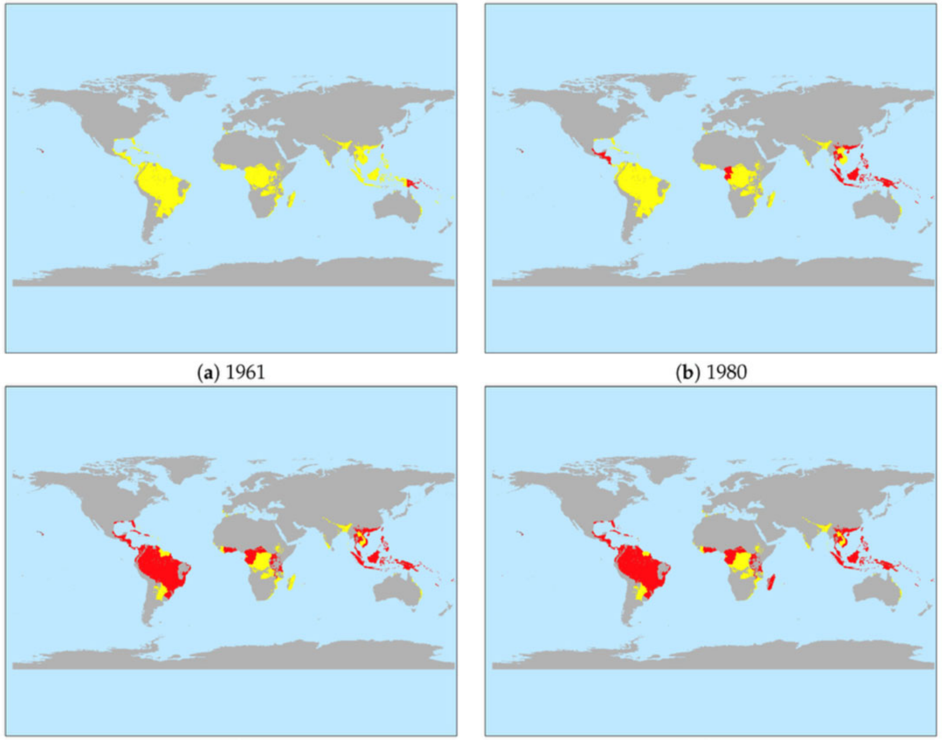
Het belang van banaan (85/15 = lokaal/export)



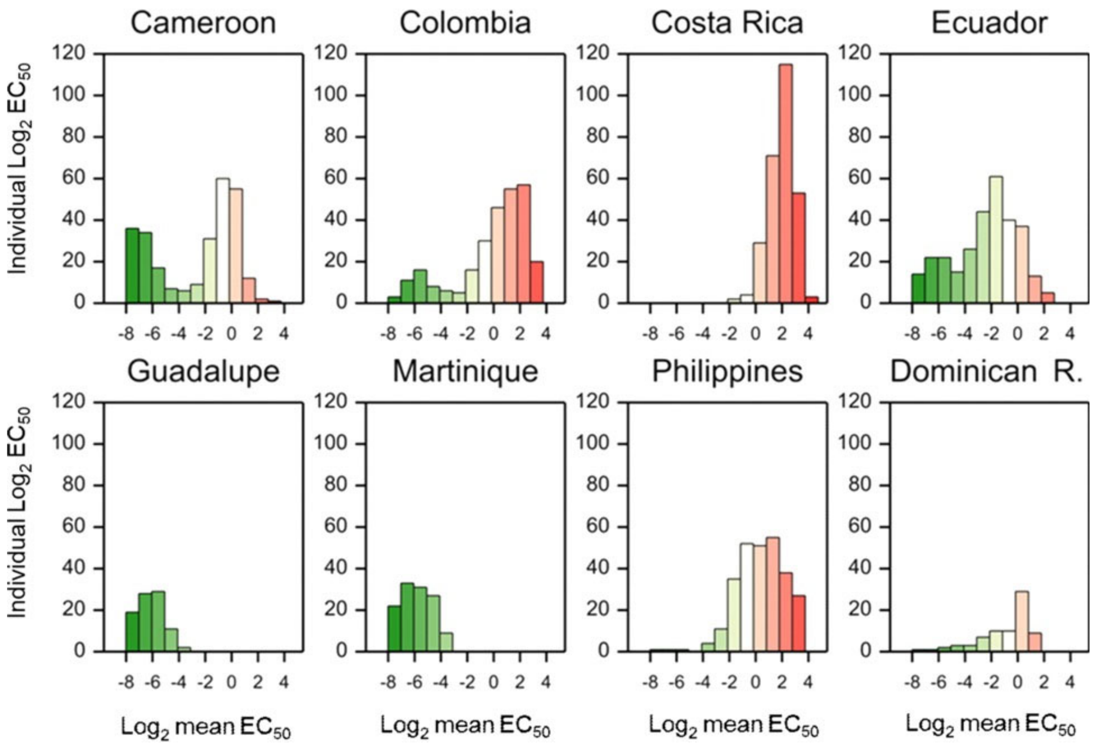
Black Sigatoka – *Pseudocercospora fijiensis*



(a) 1961 (b) 1980

(c) 1999 (d) 2016

Bananenteelt afhankelijk van fungiciden



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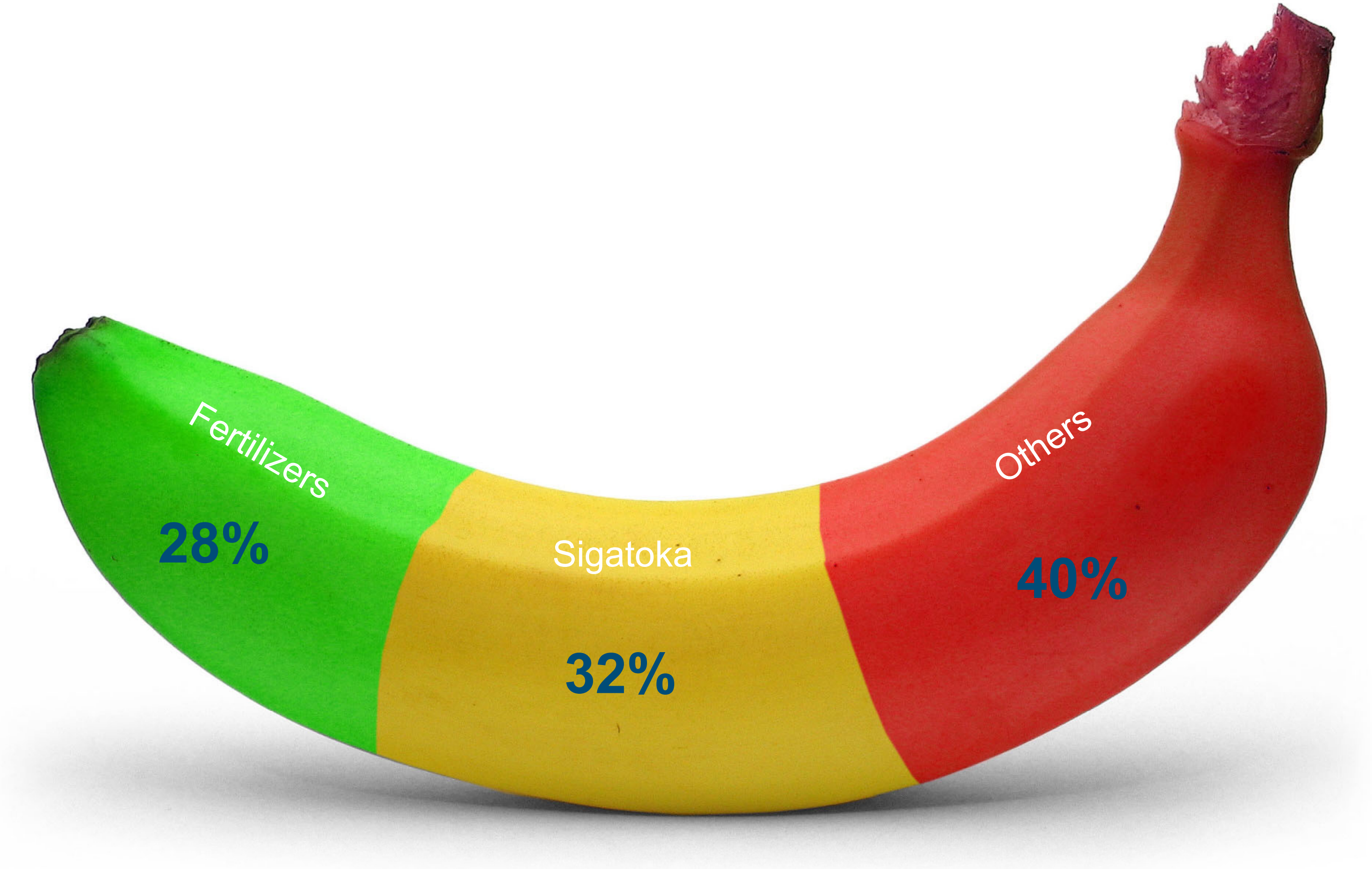
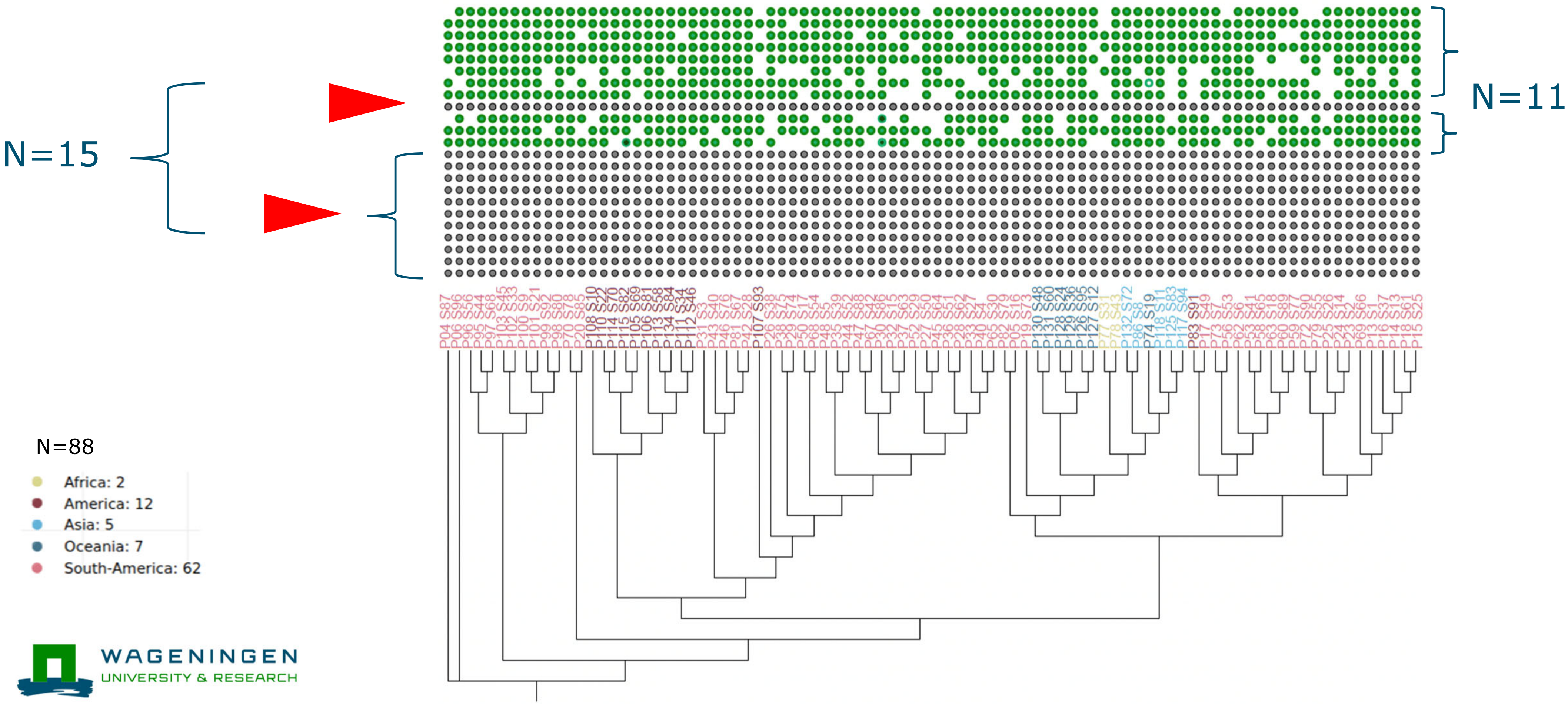

Fertilizers
28%
Sigatoka
32%
Others
40%

Af/aanwezigheid van chromosomen is onafhankelijk van phylogenie of oorsprong



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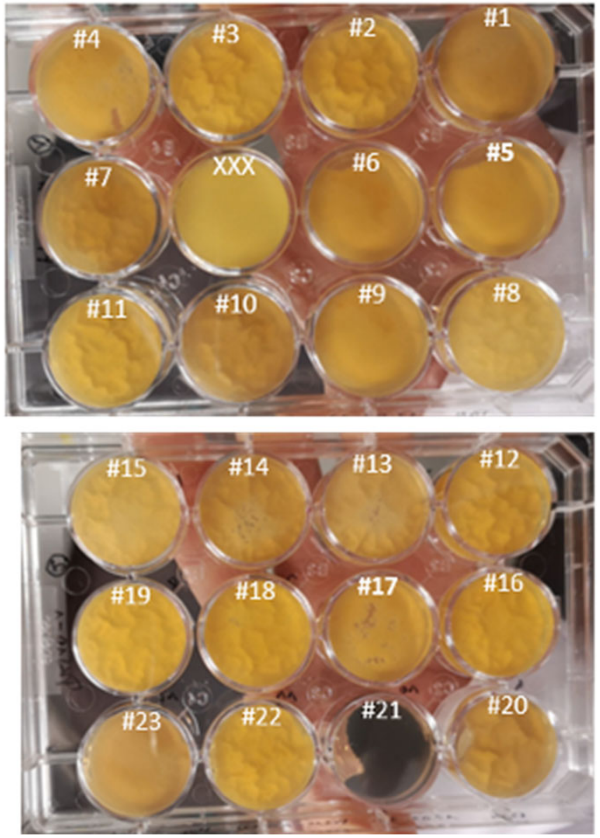
CRISPR in *Pseudocercospora fijiensis*

Target gene	Transformation efficiency
Fus3-like	41,7%
PKS7-1	18,2%
PKS8-1	59,1%
PKS8-2	14,3%
PKS10-1	95,7%
PKS10-2	38,1%



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Fusarium verwelkingsziekte van banaan

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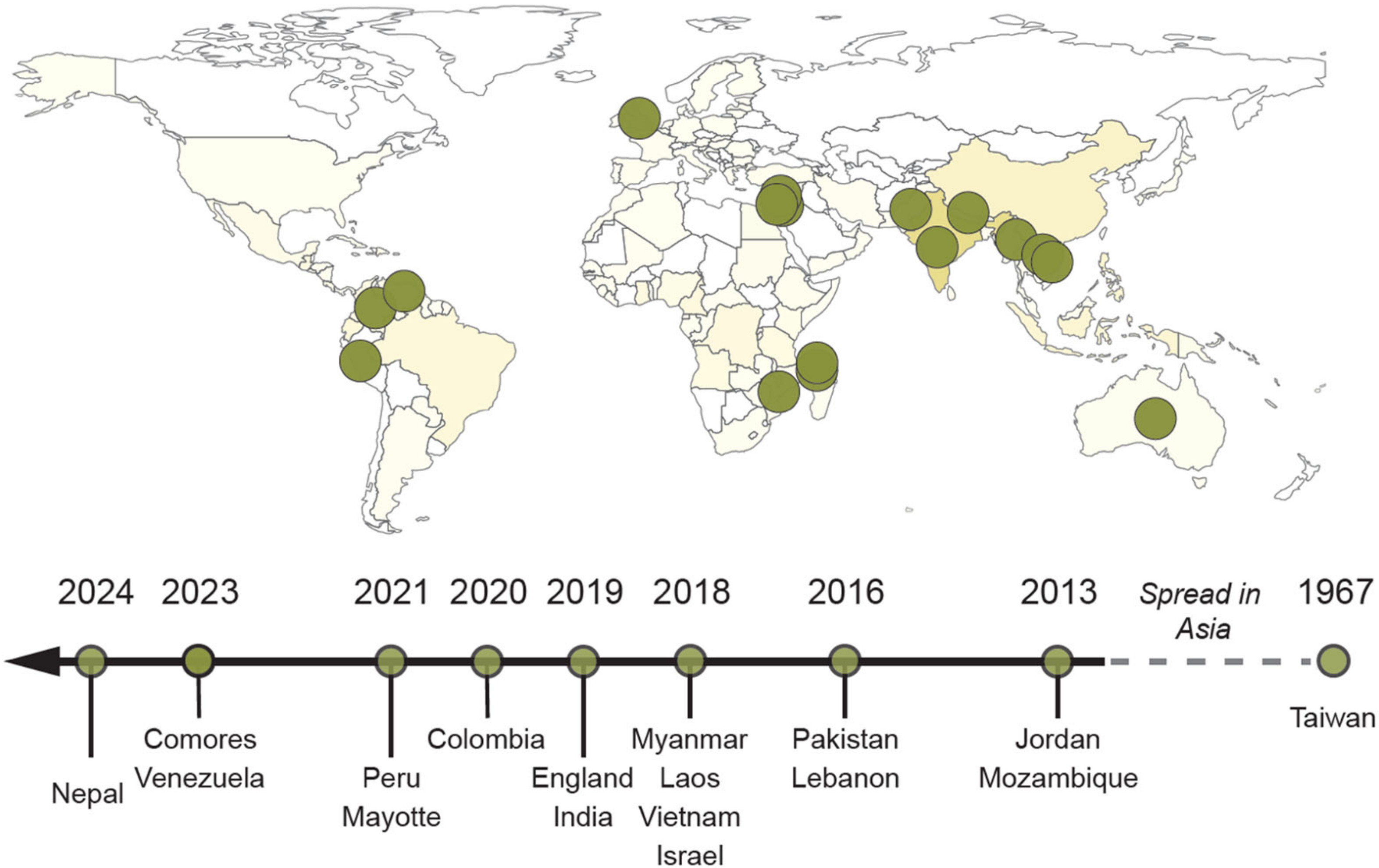
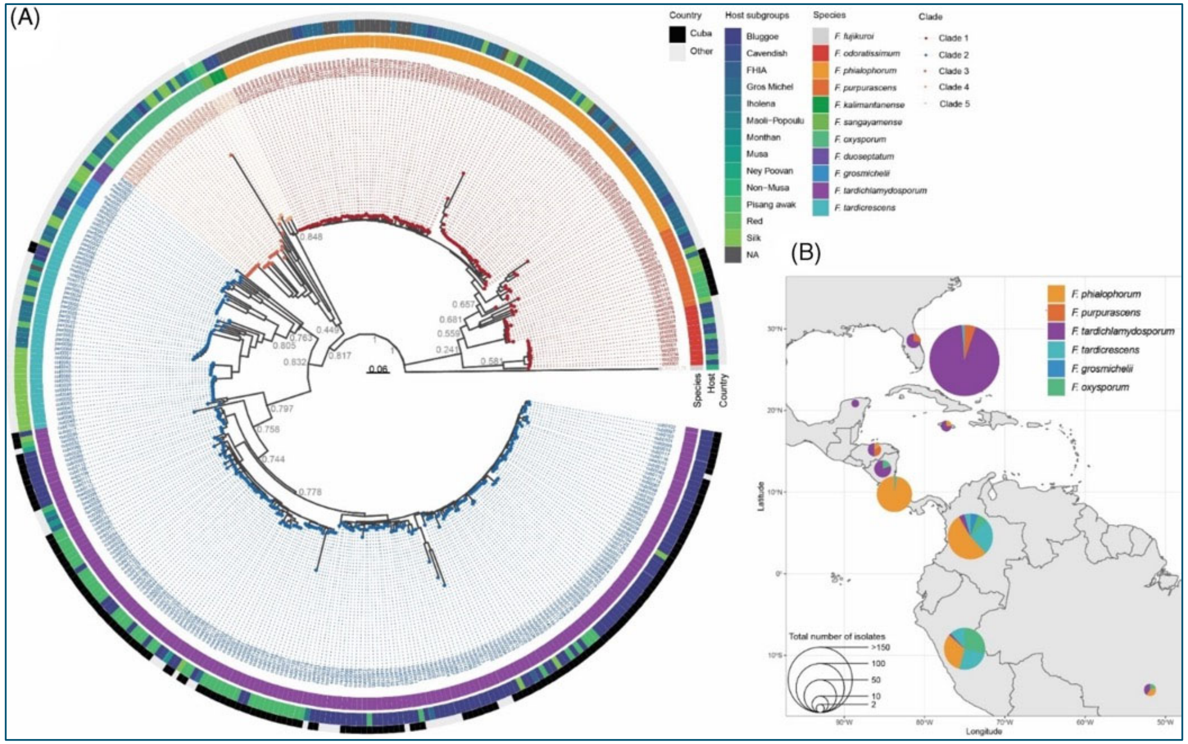
R.C. Ploetz; Honduras –disease management, ~1950

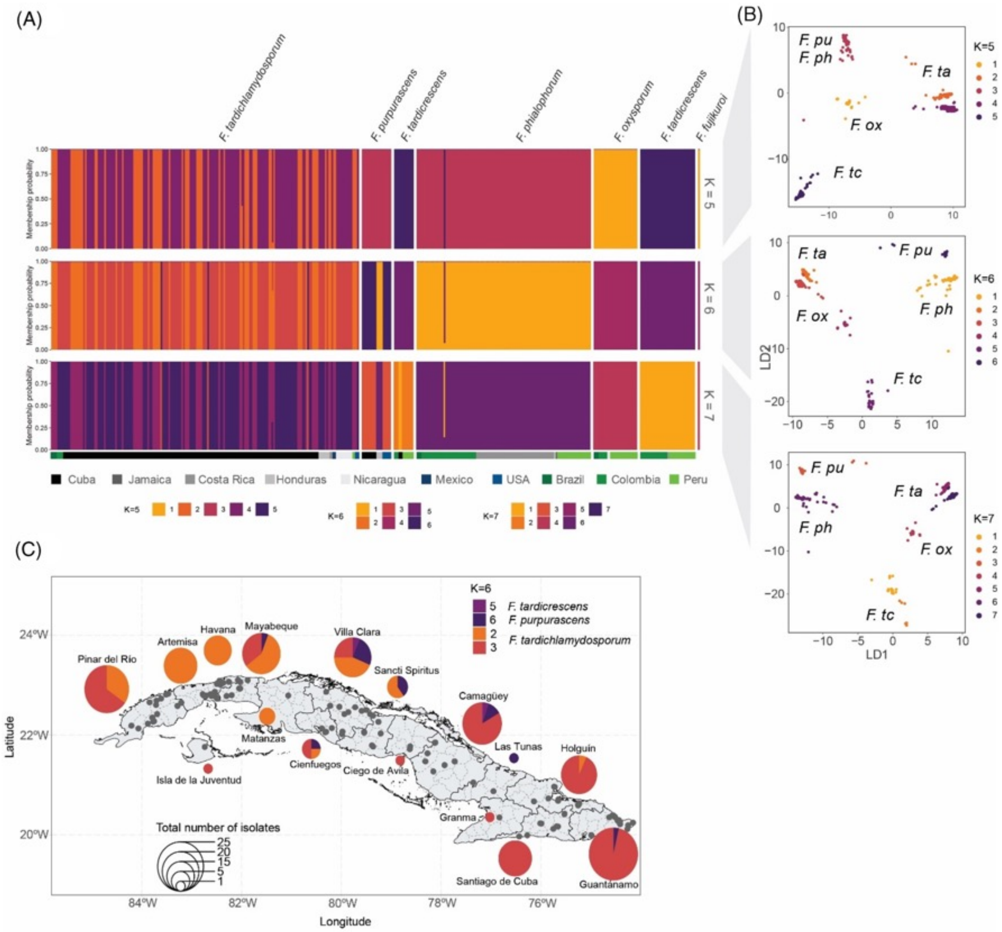
Tropical Race 4 (TR4) verspreiding sinds 1960s



WAGENINGEN UNIVERSITY & RESEARCH

Fusarium diversiteit - LAC





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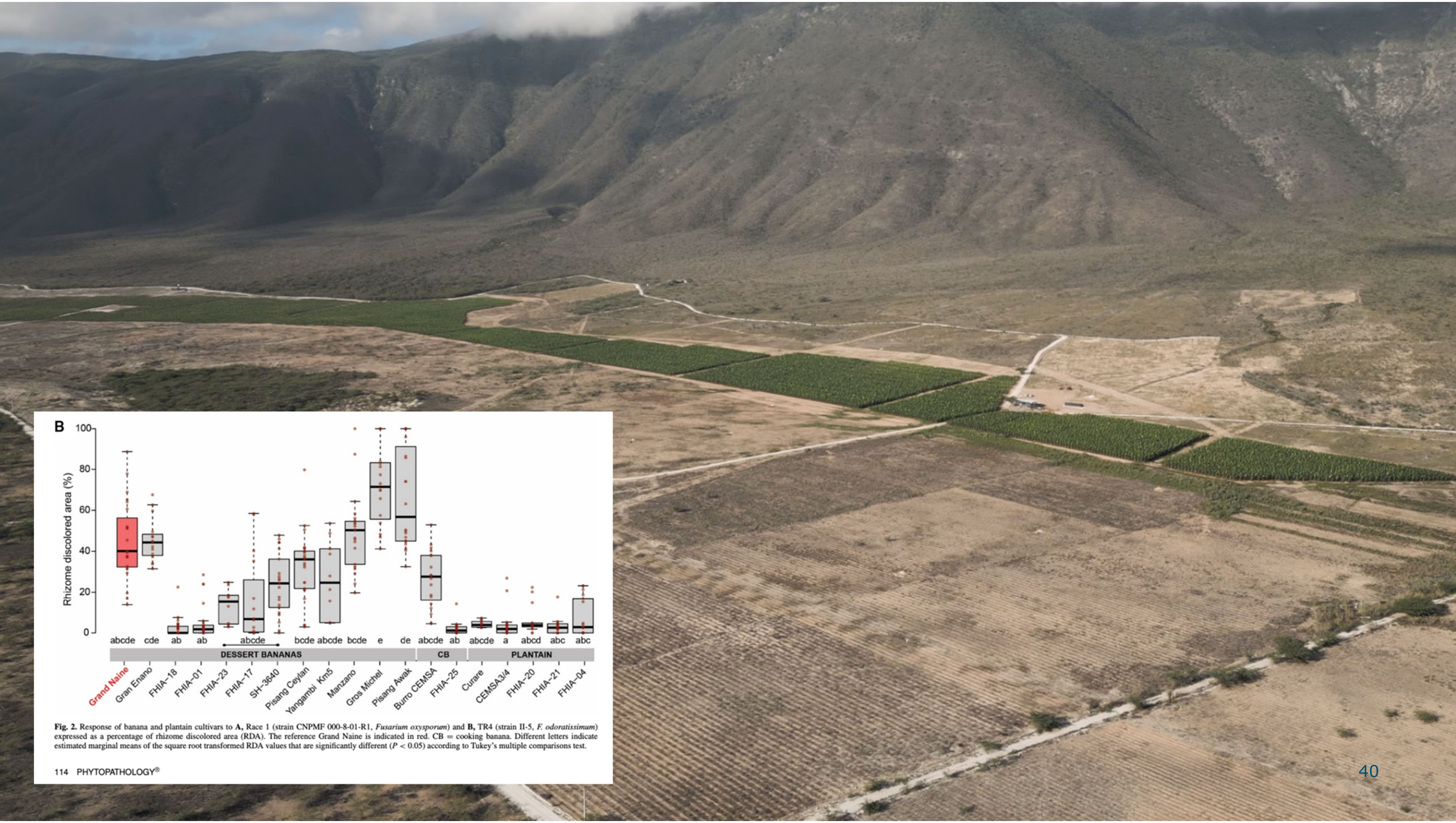
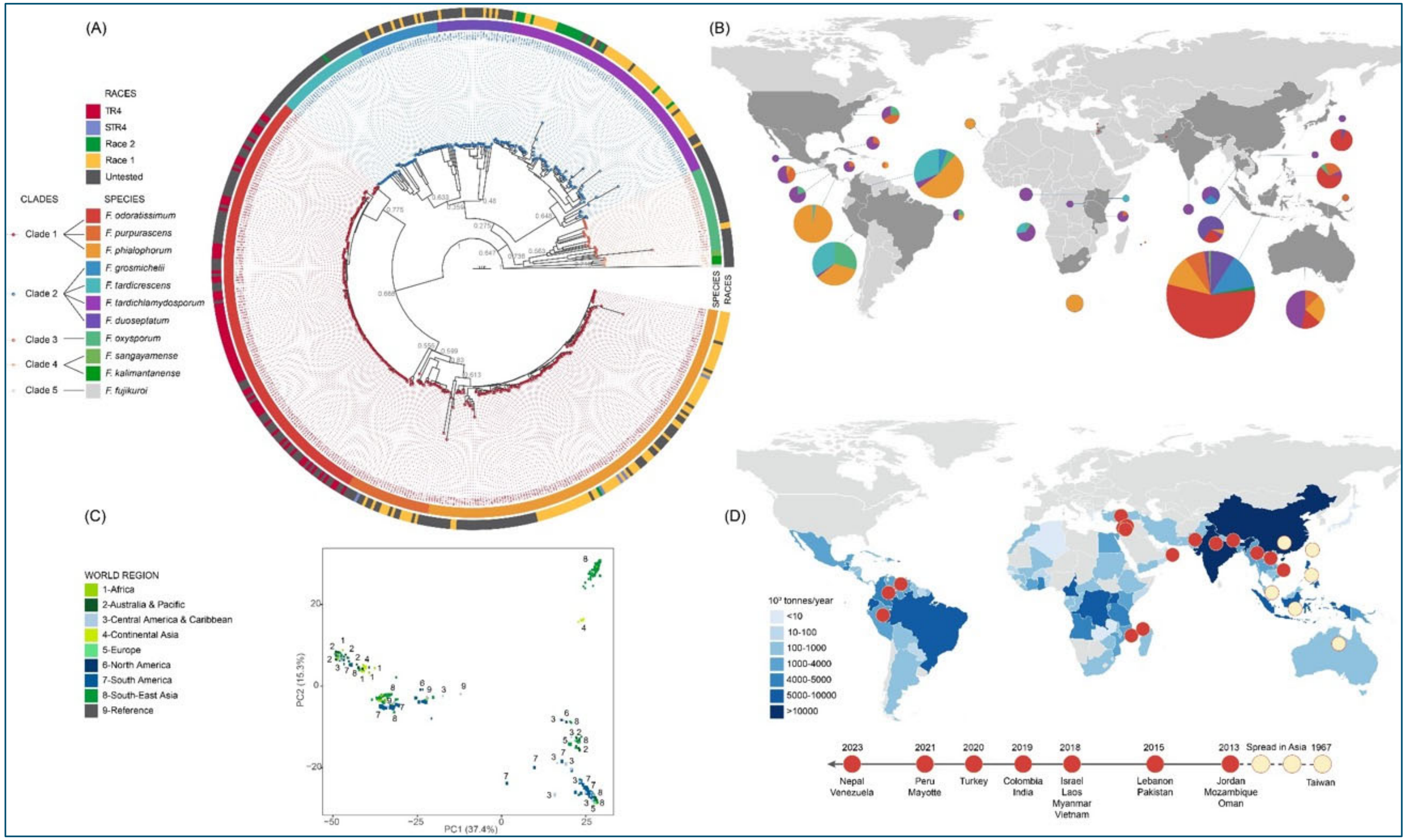
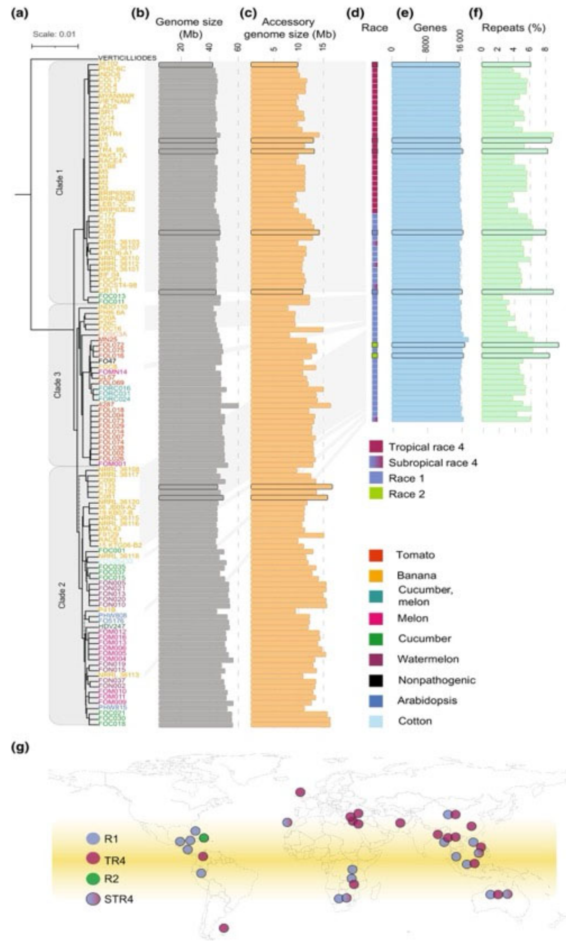


Fig. 2. Response of banana and plantain cultivars to **A,** Race 1 (strain CNPMF 000-8-01-R1, *Fusarium oxysporum*) and **B,** TR4 (strain II-5, *F. odoratissimum*) expressed as a percentage of rhizome discolored area (RDA). The reference Grand Naine is indicated in red. CB = cooking banana. Different letters indicate estimated marginal means of the square root transformed RDA values that are significantly different ($P < 0.05$) according to Tukey's multiple comparisons test.

114 PHYTOPATHOLOGY®

Fusarium diversiteit - wereld






95/21

Pablo Chong
2016

Caucasella Diaz
2018

Nani Maryani
2018

Nadia Ordóñez
2018

Maricar Salacinas
2019

Fernando Garcia
2019

Fajar Ahmad
2021

Einar Martínez de la Parte
2023

Anouk van Westerhoven

Jelmer Dijkstra

Lisanne Kottenhagen

Sen Xie

Diego Gallan

Martijn Vogelaar

Ömer Faruk Özdemir

Carolina Aguilera

Xiaoqian Shi

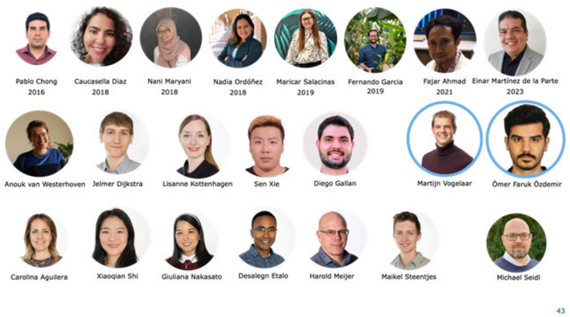
Giuliana Nakasato

Desalegn Etalo

Harold Meijer

Maikel Steentjes

Michael Seidl


Pablo Chong
2016
Caucasella Diaz
2018
Nani Maryani
2018
Nadia Ordóñez
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Maricar Salacinas
2019
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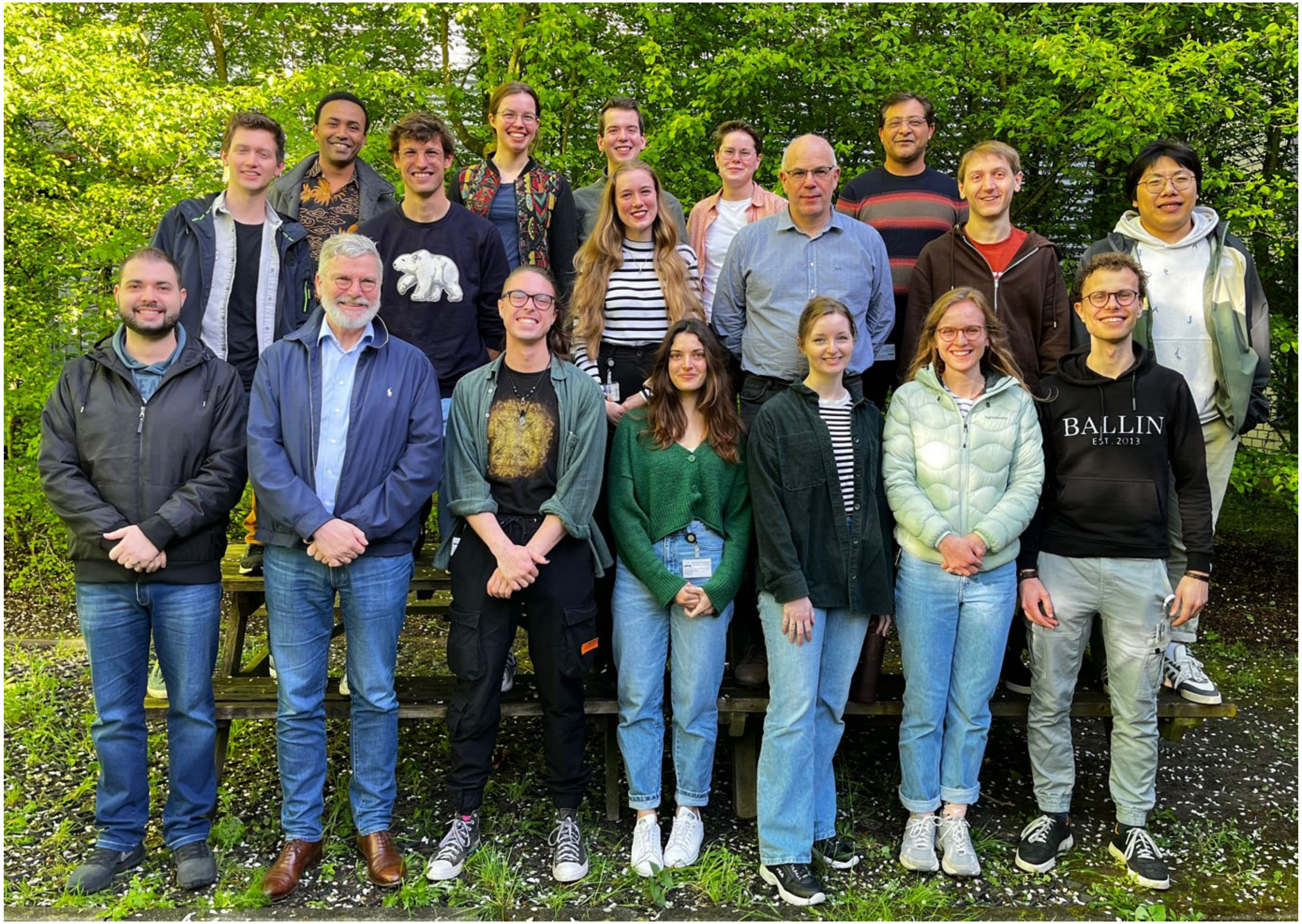
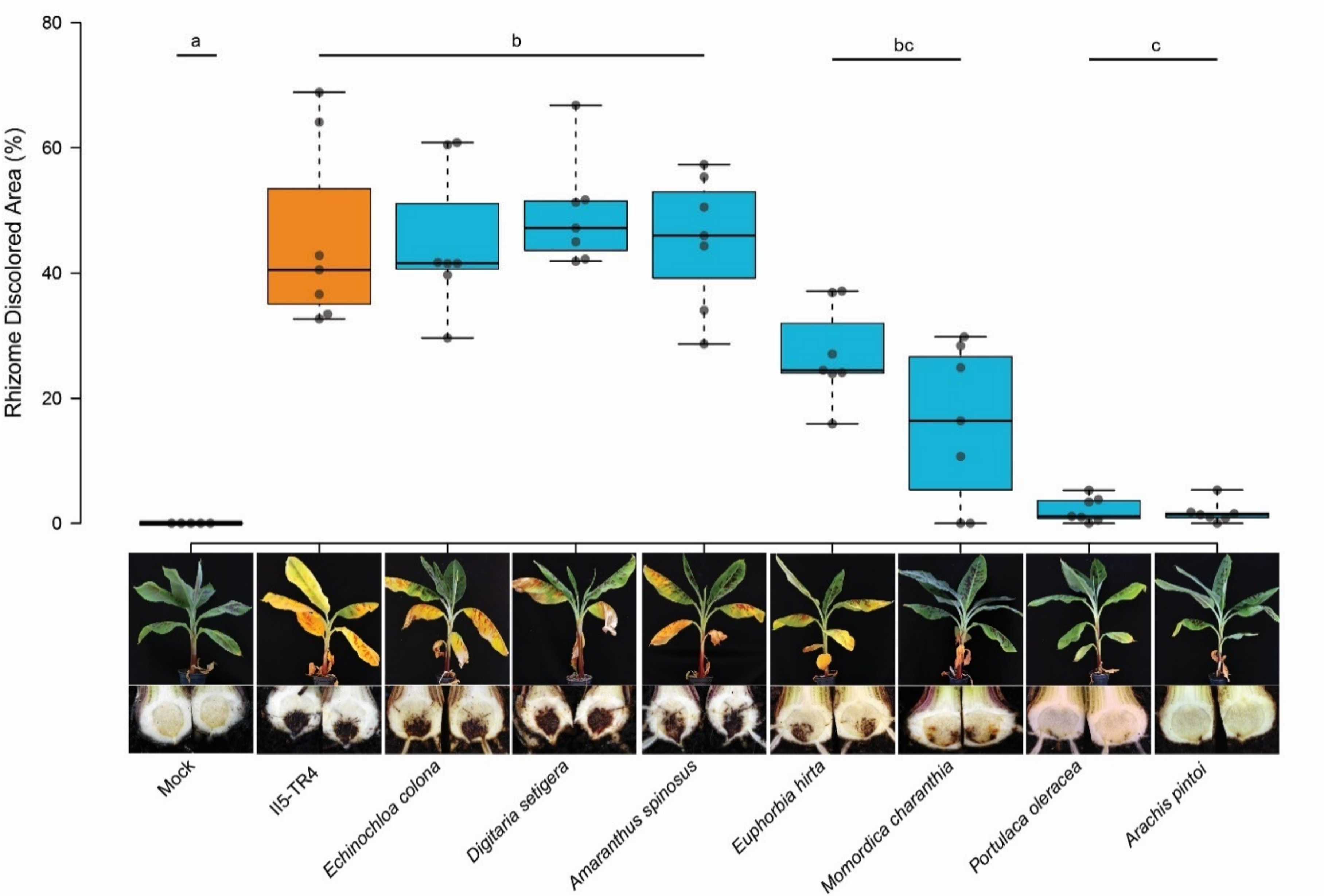
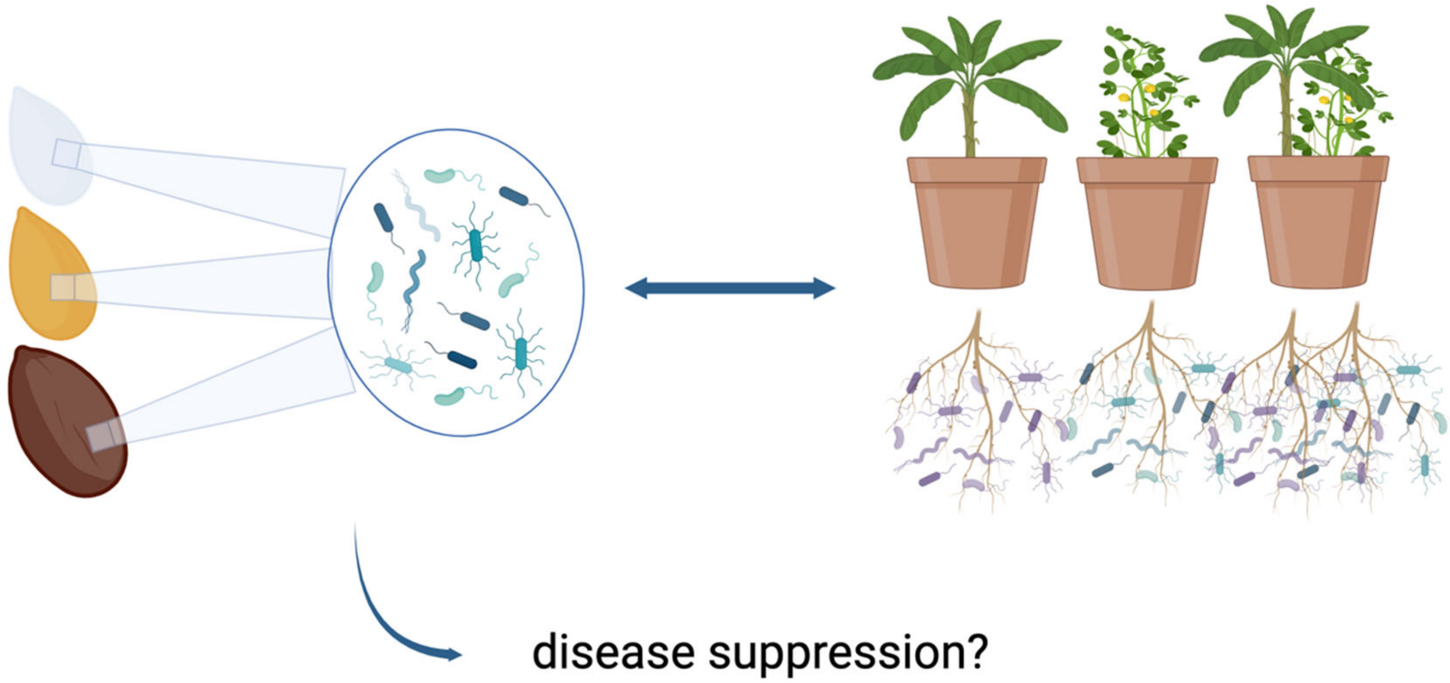
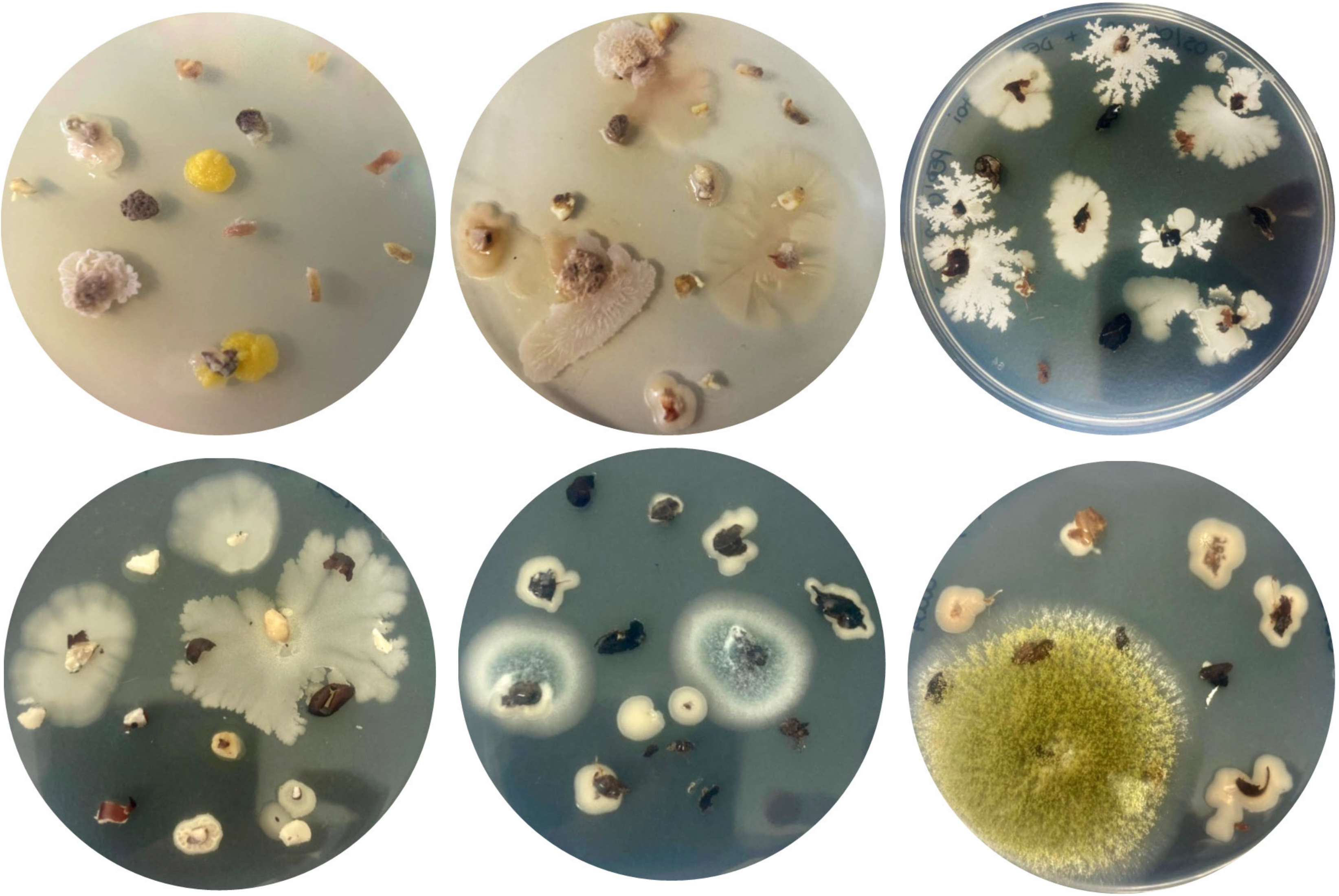
Xiaoqian Shi
Giuliana Nakasato
Desalegn Etalo
Harold Meijer
Maikel Steentjes
Michael Seidl
43


BALLIN
EST. 2013


Rhizome Discolored Area (%)
80
60
40
20
0
a
b
bc
c
Mock
II5-TR4
Echinochloa colona
Digitaria setigera
Amaranthus spinosus
Euphorbia hirta
Momordica charanthia
Portulaca oleracea
Arachis pintoi

Spelen *A. pintoi* geassocieerde microben een rol in de onderdrukking van TR4?





Luisa Pinna

>100 bacterie isolaten
8 schimmel isolaten

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MOLECULAR PLANT-MICROBE INTERACTIONS
Vol. 4, No. 1, pp. 52-59, 1991

Cloning and Characterization of cDNA of Avirulence Gene *avr9* of the Fungal Pathogen *Cladosporium fulvum*, Causal Agent of Tomato Leaf Mold

Jan A. L. van Kan, Guido F. J. M. van den Ackerveken, and Pierre J. G. M. de Wit

Agricultural University Wageningen, Department of Phytopathology, 6700 EE Wageningen, The Netherlands.
Received 7 August 1990. Accepted 27 August 1990.

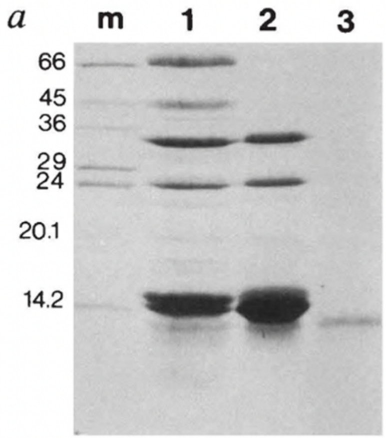
LETTERS TO NATURE

Host resistance to a fungal tomato pathogen lost by a single base-pair change in an avirulence gene

Matthieu H. A. J. Joosten, Ton J. Cozijnsen & Pierre J. G. M. De Wit*

Department of Phytopathology, Wageningen Agricultural University, PO Box 8025, 6700 EE Wageningen, The Netherlands

HOST genotype specificity in interactions between biotrophic pathogens and plants in most cases complies with the gene-for-gene model[1]; success or failure of infection is determined by absence or presence of complementary genes, avirulence and resistance genes,



KeyGene

Yelloway

A Chiquita innovation partnership

Anker Sørensen

Rahim Mehrabi

Fernando Garcia

Reza Talebi

Andrew Biles - Chiquita

Paul Smits - MusaRadix

Hanneke Hermans
MusaRadix
WUR
JII

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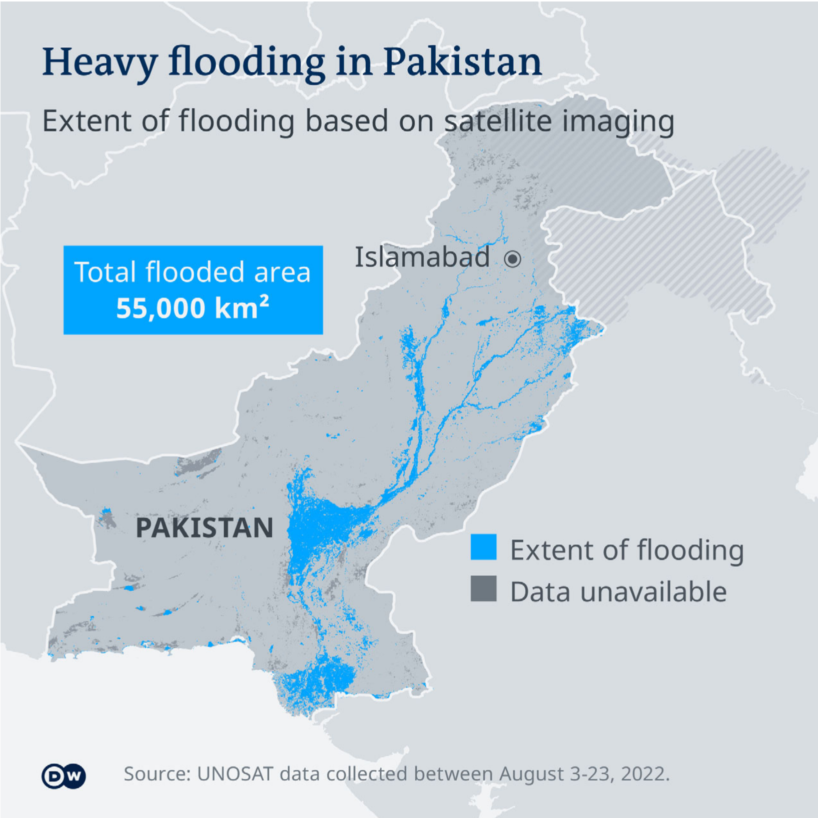
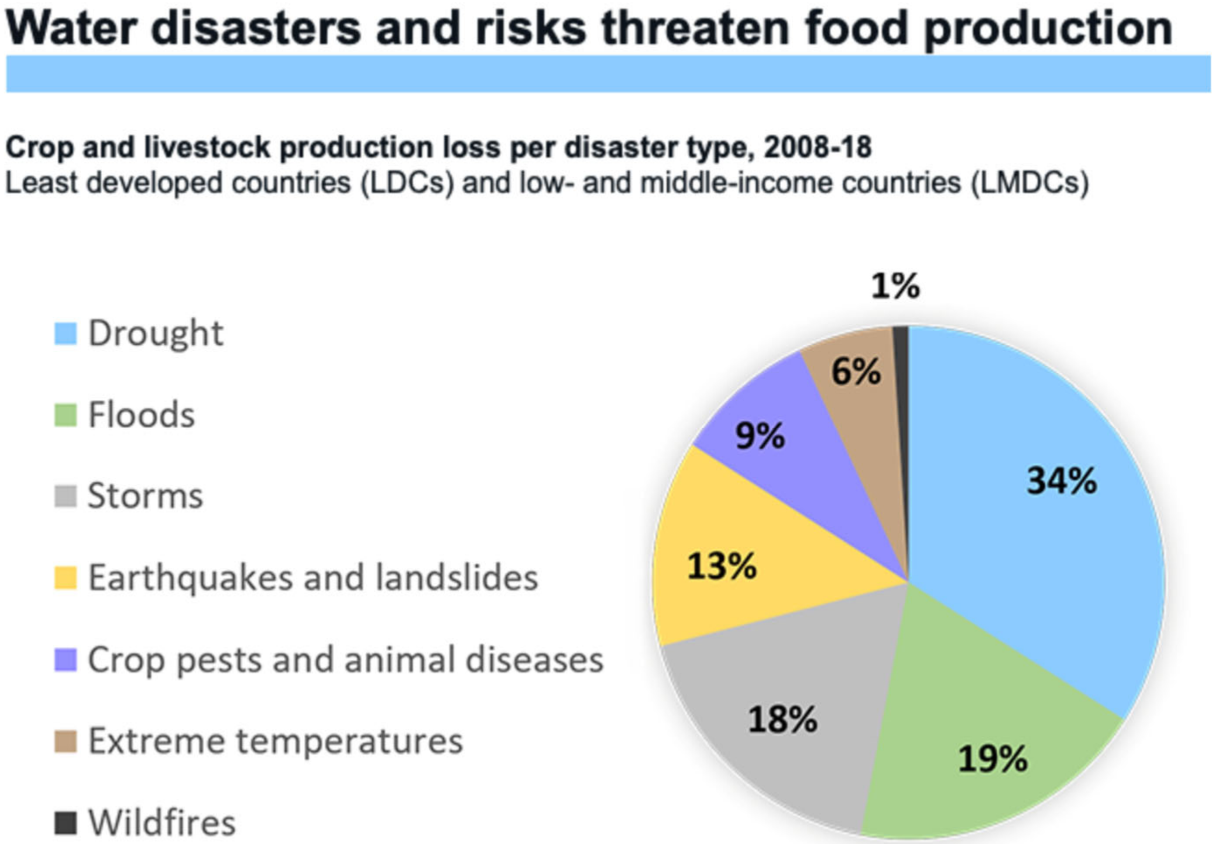
OECD - 2022





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Orkaan Pablo (Bopha) – Mindanao, 2012

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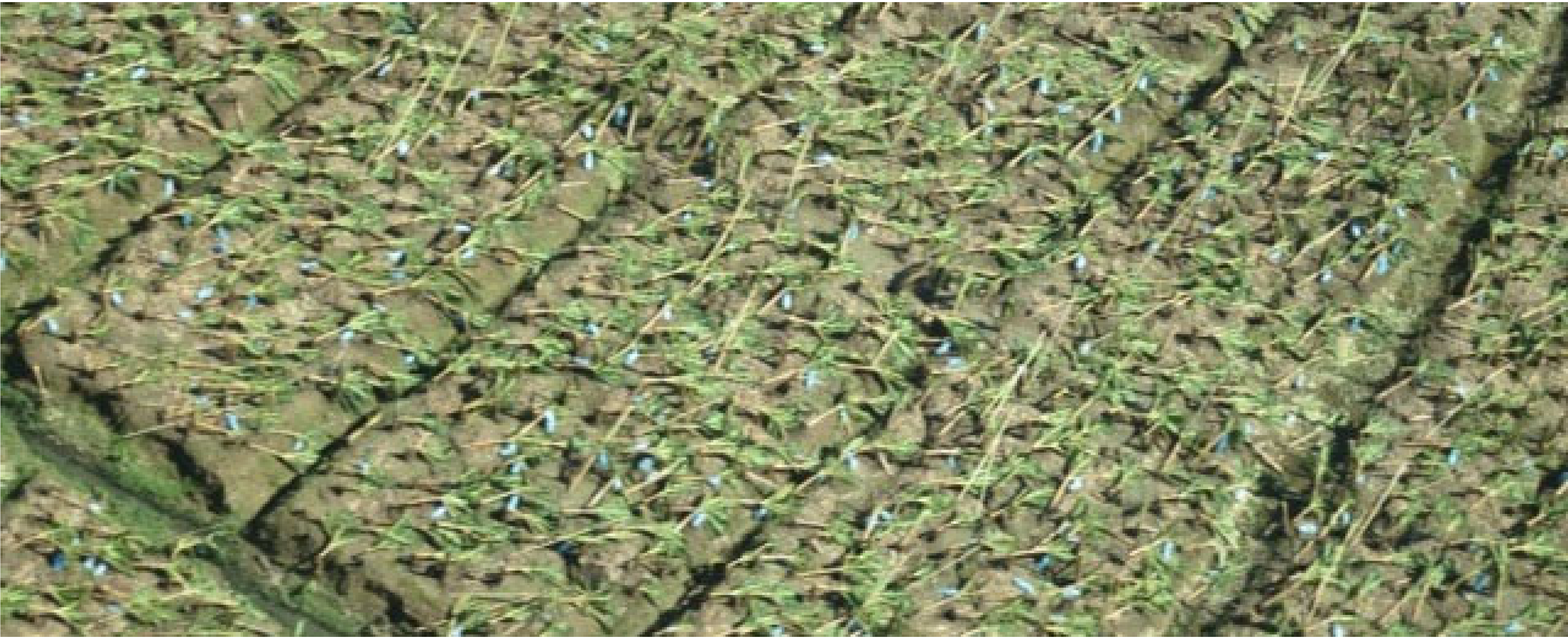

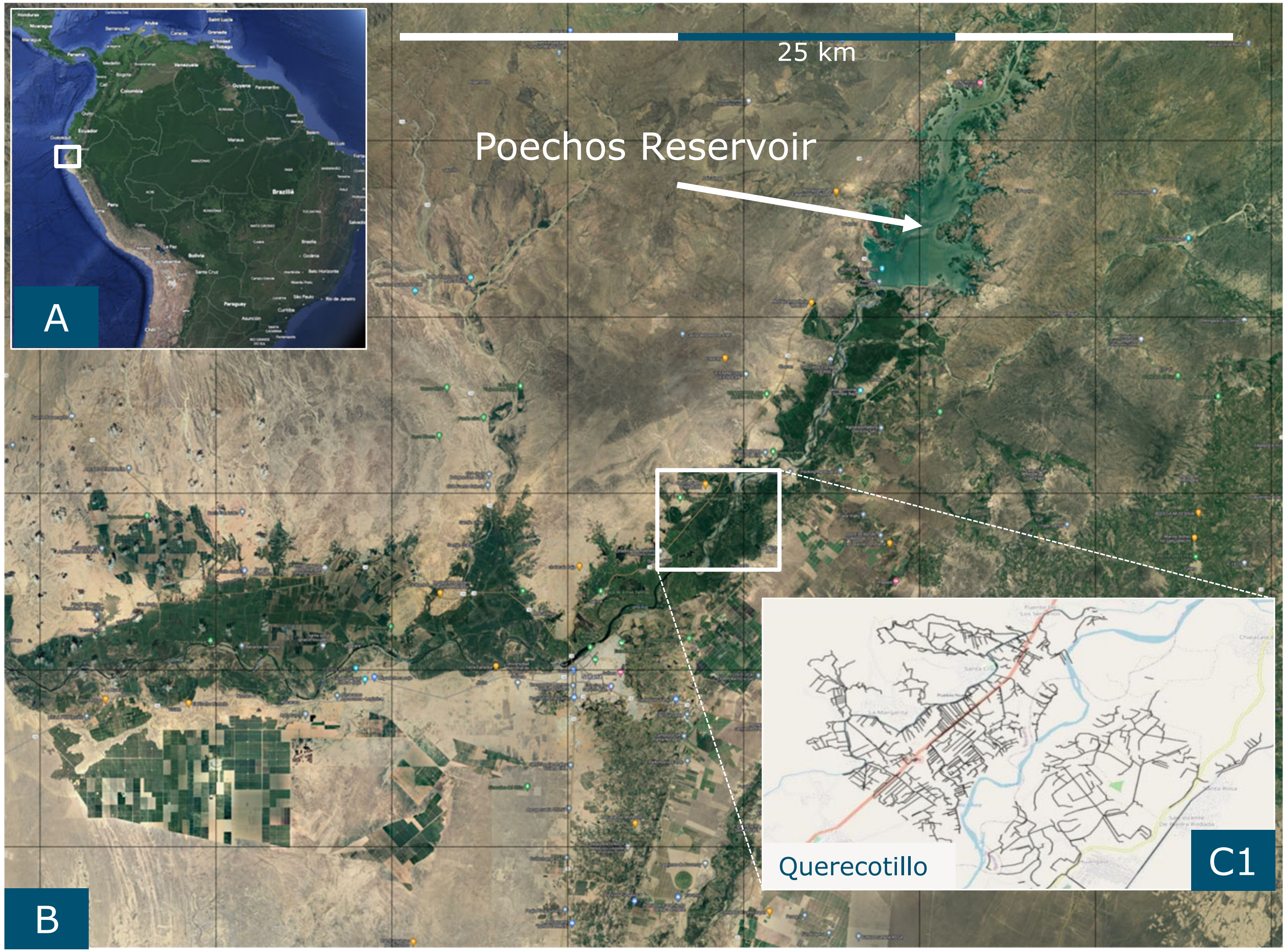

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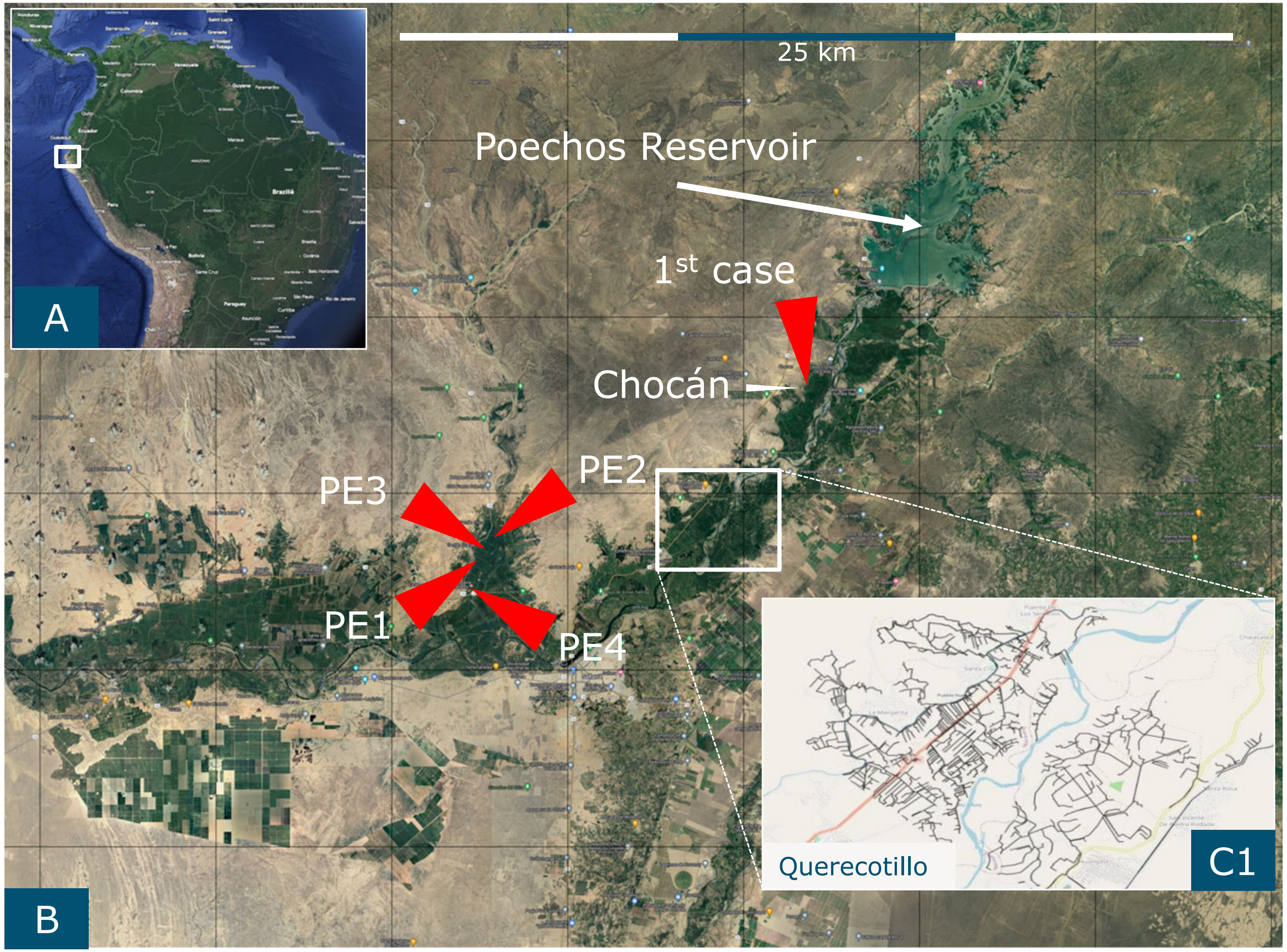

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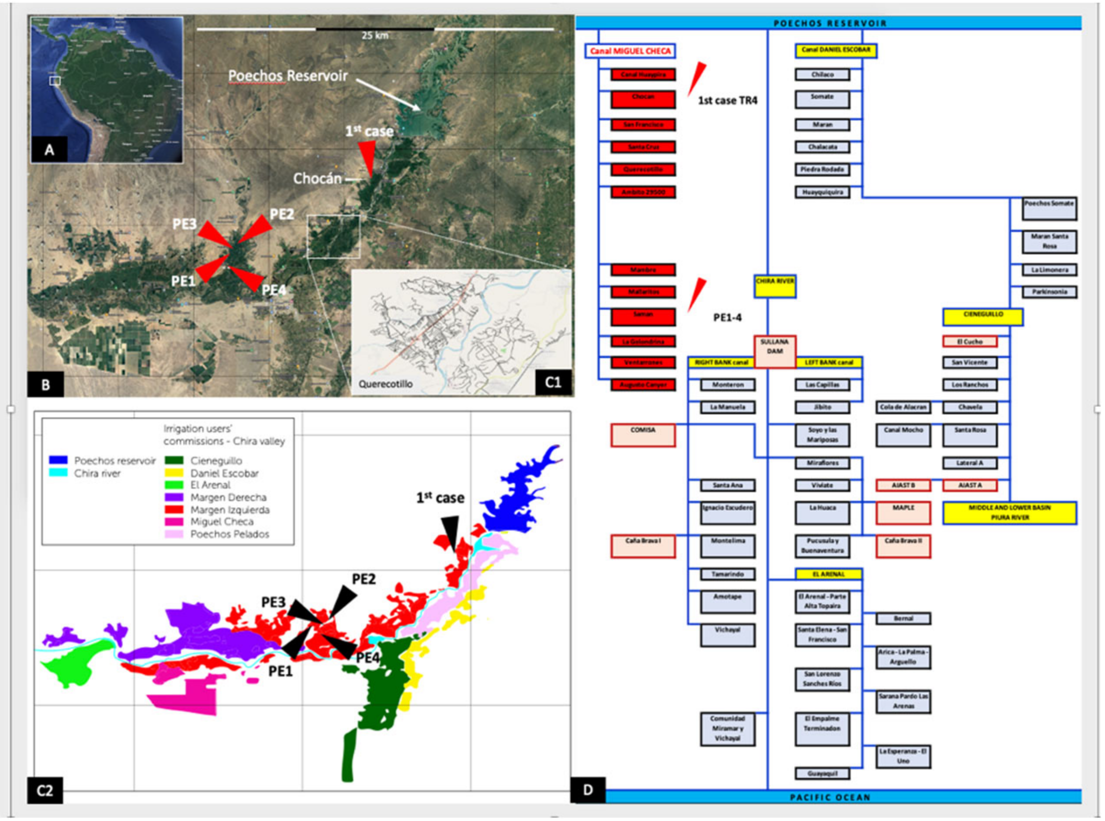
Orkaan Yaku, maart 2023



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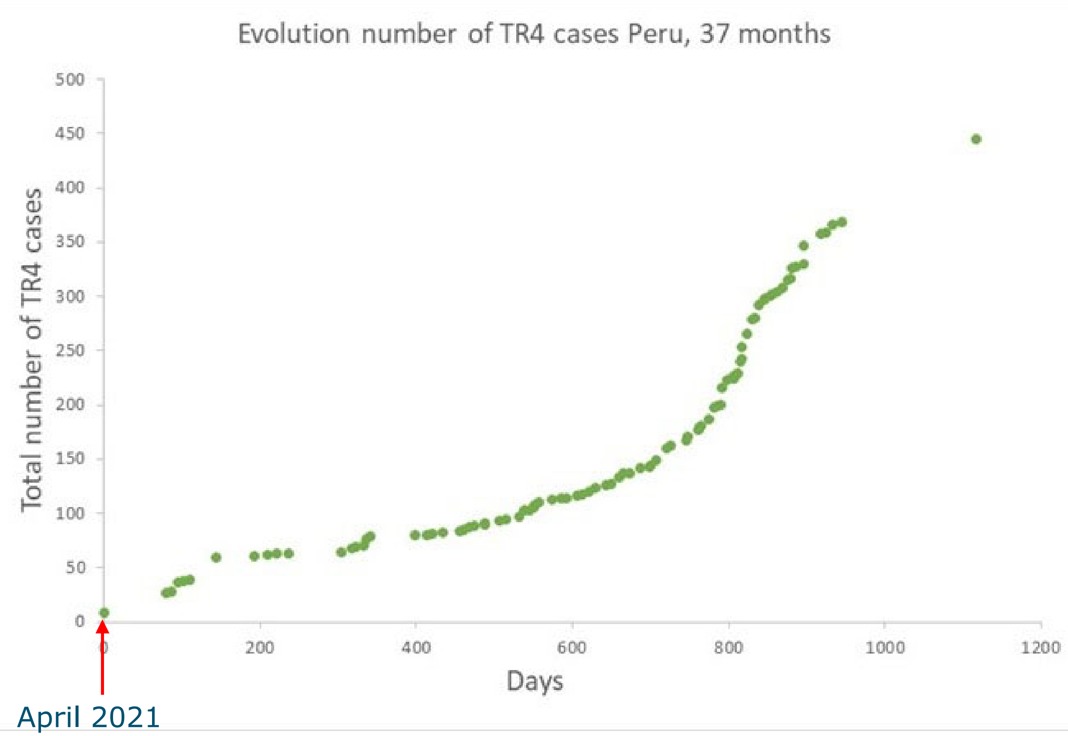
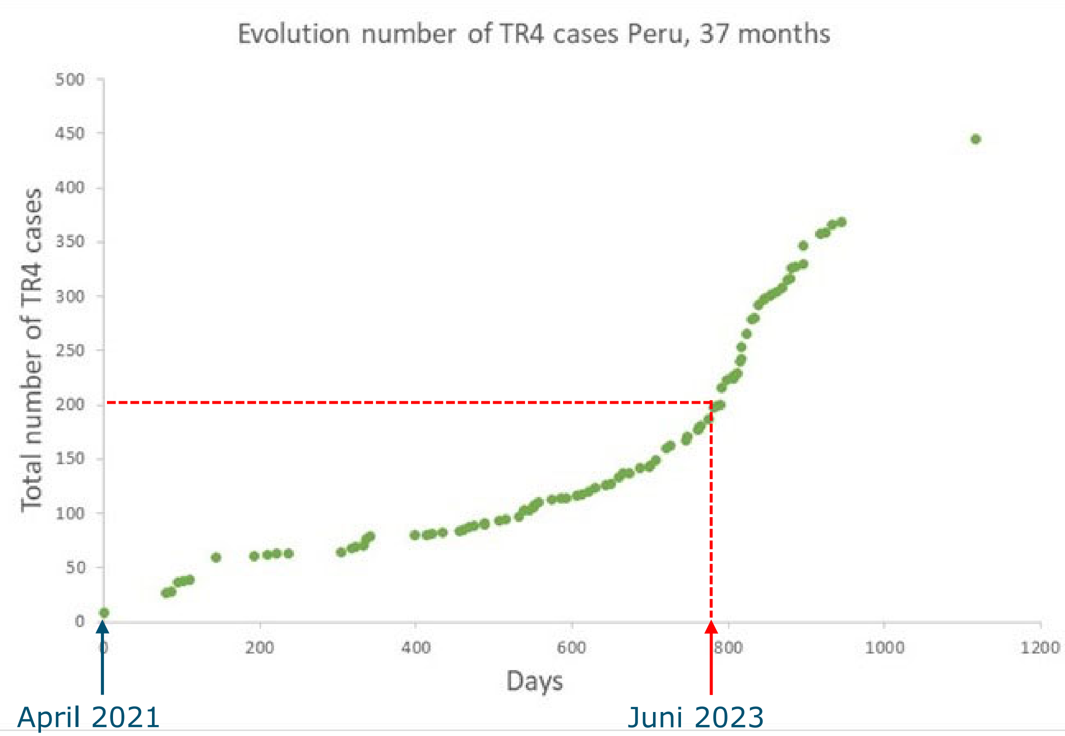
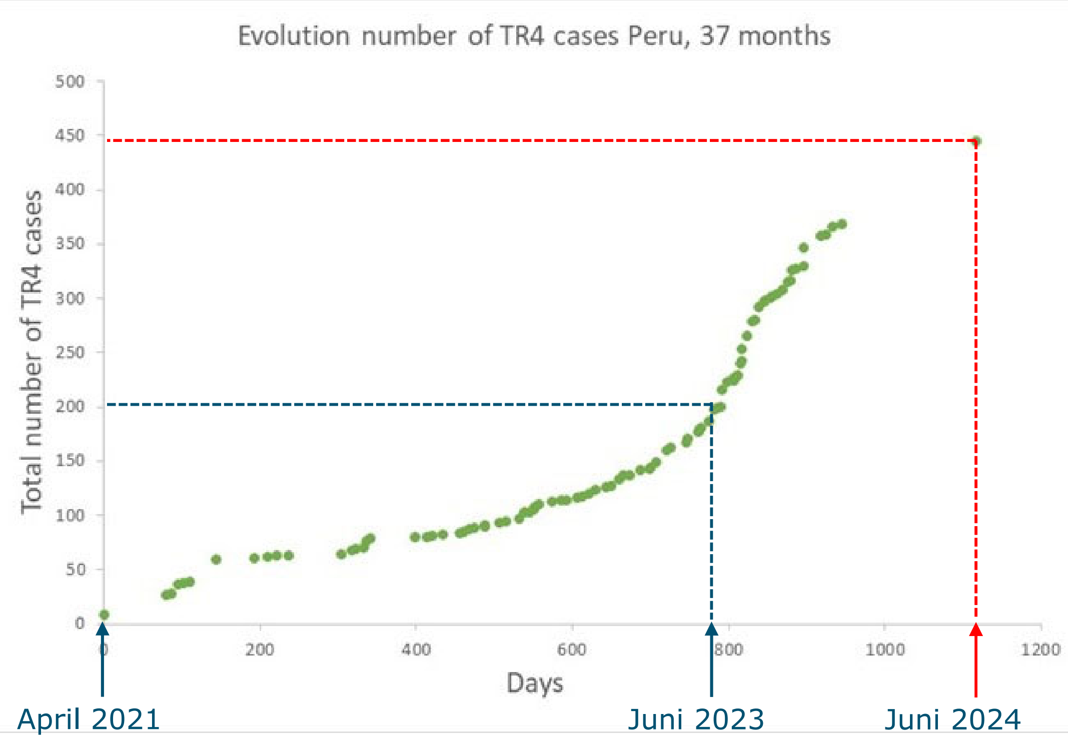
Orkaan Yaku, maart 2023



Orkaan Yaku, maart 2023



Orkaan Yaku, maart 2023



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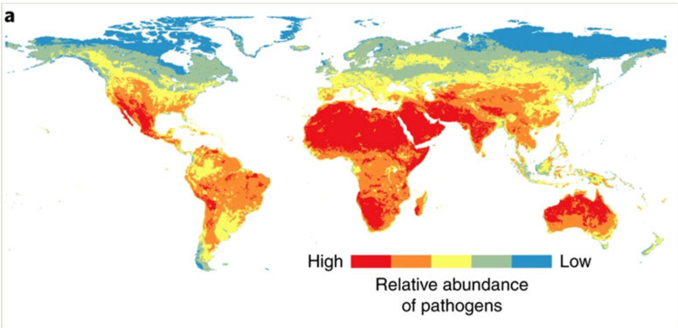
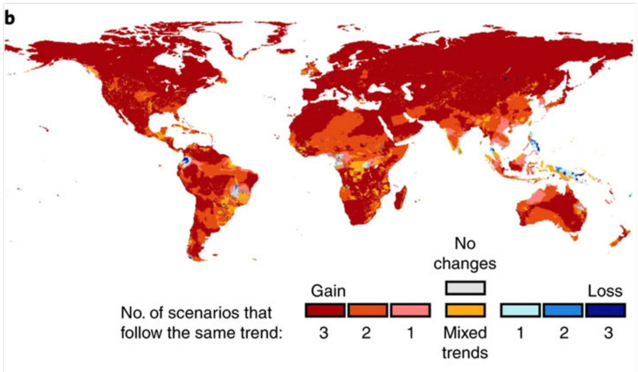
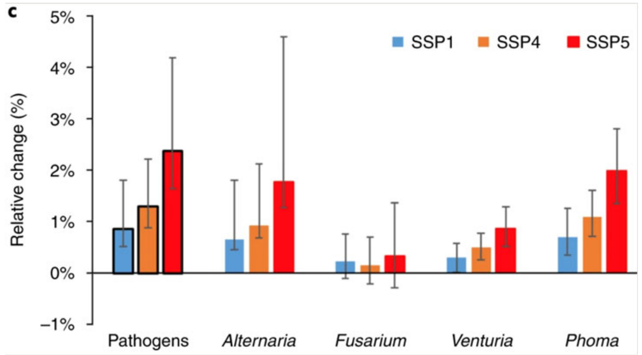
Huidige relatieve incidentie en projecties (2050) van potentiële plant pathogenen







Incidentie

Toename

Leidende pathogenen

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Delgado-Baquerizo, M., Guerra, C.A., Cano-Díaz, C. *et al. Nat. Clim. Chang.* **10**, 2020


LE JUST
LOS ANGELES
CALIFORNIA

LELIES VERUIT MEEST BESPOTEN
Gebruik chemische gewasbeschermingsmiddelen.
In kg per hectare
124,5
Lelies (bol)
30,9
Appels
29,5
Bloemen onder glas
28,8
Peren
27,2
Tulpen
21,5
Bloembollen overig
20,0
Pootaardappelen
1,7
Tarwe
270419 © de Volkskrant - bm. Bron: CBS


Diaporthe eres
Bacillus spp.
Avariato


37.7749°
ORO EN PAZ, FIERRO EN


Frosty pod rot


Bud rot
Phytophthora palmivora 600.000 ha/100.000 ha

100 jaar Fytopathologie in Wageningen

1. Onderwijs
2. Onderzoek
3. Vertaling van cel naar plant, veld, regio, continenten
4. Samenwerking en inter/multidisciplinariteit

WAGENINGEN UNIVERSITY & RESEARCH