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Agroscope

Sagropia

Sustainable agriculture through novel pesticides using an integrated approach

Josep Massana-Codina, Brice Dupuis, Paul Dahlin, Thomas Steinger, Lucius Tamm

17 Januar 2025

Sustainable agriculture through novel pesticides using an integrated approach

- **EU-Projekt** aus dem Call CL6-2023-FARM2FORK-01-7 “Innovations in plant protection: alternatives to reduce the use of pesticides focusing on candidates for substitution (CfS)”

- Reduzierung des Pestizideinsatzes bei Kartoffeln und Zuckerrüben in 5 europäischen Regionen mit Schwerpunkt auf „CfS“

- Januar 2024 - Dezember 2028

- 10 Partner (Forschung und Industrie)

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Candidates for Substitution

ANNEX

1-methylcyclopropene
aclonifen
amitrole
bifenthrin
bromadiolone
bromuconazole
carbendazim
chlorotoluron (unstated stereochemistry)
copper compounds (variants copper hydroxide, copper oxychloride, copper oxide, Bordeaux mixture and tribasic copper sulphate)
cyproconazole
cyprodinil
diclofop
difenacoum
difenoconazole
diflufenican
dimethoate
dimoxystrobin
diquat
epoxiconazole
esfenvalerate
ethoprophos
etofenprox
etoxazole
famoxadone
fenamiphos
fenbutatin oxide
fipronil
fludioxonil
flufenacet
flumioxazine
fluometuron
fluopicolide
fluquinconazole
glufosinate
haloxyfop-P
imazamox
imazosulfuron
isoproturon
isopyrazam
lambda-cyhalothrin
lenacil

linuron
lufenuron
mecoprop
metalaxyl
metam
metconazole
methomyl
metribuzin
metsulfuron-methyl
molinate
myclobutanil
nicosulfuron
oxadiargyl
oxadiazon
oxamyl
oxyfluorfen
paclobutrazol
pendimethalin
pirimicarb
prochloraz
profoxydim
propiconazole
propoxycarbazone
prosulfuron
quinoxyfen
quizalofop-P (variant quizalofop-P-tefuryl)
sulcotrione
tebuconazole
tebufenpyrad
tepraloxydim
thiacloprid
tri-allate
triasulfuron
triazoxide
warfarin
ziram

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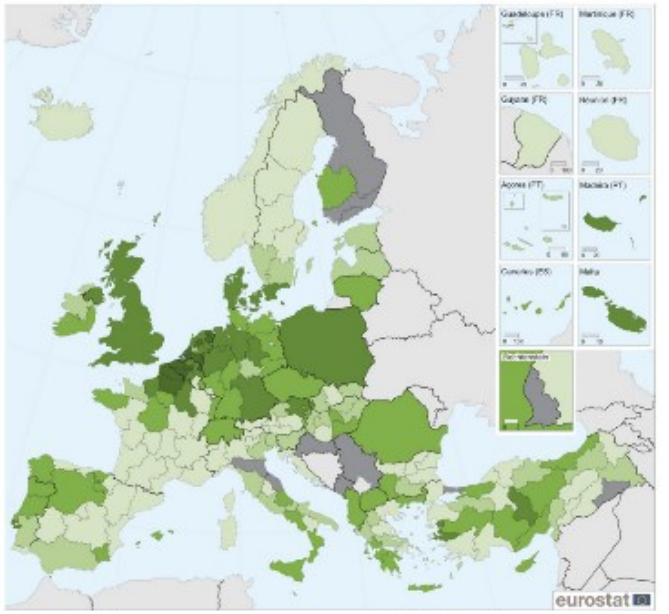
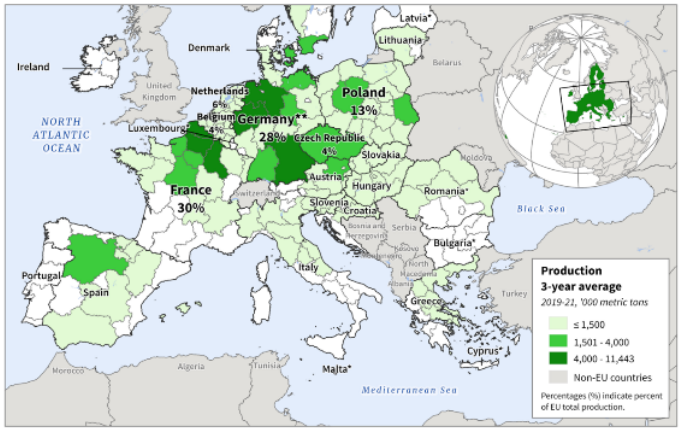
Kartoffeln und Zuckerrüben in Europa

- **Kartoffeln** und **Zuckerrüben** sind wichtige Kulturpflanzen in Europa:
  - 1,7 Millionen Hektar **Kartoffeln** (55 Millionen Tonnen) (Eurostat).
  - 1,5 Millionen Hektar **Zuckerrüben** (100 Millionen Tonnen Rüben, 14 Millionen Tonnen Zucker) (Eurostat)



European Union (EU): Sugarbeet Production



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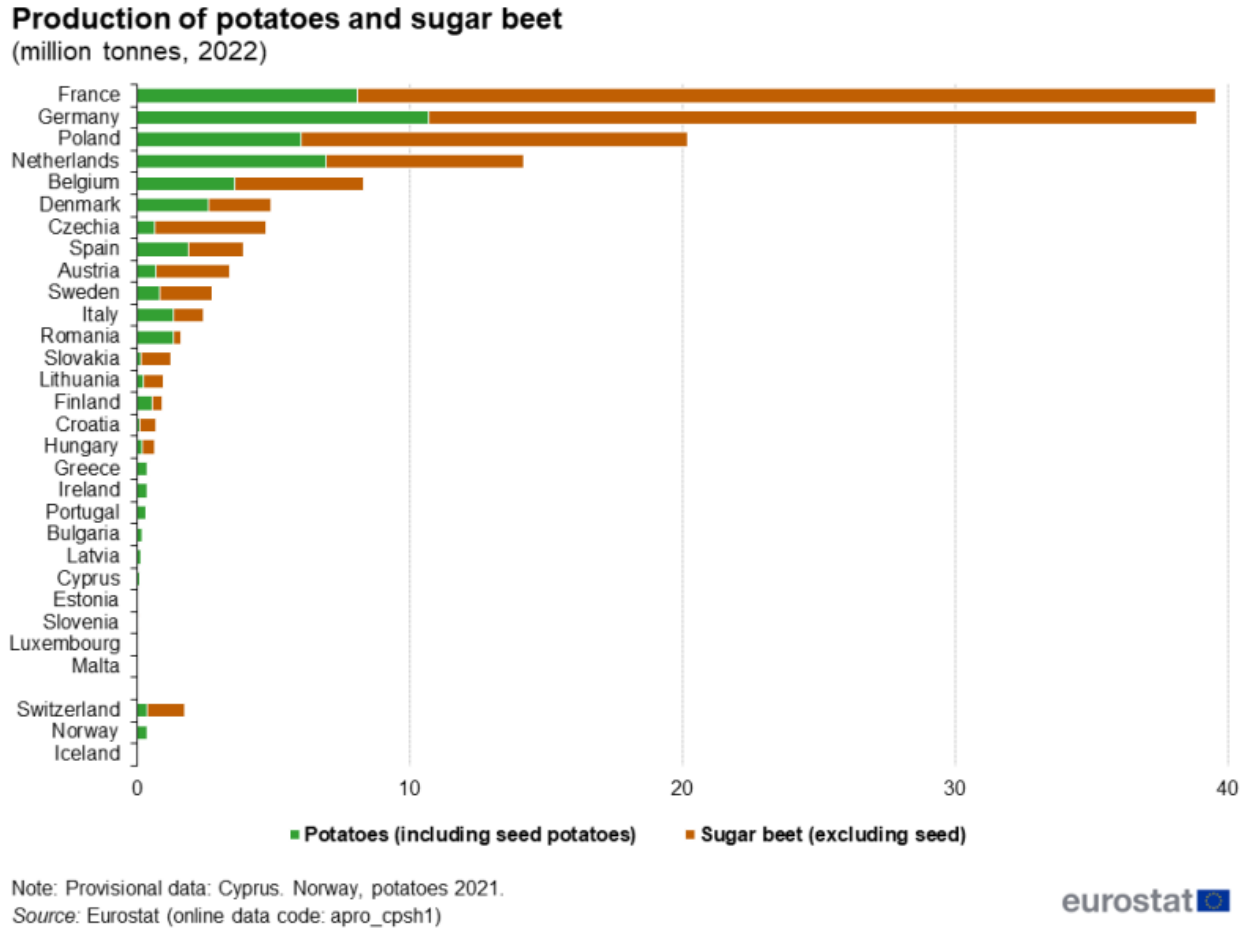
Potato and sugar beet in Europe

Integrierte Bekämpfungsstrategien „SAGROPIA“ werden in fünf europäischen Regionen entwickelt:

- **Frankreich**
- **Niederlande**
- **Deutschland**
- **Polen**
- **Schweiz**



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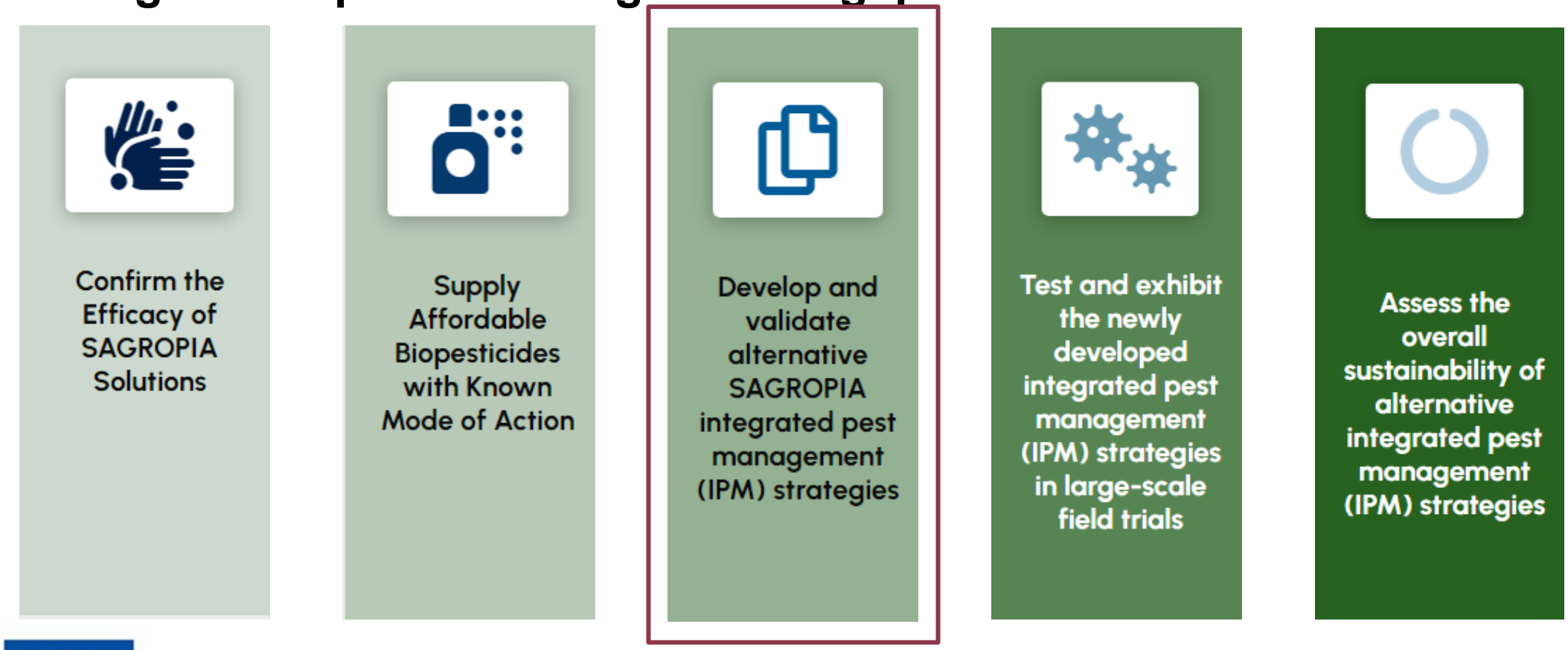
Forschungsprogramm

Ziel 3: Bewertung der allgemeinen Nachhaltigkeit der SAGROPIA-IPM-Strategien in Bezug auf Schädlinge und Krankheiten



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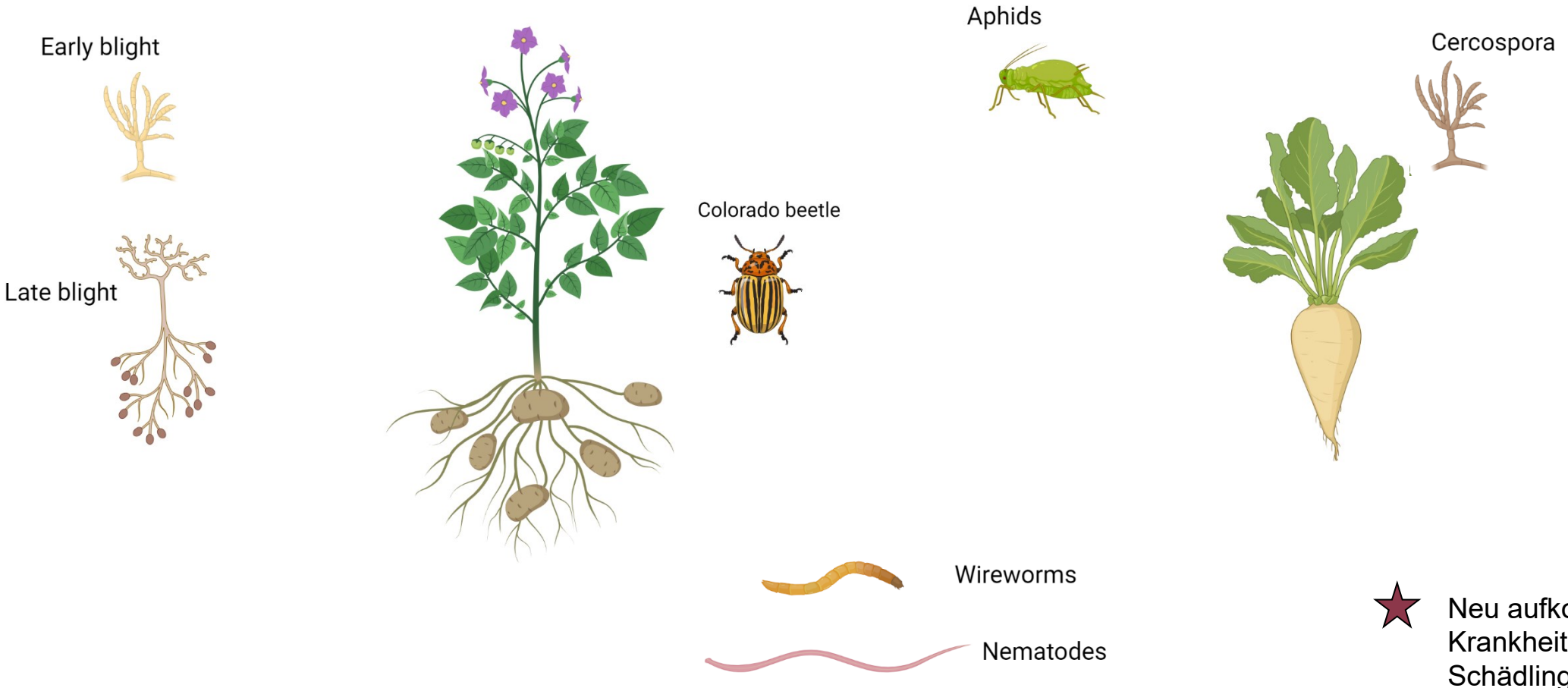
Krankheiten und Schädlinge bei Kartoffeln und Zuckerrüben in Europa



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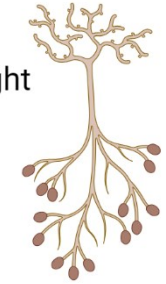
Krankheiten und Schädlinge bei Kartoffeln und Zuckerrüben in Europa

Sagropia

1 – 3 Fungizide

Early blight

Late blight



6 – 15 Fungizide

1 – 3 Insektizide

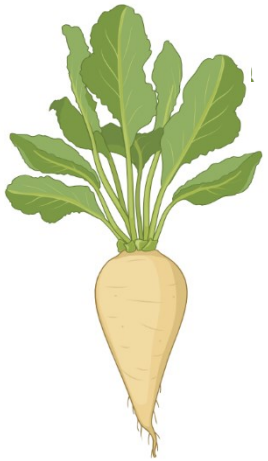
Aphids

1 – 3 Insektizide

Colorado beetle

1 – 4 Fungizide

Cercospora



Wireworms

Nematodes

★ Aufkommende Krankheiten und Schädlinge

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Einsatz von PSMs in Europa

					Mainstream strategy FR				Mainstream strategy NL				Mainstream strategy CH			
Week	Date, BBCH		Activity	Primary target	A. s. 1	A. s. 2	a.s. 1 (g / ha)	a.s. 2 (g / ha)	A. s. 1	A. s. 2	a.s. 1 (g / ha)	a.s. 2 (g / ha)	A. s. 1	A. s. 2	a.s. 1 (g / ha)	a.s. 2 (g / ha)
		0	Pre-sprouting													
		0	Nematicide treat	PCN / RKN	Fosthiazate											
		0	Insecticide treat	Wireworms												
		0	Seed treatment	Rhizoctonia	Fludioxonil		50		Fludioxonil		50		Fludioxonil		50	
-1	Apr 14		Tillage													
0	Apr 18	1	Sowing													
0	Apr 18	1	Fungicide spray	Rhizoctonia, black dot, silver scurf	Azoxystrobin		750		Azoxystrobin		750					
1	Apr 21	00 – 05	Herbicide spray	Weeds	Metobromuron		2000		Metobromuron		2000		**Aclonifen**		1200	
1	Apr 21	00 – 05	Herbicide spray	Weeds	Clomazone	Metribuzin	90	350	Clomazone	Metribuzin	90	350	Flufenacet	metribuzine	36	26.25
2	Apr 30		Mechanical weeding													
3	May 7		Mechanical weeding													
5	May 21	11 – 19	Herbicide spray	Weeds												
5	May 21	21	Fungicide spray	Late Blight	Fluazinam		200	1000	**Fluopicolide**	Propamocarb	100	1000				
5	May 21	21	Fungicide spray	Late Blight	Propamocarb		1010.8		Cyazofamid		80					
6	May 25	31	Fungicide spray	Late Blight	Amisulbrom		60									
6	May 25	31	Fungicide spray	Late Blight	Ametoctradin		240									
7	May 30	40	Insecticide spray	Aphids												
7	May 30	40	Insecticide spray	Aphids												
7	May 30	40	Fungicide spray	Late Blight	Propamocarb		1010.8		luazinam				**Fluopicolide**	Propamocarb	100	1000
7	May 30	40	Fungicide spray	Late Blight	Fluazinam		200									
8	June 7	45	Insecticide spray	Aphids												
8	June 7	49	Insecticide spray	Aphids												
8	June 7	49	Fungicide spray	Late Blight	Mandipropamid		150		metoctradin	Dimetomorph			**Fluopicolide**	Propamocarb	100	1000
8	June 7	49	Fungicide spray	Late Blight	Cyazofamid		80									
8	June 7	49	Insecticide spray	Potato Colorado Bee	**lambda-chyalothrin**		7.5		**ambda-chyalothrin**		7.5		Chlorantraniliprole		12	
9	June 14	55	Insecticide spray	Aphids												
9	June 14	55	Fungicide spray	Late Blight	Ametoctradin		240		**luopicolide**	Propamocarb	100	1000	**Fluopicolide**	Propamocarb	100	1000
9	June 14	55	Fungicide spray	Late Blight	Amisulbrom		60		Mandipropamid	**Difenoconazole**	150	150				
10	June 20	55	Fungicide spray	Late Blight	Mandipropamid	**Difenoconazole**	150	150	phosphonate				**Fluopicolide**	Propamocarb	100	1000
10	June 20	55	Fungicide spray	Late Blight	Fluazinam		200						Dimetomorph	Zoxamide	180	180
10	June 20	59	Insecticide spray	Aphids									Acetamiprid		20	
10	June 20	59	Insecticide spray	Potato Colorado Bee	Chlorantraniliprole		12		hlorantraniliprole		12		Spinosad		24	
11	June 25	59	Fungicide spray	Late Blight	**Fluopicolide**	Propamocarb	100	1000	**luopicolide**	Propamocarb	100	1000				
11	June 25	59	Fungicide spray	Late Blight												
11	June 25	59	Fungicide spray	Late Blight									Mandipropamid	**Difenoconazole**	150	150
12	July 1	61	Insecticide spray	Potato Colorado Beetle												
12	July 1	61	Fungicide spray	Late Blight	Propamocarb	**Fluopicolide**	1000	100	Mandipropamid	**Difenoconazole**	150	150	Dimetomorph	Zoxamide	180	180
12	July 1	61	Fungicide spray	Late Blight					phosphonate							
13	July 7	61	Fungicide spray	Late Blight	Mandipropamid	**Difenoconazole**	150	150	oxathiapiprolin	Amisulbrom	15	30				
13	July 7	61	Fungicide spray	Late Blight	Fluazinam		200									
14	July 14	70	Fungicide spray	Late Blight	Propamocarb	**Fluopicolide**	1000	100	Dimetomorph	Fluazinam	200	200	Dimetomorph	Zoxamide	180	180
14	July 14	70	Fungicide spray	Late Blight												
14	July 14	70	Fungicide spray	Late Blight/Early Blight									Mandipropamid	**Difenoconazole**	150	150
14	July 14	70	Insecticide spray	Aphids												
15	July 21	75	Fungicide spray	Late Blight	Cyazofamide		80		Mandipropamid		150					
15	July 21	75	Fungicide spray	Early Blight	mefentrifluconazool		93.75		K phosphonate							
16	July 28	80	Fungicide spray	Late Blight	Azoxystrobin	Fluazinam	75	187.5	Dimetomorph	Fluazinam	200	200	Cyazofamid		80	
18	Aug 7	91	Fungicide spray	Late Blight	Cyazofamid		80		Cyazofamid		80		Fluazinam		200	
18	Aug 7	91	Fungicide spray	Late Blight												
18	Aug 7	91	Fungicide spray	Early Blight	fluopyram	prothioconazole	62.5	62.5								
18	Aug 7	91	Insecticide spray	Aphids												
18	Aug 7	91	Insecticide spray	Potato Colorado Beetle	Spinosad		36		Spinosad		36					
19	Aug 12	91	Fungicide spray	Late Blight	Azoxystrobin	Fluazinam	75	187.5	Amisulbrom		100					
20	Aug 19	99	Fungicide spray	Late Blight	Cyazofamid		80		Cyazofamid		80		Cyazofamid		80	
20	Aug 19	99	Insecticide spray	Aphids												
20	Aug 19	99	Defoliation													
20	Aug 19	99	Defoliation		Carfentrazone-ethyle		60		Carfentrazone-ethyle		60		Carfentrazone-ethyle		60	
21	Aug 25	99	Fungicide spray	Late Blight	Cyazofamid		80		Cyazofamid		80		Cyazofamid		80	
21	Aug 25	99	Defoliation		Carfentrazone-ethyle		60		Carfentrazone-ethyle		60		Carfentrazone-ethyle		60	
23	sept.10		Harvest													

45	Insecticide spray	Aphids				
49	Insecticide spray	Aphids				
49	Fungicide spray	Late Blight	Mandipropamid		150	
49	Fungicide spray	Late Blight	Cyazofamid		80	
49	Insecticide spray	Potato Colorado Beetle	**lambda-chyalothrin**		7.5	
55	Insecticide spray	Aphids				
55	Fungicide spray	Late Blight	Ametoctradin		240	
55	Fungicide spray	Late Blight	Amisulbrom		60	
55	Fungicide spray	Late Blight	Mandipropamid	**Difenoconazole**	150	150
55	Fungicide spray	Late Blight	Fluazinam		200	
59	Insecticide spray	Aphids				
59	Insecticide spray	Potato Colorado Beetle	Chlorantraniliprole		12	
59	Fungicide spray	Late Blight	**Fluopicolide**	Propamocarb	100	1000
59	Fungicide spray	Late Blight				
59	Fungicide spray	Late Blight				
61	Insecticide spray	Potato Colorado Beetle				
61	Fungicide spray	Late Blight	Propamocarb	**Fluopicolide**	1000	100
61	Fungicide spray	Late Blight				
61	Fungicide spray	Late Blight	Mandipropamid	**Difenoconazole**	150	150
61	Fungicide spray	Late Blight	Fluazinam		200	
70	Fungicide spray	Late Blight	Propamocarb	**Fluopicolide**	1000	100
70	Fungicide spray	Late Blight				

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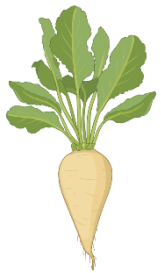
Wichtigste “CsF”

Fungizide: Fluopicolid, Difenoconazol, Formulierungen auf Kupferbasis

Insektizide: Lambda-Cyhalothrin



Fungizide: Difenoconazol, Formulierungen auf Kupferbasis

Insektizide: Lambda-Cyhalothrin

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Kartoffel- und Zuckerrübenkrankheiten und-schädlinge in Europa und Einsatz von PSMs

		Kartoffel		Zuckerrüben	
	Region	N° CfS std	N° CfS BP	N° CfS std	N° CfS BP
Maritim nass kalt	NE Frankreich	6	3	5	3
Maritim nass kalt	Niederlande	4	0	3	0
Kontinental trocken kalt	Deutschland SE	5	3	5	3
Maritim nass kalt	Deutschland NO	5	3	5	3
Kontinental gemässigt kalt	Polen	4	3	3	1
Kontinental gemässigt kalt	Schweiz Est	6	3	6	2
Kontinental trocken kalt	Schweiz Ost	6	3	6	2

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Evolution von Krankheitserregern und Resistenzen

Sagropia

Department of Agroecology

2022

A new variant of the late blight pathogen Phytophthora infestans is threatening the potato production

The results of a study on late blight show 100% resistance to one of the most important fungicides in potato production. Researchers find the development of the new variant of late blight worrying in relation to future control in Danish fields.

ELSEVIER

Crop Protection

Volume 158, August 2022, 106006

The first detection of multiple resistant (MBC and Q *beticola* Sac

Agnieszka Kiniec [a]

Studies in Mycology

Volume 89, March 2018, Pages 105-115

ORIGINAL ARTICLE | Open Access

GWAS reveals a rapidly evolving candidate avi in the Cercospora leaf spot pathogen

Chen Chen, Harald Keunecke, Felix Bemm, Gabor Gyetvai, Enzo Neu, Friedrich Bruce A. McDonald, Jessica Stapley

First published: 27 November 2023 | https://doi.org/10.1111/mpp.13407 |

Two different *R* gene loci co-evolved with *Avr2* of *Phytophthora infestans* and confer distinct resistance specificities in potato

C. Aguilera-Galvez [1], N. Champouret [1 3], H. Rietman [1 4], X. Lin [1], D. Wouters [1], Z. Chu [2 5], J.D.G. Jones [2], J.H. Vossen [1], R.G.F. Visser [1], P.J. Wolters [1], V.G.A.A. Vleeshouwers [1]

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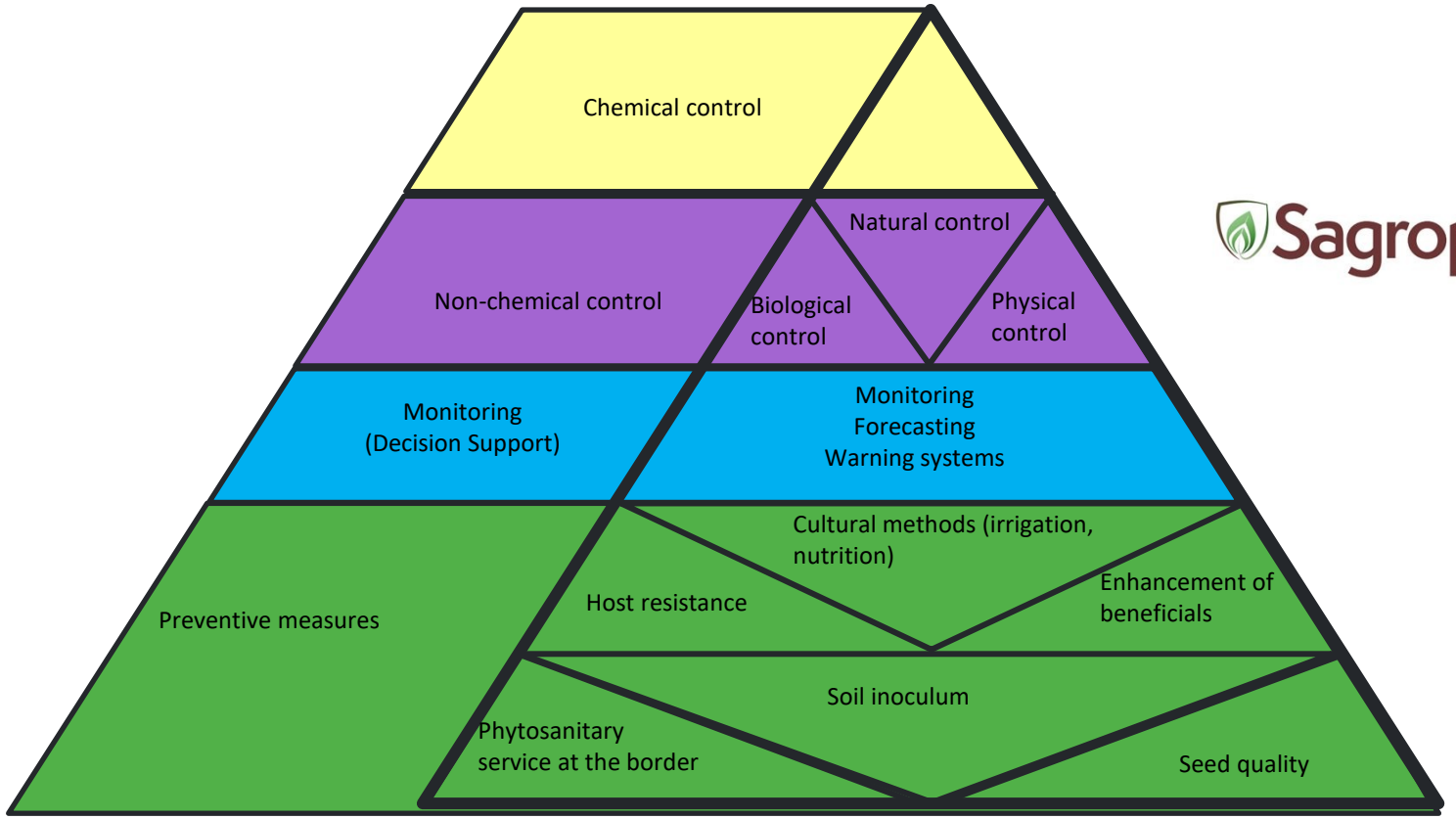
Strategien des integrierten Pflanzenschutzes



Sagropia solutions

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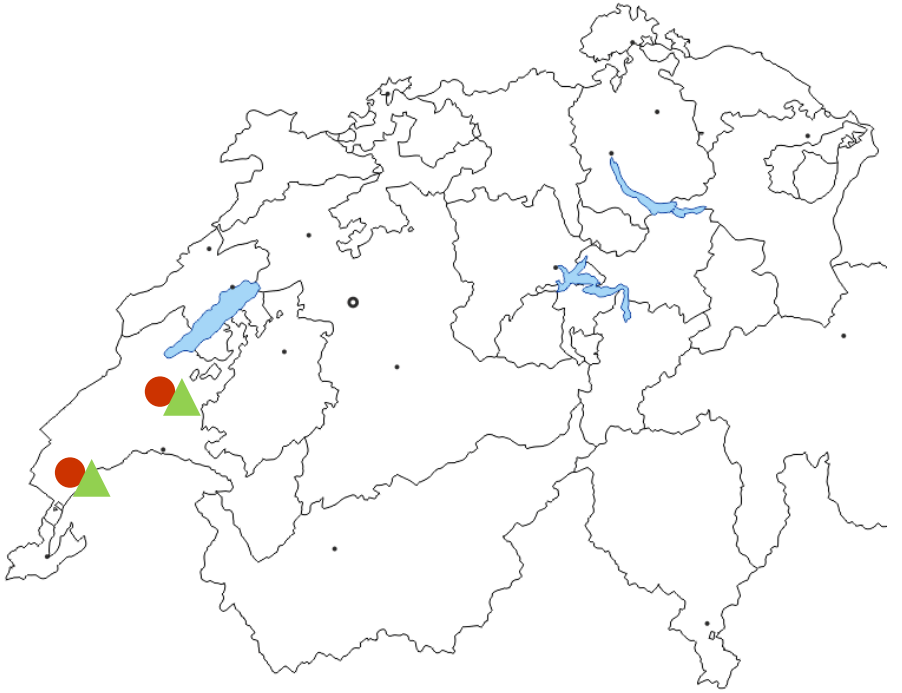
AP3 Entwicklung und Validierung alternativer integrierter Bekämpfungsstrategien



Kartoffel
Zuckerrüben

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Alternative integrierte Bekämpfungsstrategien

		Mainstream	Sagropia 1	Sagropia 2	Sagropia 3	Best Practices
Kartoffel	Verwendung von PPPs	Standard	Chemisch + Biopestizid	Chemisch + Biopestizid	Chemisch + Biopestizid	Best Practices
	Erhoffte Reduzierung von CfS	0%	>50%	50 – 100%	100%	50 – 100%
	Erhoffte Reduzierung von PPPs	0%	0 – 25%	10 – 30%	25 - >50%	0 – 25%
Zuckerrüben	Verwendung von PPPs	Standard	Chemisch + Biopestizid	Chemisch + Biopestizid	Biopestizid	Best Practices
	Erhoffte Reduzierung von CfS	0%	>50%	50 – 100%	100%	50 – 100%
	Erhoffte Reduzierung von PPPs	0%	25 – 50%	50 – 100%	100%	0 – 25%

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Beispiel für eine alternative Strategie (Zuckerrübe)

							Mainstream strategy				SAGROPIA 1				SAGROPIA 2				SAGROPIA 3			
Wee	Date, BBCH		Activity	Primary target	Comment		A. s. 1	A. s. 2	Dosage a.s. 1 (g/ha)	Dosage a.s. 2 (g/ha)	A. s. 1	A. s. 2	Dosage a.s	Dosage a.s	A. s. 1	A. s. 2	Dosage a.s	Dosage a.s	A. s. 1	A. s. 2	Dosage a.s	Dosage a.s
		0																				
		0	Nematicide treatment																			
		0	Insecticide treatment	Wireworms																		
		0	Seed treatment	Seedling diseases			Hymexazole		40		Hymexazole		40		Hymexazole		40		Hymexazole		40	
		0	Seed treatment	Seedling diseases			Tefluthrine		12		Tefluthrine		12		Tefluthrine		12		Tefluthrine		12	
-1			Tillage																			
0		1	Sowing																			
1	April	00 – 05	Herbicide spray	Weeds	Exemple of weed management; other strategies possible. Weed management should be carried out depending on weed species and regional mainstream practices		Ethofumesate	Phenmedipham	150	120	Ethofumesate	Phenmedipham	150	120	Ethofumesate	Phenmedipham	150	120	Ethofumesate	Phenmedipham	150	120
1	April	00 – 05	Herbicide spray	Weeds			Phenmedipham		80		Phenmedipham		80		Phenmedipham		80		Phenmedipham		80	
1	April	00 – 05	Herbicide spray	Weeds			Metamitromn		350		Metamitromn		350		Metamitromn		350		Metamitromn		350	
2	May	11 – 19	Herbicide spray	Weeds			Ethofumesate	Phenmedipham	150	120	Ethofumesate	Phenmedipham	150	120	Ethofumesate	Phenmedipham	150	120	Ethofumesate	Phenmedipham	150	120
2	May	11 – 19	Herbicide spray	Weeds			Phenmedipham		80		Phenmedipham		80		Phenmedipham		80		Phenmedipham		80	
2	May	11 – 19	Herbicide spray	Weeds			Metamitromn		350		Metamitromn		350		Metamitromn		350		Metamitromn		350	
3	May	11 – 19	Herbicide spray	Weeds			Ethofumesate	Phenmedipham	150	120	Ethofumesate	Phenmedipham	150	120	Ethofumesate	Phenmedipham	150	120	Ethofumesate	Phenmedipham	150	120
3	May	11 – 19	Herbicide spray	Weeds			Phenmedipham		80		Phenmedipham		80		Phenmedipham		80		Phenmedipham		80	
3	May	11 – 19	Herbicide spray	Weeds			Metamitromn		350		Metamitromn		350		Metamitromn		350		Metamitromn		350	
3	May	11 – 19	Herbicide spray	Weeds			Quinmerac	dimethenamide	200	100	Quinmerac	dimethenamide	200	100	Quinmerac	dimethenamide	200	100	Quinmerac	dimethenamide	200	100
4	May	25	Herbicide spray	Weeds																		
4	May	25	Herbicide spray	Weeds																		
4	May	25	Herbicide spray	Weeds																		
5	May																					
6	June	31	Insecticide spray	Aphids	First treatment based on threshold and DSS	Tank mix	Flonicamid (Teppeki)		140 g/ha (70)		Flonicamid (Teppeki)		105 g/ha (52.5)		Certis_Bio_1		50%		Certis_Bio_1		50%	
6	June	31	Insecticide spray	Aphids							Rovensa_Next_1		0.4% (0.8 L/ha)		Rovensa_Next_1				CYN-21			
6	June	31	Fungicide spray	Rhizoctonia	Rhizoctonia																	
7	June	40	Insecticide spray	Scrobipalpa ocel	Treatment based on threshold and DSS	Tank mix	**Lambda-chyalothrin (Karate Zeon)**		0,063 L/ha (6,3)		Deltamethrin		0.05625 L/ha (5.625)		Certis_Bio_1		100%		Certis_Bio_1		50%	
7	June	40	Insecticide spray	Scrobipalpa ocel							Rovensa_Next_1		0.4% (0.8 L/ha)						Certis_Bio_2			
8	June	31	Insecticide spray	Aphids	Second treatment based on threshold and DSS AND ONLY IF NECESSARY	Tank mix	Flonicamid (Teppeki)		140 g/ha (70)		Flonicamid (Teppeki)		105 g/ha (52.5)		Certis_Bio_1		50%		Certis_Bio_1		50%	
8	June	31	Insecticide spray	Aphids							Rovensa_Next_1		0.4% (0.8 L/ha)		Rovensa_Next_1				CYN-21			
9	June	40	Preventive Fungicide spr	CLS	Preventive treatment (based on disease in the region)	Tank mix					Amoeba_1		270		Amoeba_1		270		Amoeba_1		270	
9	June	40	Preventive Fungicide spr	CLS																		
10	July	40	Preventive Fungicide spr	CLS	2nd Preventive treatment (based on disease in the region)	Tank mix					Amoeba_1		270		Amoeba_1		270		Amoeba_1		270	
10	July	40	Preventive Fungicide spr	CLS																		
11	July	40	Fungicide spray	CLS	First treatment based on first observations in the field	Tank mix	Fenpropidine (SPYRALE)	**Difenoconazole (SPYRALE)**	1L/ha (375)	1 L/ha (100)	Porthioconazole (Proline)		0.6 L/ha (150)		Rovensa_Next_2		4 L/ha		Rovensa_Next_1		0.4% (0.8 L/ha)	
11	July	40	Fungicide spray	CLS			**Copper hydroxide (Funguran Flow)**		2 L/ha (600)		Rovensa_Next_1		0.4% (0.8 L/ha)		Certis_Bio_3		100		Amoeba_1		270	
14	aug	45	Fungicide spray	CLS	2nd treatment based on threshold	Tank mix	Porthioconazole (Proline)		0.6 L/ha (150)		Rovensa_Next_2		4 L/ha		Rovensa_Next_2		4 L/ha		Rovensa_Next_2		4 L/ha	
14	aug	45	Fungicide spray	CLS			**Copper hydroxide (Funguran Flow)**		2 L/ha (600)		Certis_Bio_3				Certis_Bio_3		100		Certis_Bio_3		100	
17	Aug	49	Fungicide spray	CLS	3rd treatment based on threshold AND ONLY IF NECESSARY	Tank mix	Azoxystrobin (Priori Top)	**Difenoconazole (Priori Top)**	1L/ha (200)	1 L/ha (125)	Porthioconazole (Proline)		0.6 L/ha (150)		Porthioconazole (Proline)		0.6 L/ha (150)		Rovensa_Next_2		4 L/ha	
17	Aug	49	Fungicide spray	CLS			**Copper hydroxide (Funguran Flow)**		2 L/ha (600)		Rovensa_Next_1		0.4% (0.8 L/ha)		Rovensa_Next_1		0.4% (0.8 L/ha)					
23	Oct		Harvest																			
	TOTAL Number of passages (I+F)						6				8				8				8			
	TOTAL Number of chemical foliar fungicides						3 (8 actives)				2				1				0			
	Total number of chemical foliar insecticides						3				3				0				0			
	TOTAL Number of Sagropia foliar fungicides						0				5 (6 actives)				5 (7 actives)				5 (7 actives)			
	TOTAL Number of Sagropia foliar insecticides						0				3				3 (5 actives)				3 (5 actives)			
	Total number of CfS						**6**				**0**				**0**				**0**			

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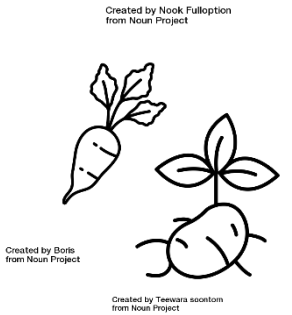
Alternative integrierte Bekämpfungsstrategien

3 Jahre: 2025, 2026 und 2027

2 Kulturen: Kartoffel und Zuckerrübe



5 regions

1 - 2 Versuche / Region

Gesamt > 30 Feldversuche

- Kartoffel
- Zuckerrüben

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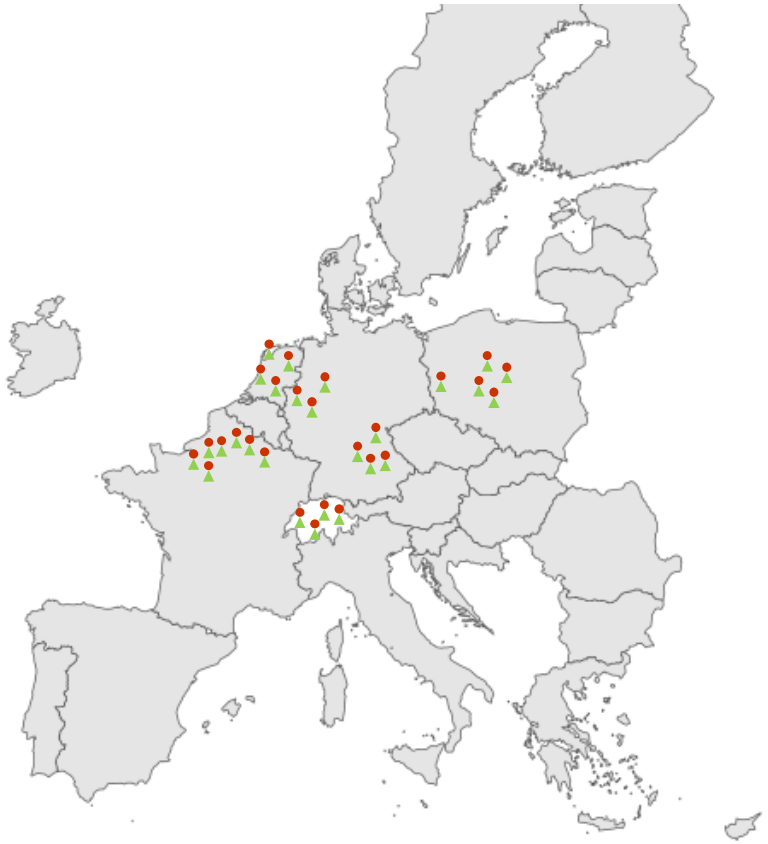
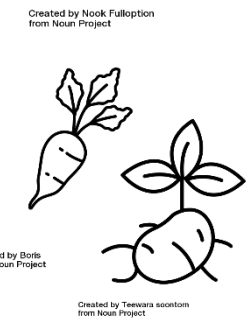
Demonstrationsversuche



Gross angelegte Demonstrationsversuche: Streifenversuche zum Vergleich der Mainstream-Strategie und der Sagropia-Strategien auf dem Bauernhof (on-farm).

3 Jahre: 2025, 2026 und 2027

2 Kulturen: Kartoffel und Zuckerrübe



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Partner des SAGROPIA-Projekts

RTDS GROUP

Confirm the Efficacy of SAGROPIA Solutions

Supply Affordable Biopesticides with Known Mode of Action

Develop and validate alternative SAGROPIA integrated pest management (IPM) strategies

Test and exhibit the newly developed integrated pest management (IPM) strategies in large-scale field trials

Assess the overall sustainability of alternative integrated pest management (IPM) strategies

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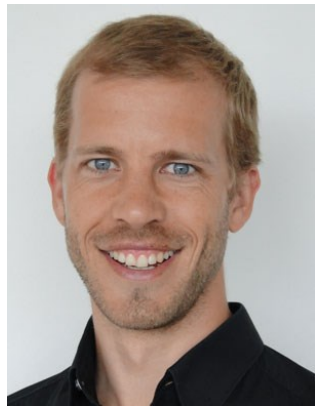

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Thank you for your attention

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