

# Developments in Multispectral Imaging and Image Analysis on seeds

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# Developments in research

Seed health

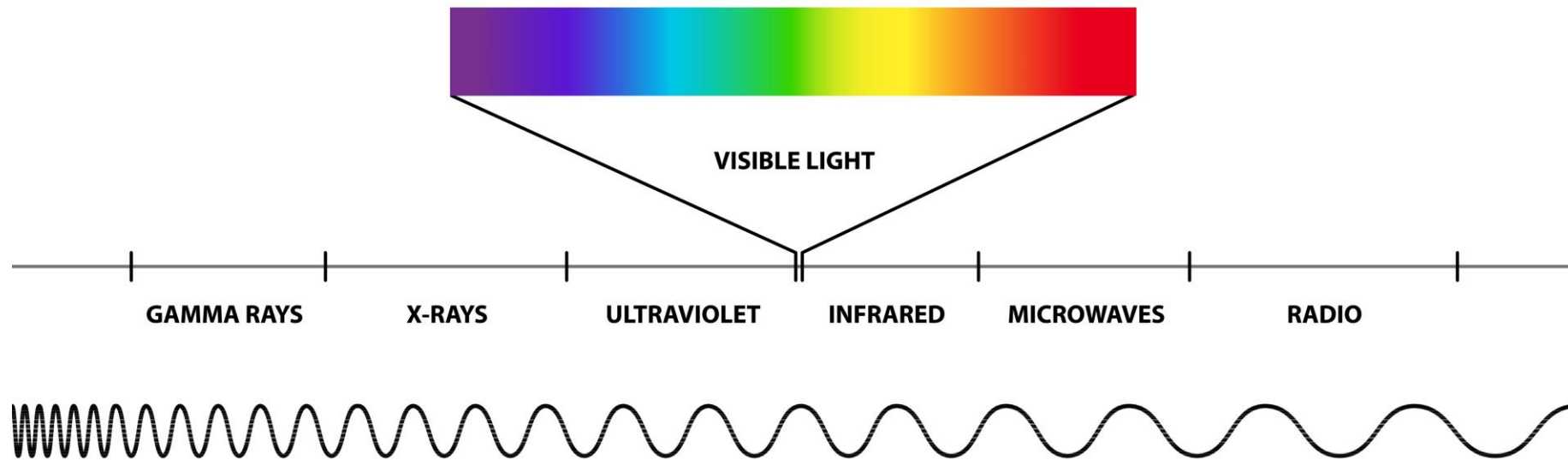
Seed germination and vigour

Other seed determination and purity



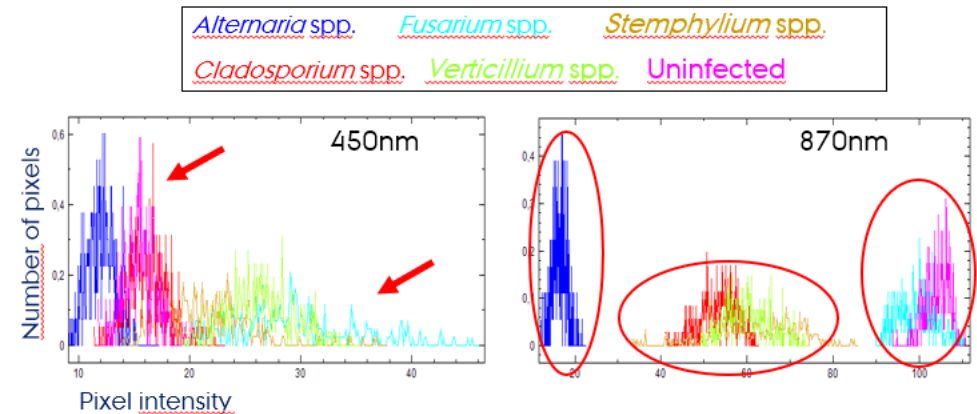
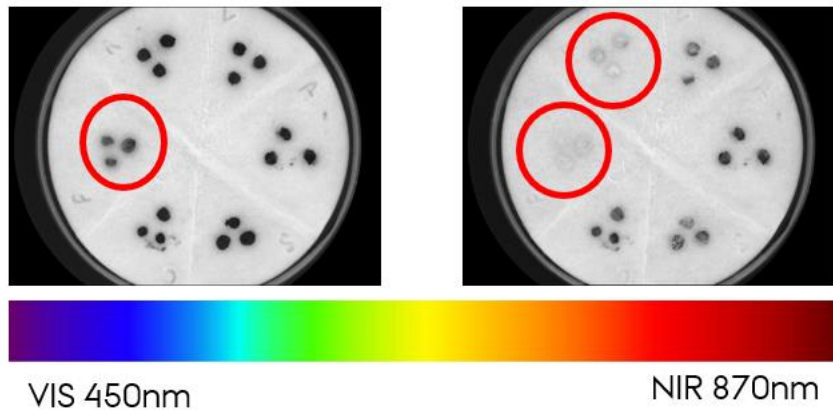
# The electromagnetic spectrum

RGB, multispectral, hyperspectral



# Seed health in Spinach Seed by multispectral imaging

Our first presentation on multispectral imaging during the ISTA congress in Cologne, 2010



Seed Science and Technology  
Olesen et al., 2011

# Recent publications - seed health

Scientia Horticulturae 321 (2023) 112219



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journal homepage: [www.elsevier.com/locate/scihorti](http://www.elsevier.com/locate/scihorti)



Higher seed maturity levels, darker pericarp, and smaller seed size relate to improved damping-off tolerance in spinach

Kim J.H. Magnée<sup>a,b</sup>, Olga E. Scholten<sup>a</sup>, Jan Kodde<sup>a</sup>, Joeke Postma<sup>a</sup>, Gerrit Gort<sup>c</sup>, Edith T. Lammerts van Bueren<sup>a</sup>, Steven P.C. Groot<sup>a,\*</sup>

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frontiers | Frontiers in Plant Science

scientific reports

OPEN

Fluorescence spectroscopy and multispectral imaging for fingerprinting of aflatoxin-B<sub>1</sub> contaminated (*Zea mays* L.) seeds: a preliminary study

Dragana Bartolić<sup>1</sup>, Dragosav Mutavdžić<sup>1</sup>, Jens Michael Carstensen<sup>2</sup>, Slavica Stanković<sup>3</sup>, Milica Nikolić<sup>3</sup>, Saša Krstović<sup>4</sup> & Ksenija Radotić<sup>1,3\*</sup>

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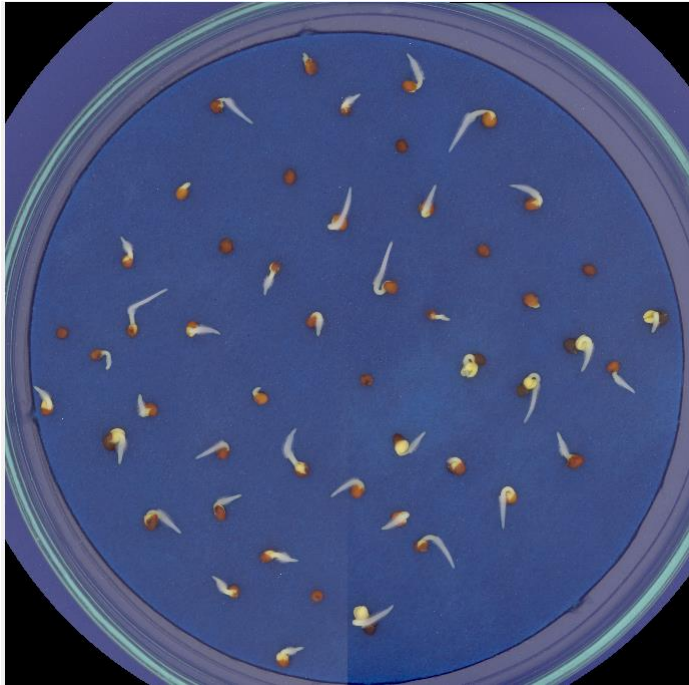
SPECIALTY SECTION  
This article was submitted to  
Technical Advances in Plant Science,  
a section of the journal  
Frontiers in Plant Science

Fungal identification in peanuts seeds through multispectral images: Technological advances to enhance sanitary quality

Julia Marconato Sudki<sup>1</sup>, Gustavo Roberto Fonseca de Oliveira<sup>2</sup>, André Dantas de Medeiros<sup>3</sup>, Thiago Mastrangelo<sup>1</sup>, Valter Arthur<sup>1</sup>, Edvaldo Aparecido Amaral da Silva<sup>2</sup> and Clíssia Barboza Mastrangelo<sup>1\*</sup>







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# Seed germination and seed vigour



ARTICLE

## Quantification of chlorophyll fluorescence in soybean seeds by multispectral images and their relationship with physiological potential

Fabiano França-Silva<sup>1\*</sup>, Silvio Moure Cicero<sup>1</sup>, Francisco Guilhien Gomes-Junior<sup>1</sup>, André Dantas Medeiros<sup>2</sup>, José de Barros França-Neto<sup>3</sup>, Denise Cunha Fernandes Santos Dias<sup>2</sup>

M.-H. Wagner, A.A. Powell, A. Dupont, T. Shinohara and S. Ducournau (2023).  
*Seed Science and Technology*, **51**, 3, 291-296.  
<https://doi.org/10.15258/sst.2023.51.3.01>



## Research Note

### Radicle emergence test for cabbage can be assessed using multispectral imaging

Marie-Hélène Wagner<sup>1\*</sup>, Alison A. Powell<sup>2</sup>, Audrey Dupont<sup>1</sup>, Takashi Shinohara<sup>3</sup> and Sylvie Ducournau<sup>1</sup>

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## Vigour testing for the rice seed with computer vision-based techniques

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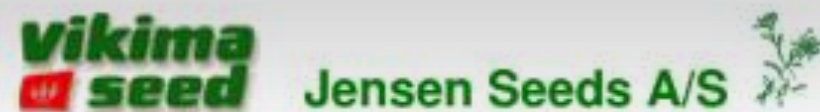


SpectraSeed

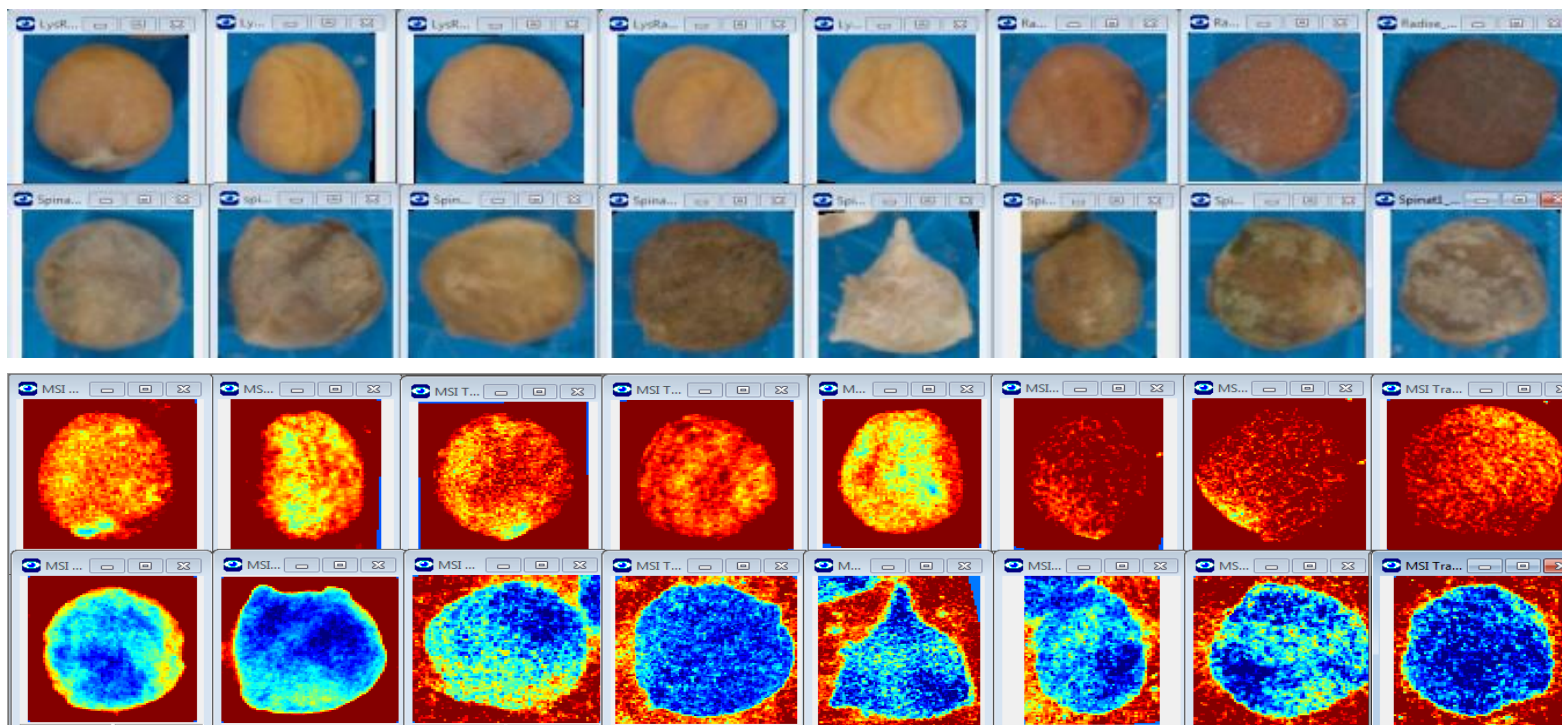
Bevillingsgiver:



Partnere:



# Discriminate spinach and radish seeds



RGB view of radish seeds  
RGB view of spinach seeds

nCDA transform on multi-spectral image enhances color contrast between spinach and radish.



# Other seeds determination - spinach

Predicted \ Reference	Cereal	Spinach	Cleavers	Black bindweed	Radish	Rapeseed	Hemp-nettle	Total	Error
Cereal	99.7	0.3	0	0	0	0	0	1.2	0.3
Spinach	0	99.9	0.1	0	0	0	0	75.2	0.1
Cleavers	0	0.4	99.5	0.1	0	0.1	0	7.5	1.5
Black bindweed	0	0.3	0	99.7	0	0	0	10.1	0.4
Radish	0	1.8	0.5	0	97.6	0	0.1	2.6	2.5
Rapeseed	0	0.5	0.9	0	0.4	97.9	0.4	2.3	2.1
Hemp-nettle	0	0.5	0.2	0	0.2	0.9	98.2	0.8	1.8
Total	1.2	75.3	7.5	10.1	2.5	2.2	0.8	57115	
Error	0	0.2	1.6	0.3	0.7	1.2	3.2		0.4

Classifier performance on a test set with 57.115 seeds

2018: Classification 99.9 on spinach and >97% on weed seeds

Current status, 2024: 99.8 – 99.9% on weed seeds



# Today the technology actively used in the seed processing line in Vikima seed

Kim Nielsen, Vikima Seed, pers. comm.



# ISTA Special Project: New Technologies for Other Seeds Determination, 2023

## PT 13-3 Oilseed rape

Lot	Species name	Seeds added (Net A/B/C)	Rejected crop seed Recall (%)				ISTA test Retrieval rate (%)
			Net A	Net B	Net C	Avg.	
Lot 1	<u>Galium aparine</u>	4	75	100	50	75	96
	<u>Sinapis arvensis</u>	5/6/6	100	83	100	94	63
	<u>Stellaria media</u>	5	100	100	100	100	89
	<u>Thlapsi arvense</u>	5	40	80	00	40	97
Lot 2	<u>Chenopodium album</u>	4	100	100	100	100	93
	<u>Lactuca sativa</u>	2	100	100	100	100	99
	<u>Phacelia tanacetifolia</u>	3	67	67	67	67	93
	<u>Vaccaria hispanica</u>	3/3/2	0	0	0	0	46
Lot 3	<u>Fallopia convolvulus</u>	2	100	100	100	100	90
	<u>Raphanus sativus</u>	3	100	100	100	100	92
	<u>Rumex crispus</u>	3	100	100	0	67	98
	<u>Sinapis alba</u>	4	100	100	100	100	91

# Overall recall / retrieval rate

Summarized comparison between the average recall of Net A-C and the retrieval rate from the ISTA PT-tests across all weed species.

- Row 1: The number of weed species, where the average recall is greater than or equal to the retrieval rate (38)
- Row 2: The number of weed species, where the average recall is greater than or equal to the retrieval rate (24)

	<b>Timothy*</b>	<b>Oilseed rape</b>	<b>Sunflower</b>	<b>White clover</b>	<b>Perennial ryegrass</b>	<b>Total</b>
Avg. recall $\geq$ retrieval rate	5	7	10	7	9	38
Avg. recall $<$ retrieval rate	6	5	4	3	6	24

Weeds were not classified to species level

# Other seeds determination - classification to species level

- An area with much research and many recent publications
- Concerns weed seeds, agricultural and horticultural crops
- Typically high accuracies (up to 100%) but based on small sample sizes (training sets < 5.000 seeds) and local models

Mortensen et al., 2021

<https://doi.org/10.3390/agriculture11040301>

Development in seed industry: PT tests performed (Bayer Crop Science, DLF .....)

# Other seeds determination - classification to species level

- The current research indicates that the potential is there
- To advance further towards robust and global models more work is required
- ISTA can play a role in accommodating a reference library to secure validated, reliable training sets of work samples
- Collaboration between research, ISTA and the seed sector is important to secure progress



Thank you

 **ISTA ANNUAL MEETING 2024**



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