Near infrared (NIR) perspectives to detect toxic contaminants in cereals

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Introduction

Since decades, NIR spectroscopy is widely used in the food and feed sectors to implement rapidly, inexpensive and efficient control tools for the quality of products. NIR spectrum can be considered as a fingerprint of a product which can be affected by factors as the presence of undesirable substances. The aim of this work is to demonstrate, through some studies, the performance of NIR technology to detect toxic contaminants in cereals destined to the food and feed sectors.

Reference method

Contaminants in cereals concern, among others, impurities such as straw, grains coming from other botanical origins or insects but also undesirable toxic substances such as sclerotium of ergot (*Claviceps purpurea),* datura seeds (*Datura stramonium)* and grains damaged by fusariosis (*fusarium* sp.) known for their high probability of content in toxins. The method used in food/feed companies is based on visual observations and on confirmation by optical microscopy.

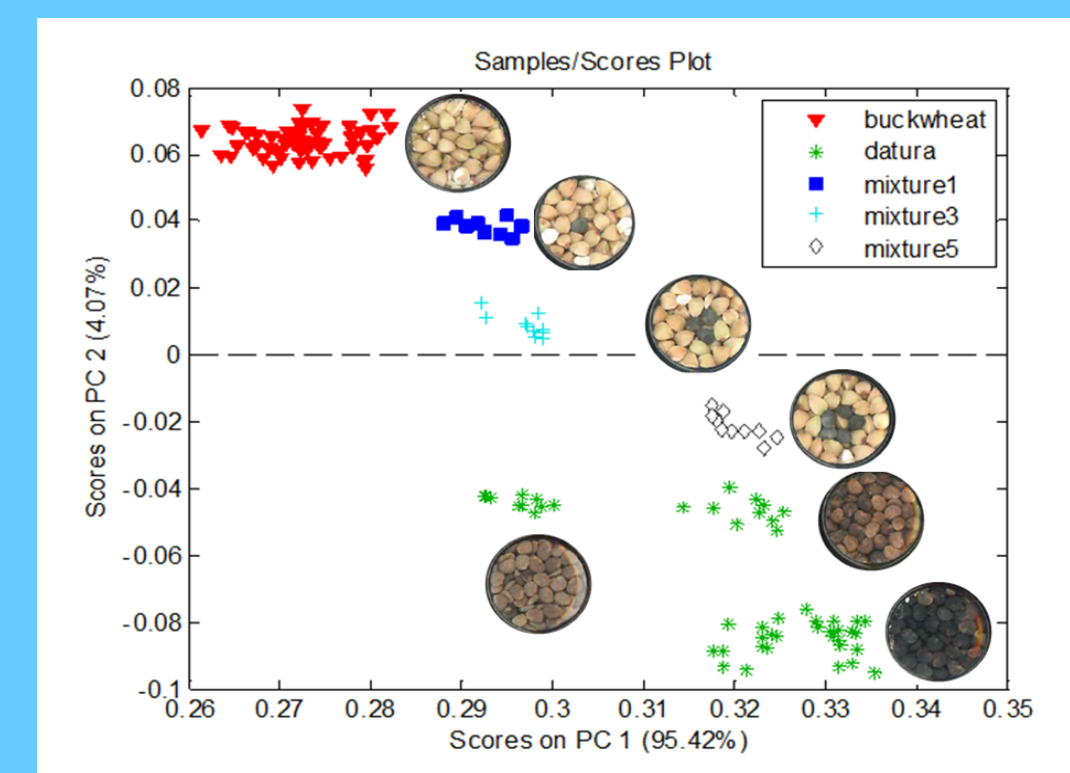**Sorting by visual observation**

Confirmation by microscope

IAG-Method A4: Method for the determination of ergot (claviceps purpurea) in animal feedingstuff
Commission Regulation EU n° 742/201, EN 15587

NIR spectroscopy at laboratory level

**NIR Sampling accessories
for quantitative and qualitative analysis**

**Discrimination by PCA on spectra
between Datura seeds and buckwheat kernels**

With the recent high throughput sampling accessories, classical NIR spectrometers allow analysing a higher number of reduced size subsamples by acquiring one spectrum by subsample. Moreover, simple chemometric tools such as PCA, applied to the NIR spectra allow discriminating between pure Datura seeds, buckwheat kernels and mixture of both.

Vermeulen P. , Fernández Pierna J.A. , Dardenne P. & Baeten V. (2013). Detection of datura seeds containing alkaloids in buckwheat production by NIRS and NIR hyperspectral imaging. Poster in: 16th ICNIRS, 3-7 June 2013, Montpellier - France
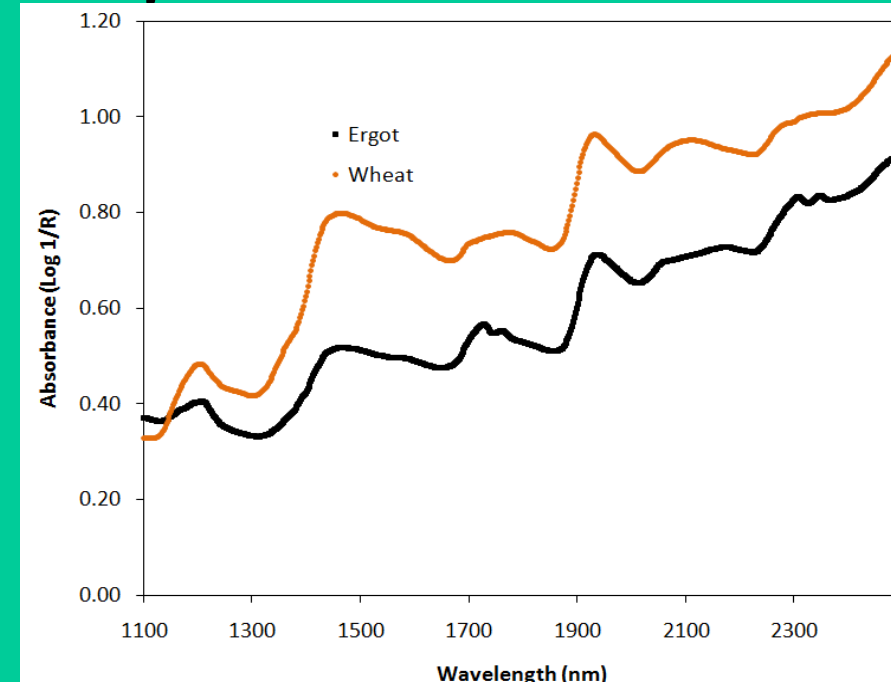
Light Microscopy
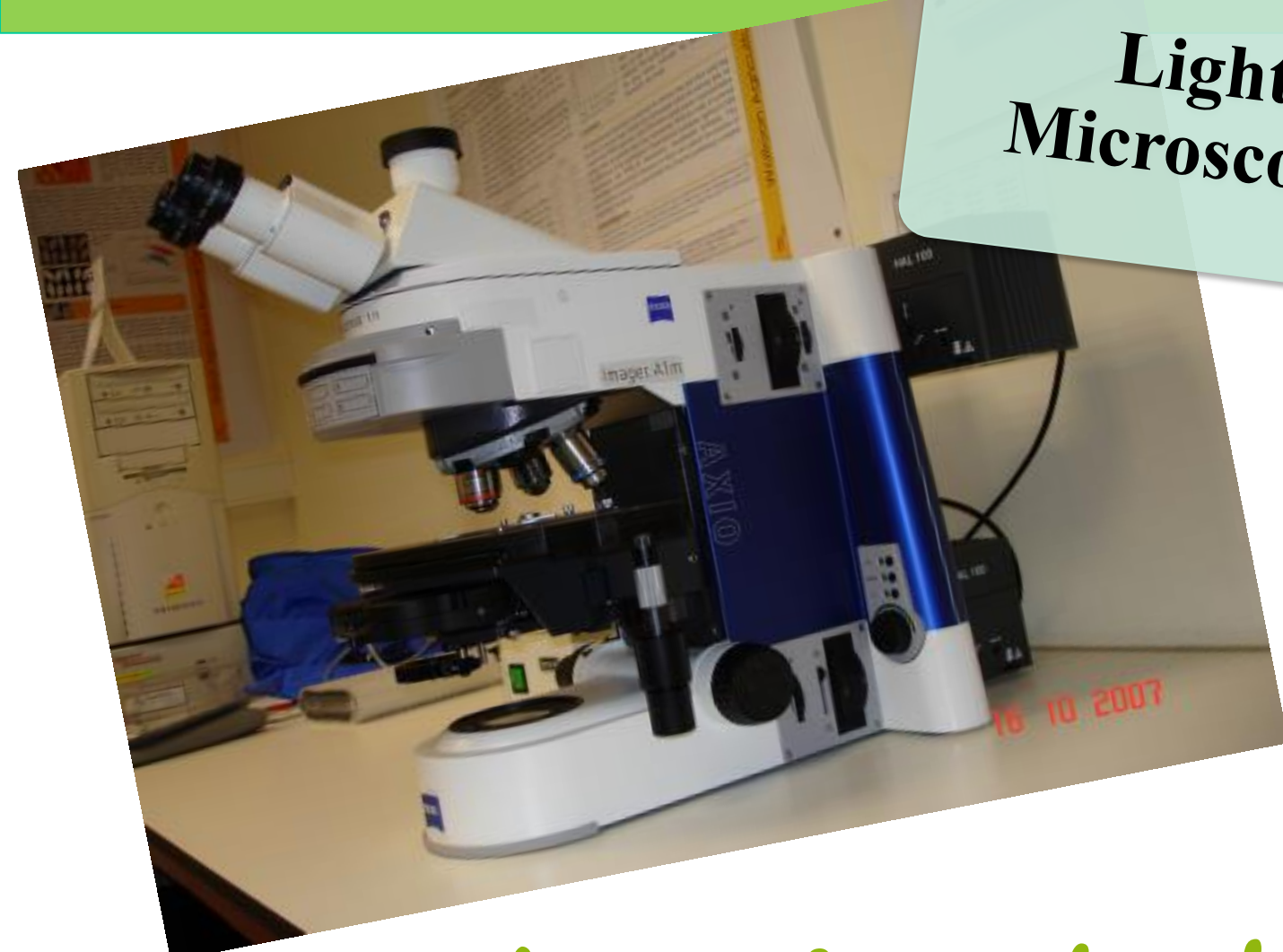
High skilled personal

Size sample 250g

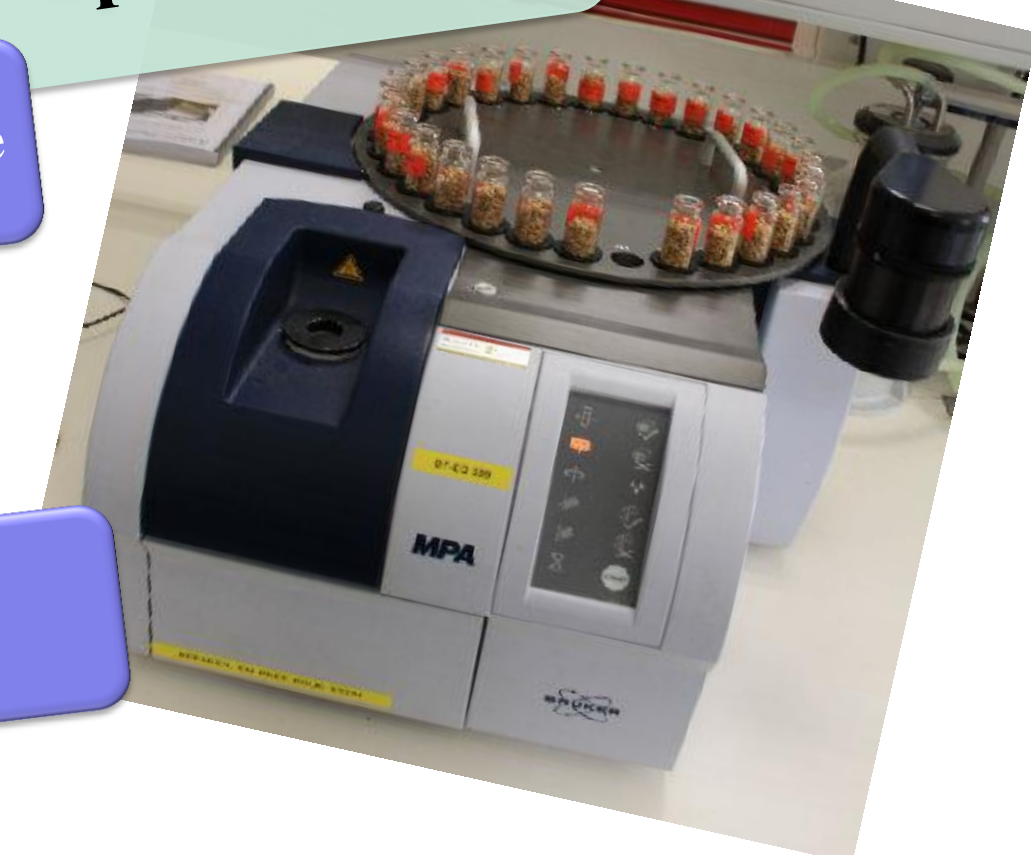Morphological markers distroyed in silage

Spectral information

Non Destructive

1 spectrum/ subsample

Screening method

Rapid method

NIR Spectroscopy

From the visual observation ...
to the NIR Spectroscopy ...
and NIR hyperspectral imaging system

A screening method for detection of contaminants in cereals

At the lab level ...

On-line analysis

Thousands spectra/ subsample

Spatial information

Large samples analysis

Detection of multiple contaminants

NIR Hyperspectral Imaging

## up to the field level

In field analysis

Early detection

Precision farming

Ground-based systems

NIR hyperspectral imaging in the laboratory

NIR hyperspectral imaging system (NIR-HIS) combines spectral and spatial information and allows to acquire several thousand spectra per sample. NIR-HIS and chemometric tools, together with image analysis can be used as control method to assess the presence and the quantity of contaminants such as ergot bodies in cereals. Using such technology, up to 50 kg of cereals can be analysed in 1 hour with a limit of detection of 145 mg/kg for ergot, below the limit of 500 mg/kg fixed by the European Commission for food. This methodology allows multi contaminants detection and can be easily integrated in an automatic cereal control scheme.

Red: pixels ergot

Blue: pixels wheat
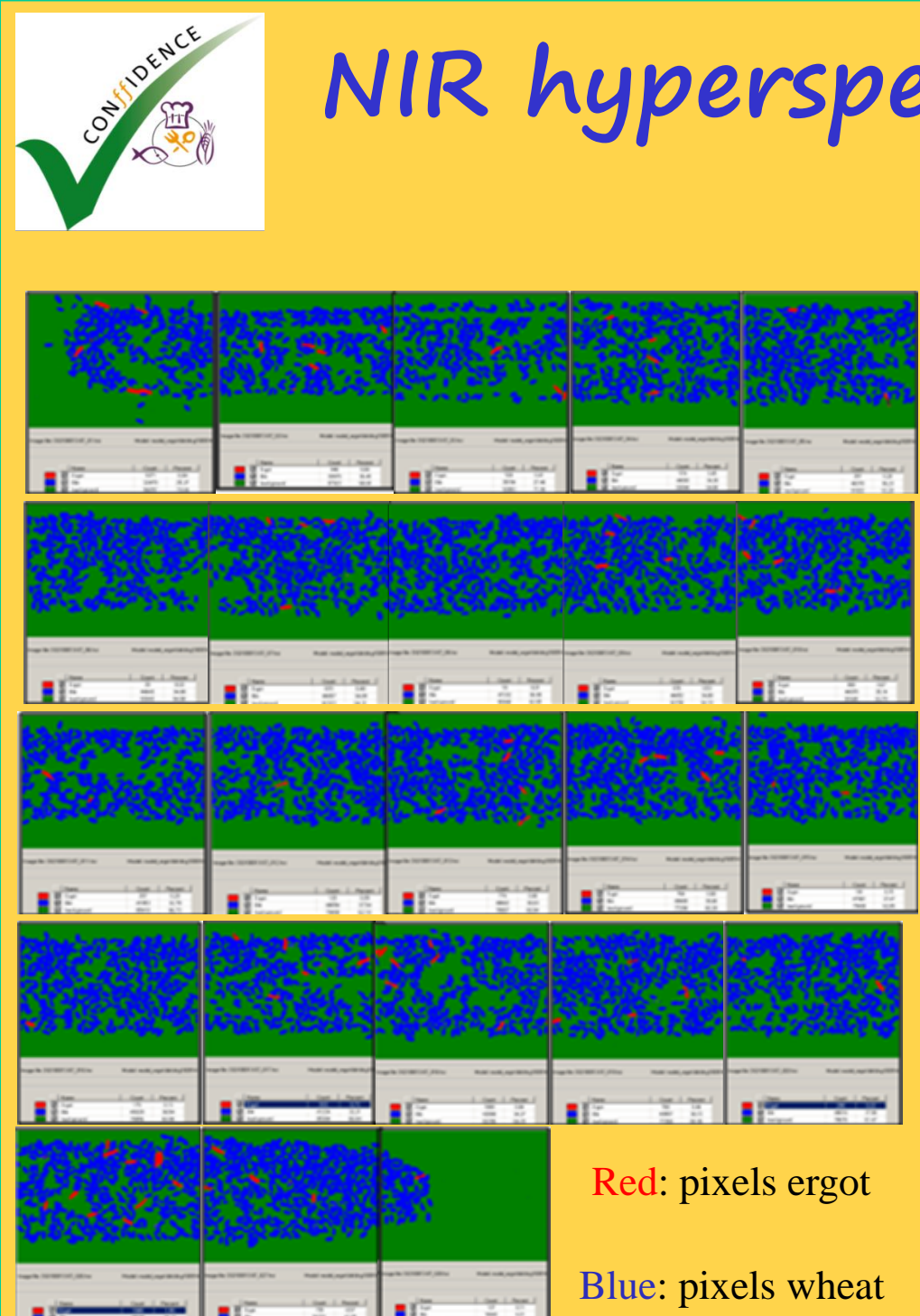
**Ergot quantification in cereals**

Vermeulen P. , Fernández Pierna J.A. , van Egmond H.P. , Zegers J. , Dardenne P. & Baeten V. (2013). Validation and transferability study of a method based on near-infrared hyperspectral imaging for the detection and quantification of ergot bodies in cereals. *Analytical and Bioanalytical Chemistry,* 405: (24), 7765-7772

Follow up in the field

For crop management on field scale, ground based systems are advantageous against satellite and airborne. The information provided by the sensor installed on i.e. the tractor could be applied on-line for precision disease control independently of the weather conditions (clouds) and with the spatial resolution required. Together with the reduction of weight, size and price, the implementation of these sensors on platforms such as tractors could play an important role in the framework of the implementation of precision agriculture.
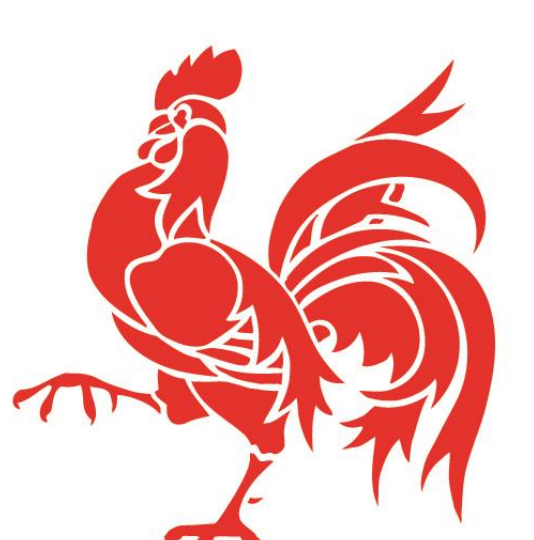
**Fusariosis symptoms on wheat heads
in experimental fields at CRA-W**
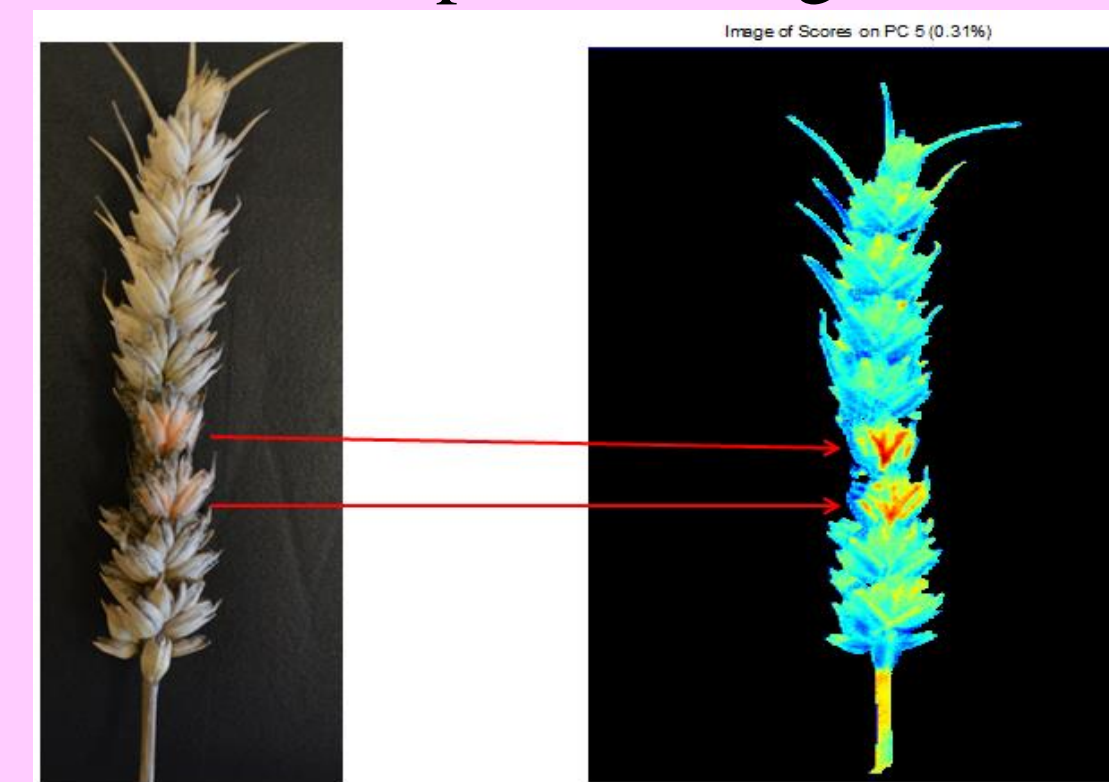
**Discrimination by NIR and chemometric tools
between healthy and diseased wheat head**

Conclusions

The high throughput sampling accessories and the hyperspectral imaging systems are adequate tools to bring the NIR technology in the field of the detection and quantification of contaminants. They allow scanning rapidly small sample fractions in order to lower the limit of the detection and to match the official control requirement. This approach can be used as control tool at the reception of grains and in the future at the field level for early detection.

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