Agricultural Engineering | Sensor systems and measuring instruments | Technology Offer

Rapid Phenotyping of Seed Oil Content – Novel fully automated high-throughput sorting device

Field of application

Plant research, especially breeding of oil plants, require rapid and non-destructive methods to determine the exact properties of individual seeds from a bulk of seeds. In particular, the measurements must be traceable back to the individual seeds in order to identify/sort seeds based on their properties.

State of the art

Various measuring methods exist for analyzing the properties of individual seeds, including solvent extraction, microwave-assisted extraction and soxtherm extraction. Unfortunately, these methods are time-consuming and labor-intensive, while also often using chemicals which may destroy the seeds or constituents thereof. Therefore, methods which use nuclear magnetic resonance (NMR) have been developed as a quick, nondestructive and precise measuring method for determining properties of individual seeds.
However, available devices neither solve the problem of removing individual seeds from a bulk nor achieve the task of selecting and/or sorting desired seeds from a bulk of seeds.

Innovation

Inventors at the Institute of Plant Breeding of the University of Hohenheim, Germany have solved the problem of how to analyze the oil content of large numbers of seeds in a time-saving manner and, at the same time, sort the seeds based on their oil content.
The inventors have developed a fully automated high-throughput device for (i) singling, (ii) weighing and (iii) oil mass measurement using NMR and (iv) sorting of individual seeds. The device has a modular design, including a sampling device and a final module that sorts seeds according to their oil content. The seeds are moved pneumatically within the device and can finally be placed on a tray in a grid pattern. A computer tracks the placement of each individual seed and, for example, identifies the top 10 % of seeds based on their oil content. Sorting into categories is also possible, such as distinguishing haploid from diploid seeds. The device is easy to handle and fully automated, enabling for example operation overnight.

Patent portfolio

German Patent DE 102015226349 granted; Patent applications pending in Europe, USA, Canada and China.

Your benefits at a glance

- ✓ High-throughput measuring and sorting device for seeds
  - fully automated
  - non-destructive
  - high accuracy
  - high speed (600 seeds per hour)
- ✓ Device uses commercially available TD-NMR equipment, but optical measuring methods such as infrared (IR) or near infrared (NIR) may also be integrated
- ✓ Measurement of oil content of canola, castor bean, cotton, jatropha, maize, soybean and sunflower successfully tested
- ✓ Device also works after adjustment with properties other than oil content

Technology transfer

TLB GmbH manages inventions until they are marketable and offers companies opportunities for license and collaboration agreements.

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Additional information

Melchinger, A.E., S. Munder, F. J. Mauch, V. Mirdita, J. Böhm, J. Müller 2017. High-throughput platform for automated sorting and selection of single seeds based on time-domain nuclear magnetic resonance (TD-NMR) measurement of oil content. Biosystems Engineering 164: 213-220.
DOI: 10.1016/j.biosystemseng.2017.10.011

Melchinger, A.E., J. Böhm, H. F. Utz, J. Müller, S. Munder, and F. J. Mauch 2018. High-Throughput Precision Phenotyping of the Oil Content of Single Seeds of Various Oilseed Crops. Crop Sci. 58: 670- 678.
DOI: 10.2135/cropsci2017.07.0429

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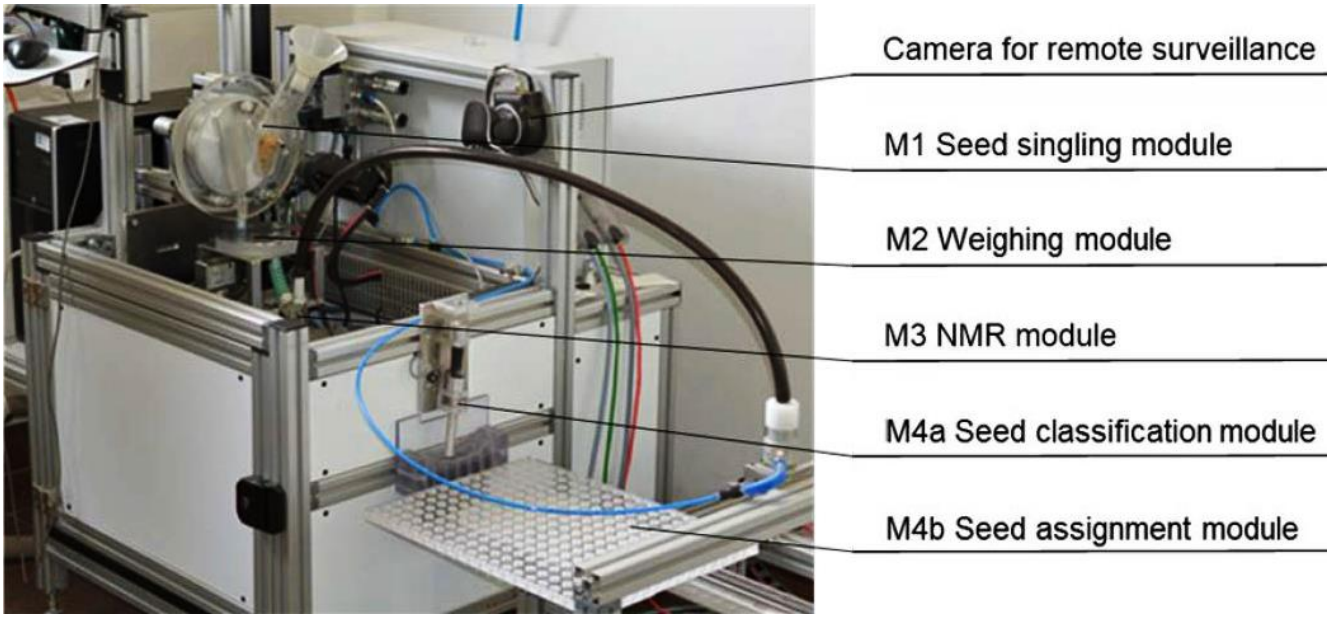

Figure 1: Overview of the invention with five functional modules with M1 for removing individual seeds from a bulk of seeds, M2 for weighing each seed, M3 for obtaining NMR measurements of seed oil mass, and either M4a for sorting individual seeds into predefined classes based on oil content or M4b for placing individual seeds in cells of a matrix tray to retain individual seed data [University of Hohenheim].

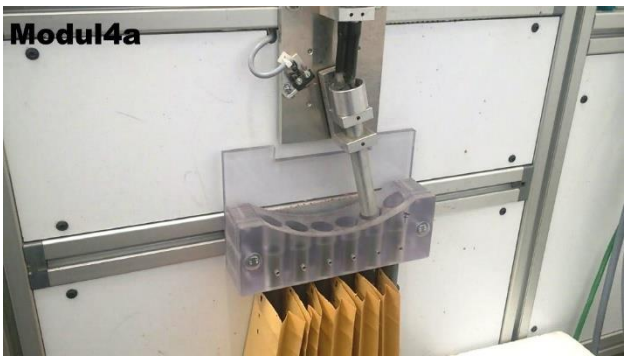

Figure 2: Close-up of the Module 4a for sorting a bulk of seeds into different classes. Here, each seed bag represents a different fraction of seeds based on oil content. The first class with lowes oil content contains mostly embryoless seeds, while the next two fractions with lowest oil content contail almost exclusively haploid seeds. In contrast, the highest oil fraction contains almost exclusively diploid seeds [University of Hohenheim].

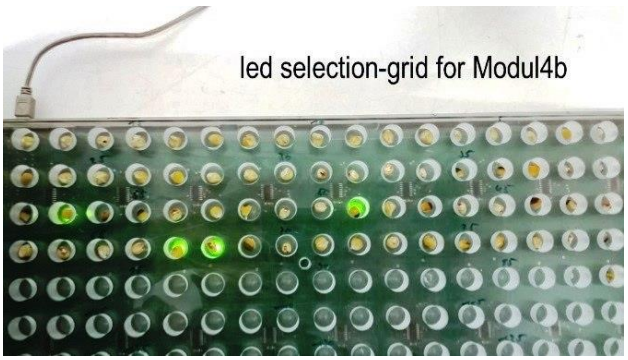

Figure 3: Close up of the matrix tray of Module 4b. Here, a bulk of seeds was phenotyped by the high-throughput platform for oil content and placed in individual cells of the tray with help of a computer-controlled X-Y table. Cells in the tray illuminated with greed LEDs are the individual seeds meeting the selection criteria (defined by the user using a simple graphical interface for control software on the integrated computer) [University of Hohenheim].

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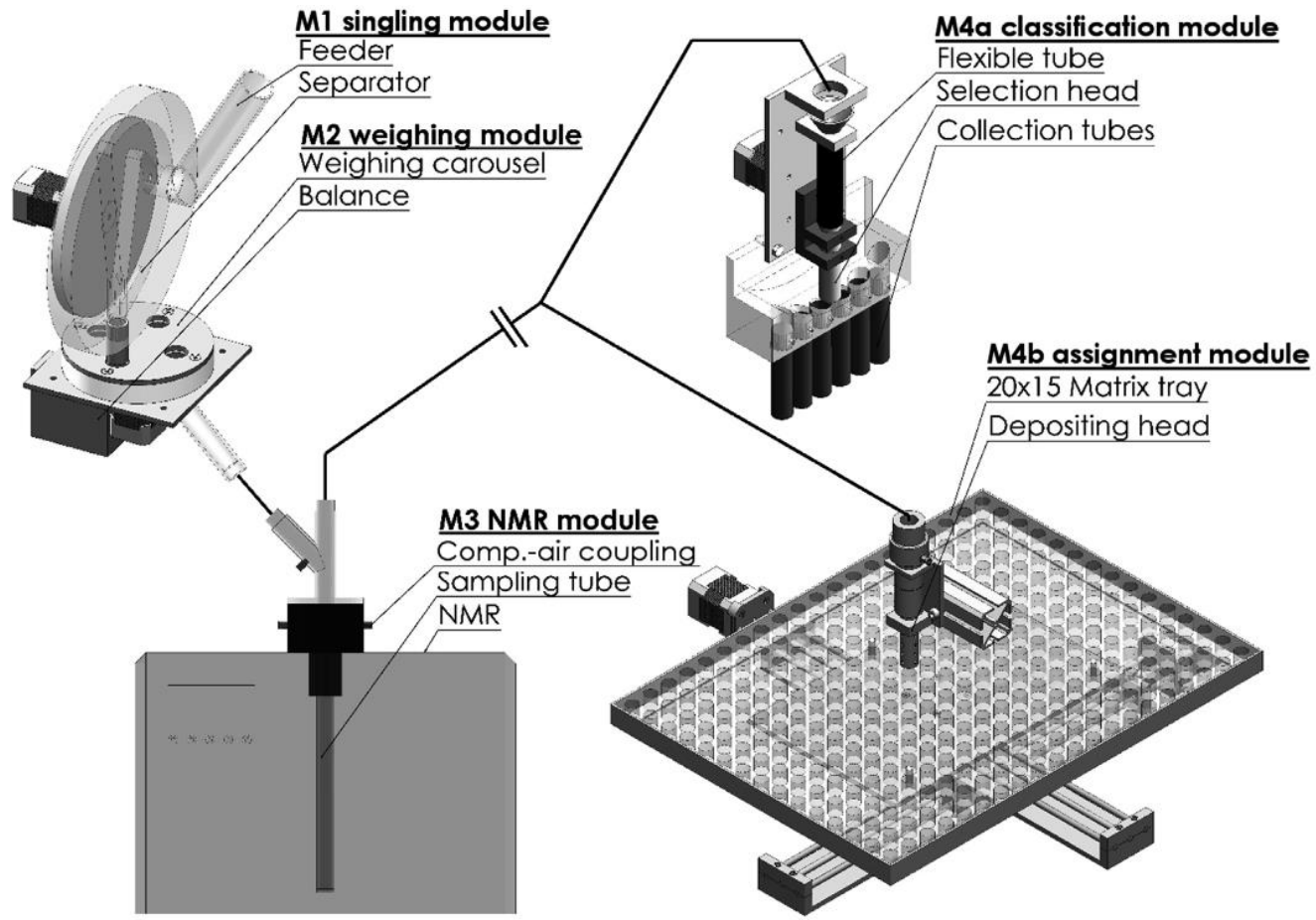

Figure 4: Schematic representation of all five functional modules [University of Hohenheim].

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