



Data standards for plant phenotyping: MIAPPE and its implementations

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► To cite this version:

Cyril Pommier, Guillaume Cornut, Thomas Letellier, Célia Michotey, Pascal Neveu, et al.. Data standards for plant phenotyping: MIAPPE and its implementations. 26. Plant and Animal Genome Conference (PAG XXVI), Jan 2018, San Diego, Californie, United States. pp.24 slides. hal-02789754

HAL Id: hal-02789754

<https://hal.inrae.fr/hal-02789754>

Submitted on 5 Jun 2020

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MIAPPE Plant Phenotyping Data standard

Minimum Information About Plant Phenotyping Experiment and its implementations

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14 Jan 2018



PLANT PHENOTYPING DATA STANDARD NEED



Plant Phenotyping Experiment Data

- Heterogeneous Datasets
 - Single field trial
 - Phenotyping Field networks on multiple years
 - Automated Greenhouse
- Heterogeneous measure types
 - Experimenter measures and notations
 - Low throughput sensors and measurement devices
 - Yield, plant height, disease notations, NIRS
 - Automated measures
 - High throughput Greenhouses or Field
 - Drones, Phenomobiles, sensor networks
 - Images, Multispectral, LIDAR, NIRS
- Heterogeneous, multiscale variables
- Highly distributed repositories: Experimental platform, Projects, Institutes

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Plant Phenotyping Experiment Data Interoperability

- High Data Interoperability need
 - Intra dataset interoperability
 - Phenotyping networks consolidation
 - Project integration
 - Inter dataset interoperability
 - large scale breeding
 - genetic analysis
 - climat change studies
 - ...
- Interoperability and sharing principle
FAIR

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Plant Phenotyping Experiment Data FAIR Data Principles

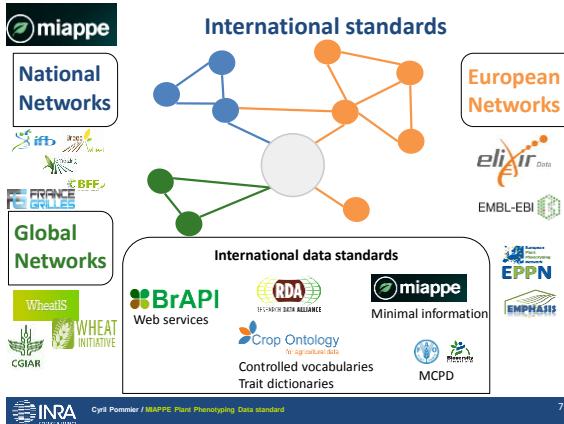
F indable	A ccessible	I nteroperable	R eusable
Ids Metadata Indexed	Open Protocol Perennial Metadata	Linked Data Vocabularies	License Well described Provenance Standards https://www.ontoforce.com

Wilkinson, M. D. et al. The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data* 3, 160018 (2016).

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MIAPPE STANDARD

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Minimum Information About Plant Phenotyping Experiment

- Standard
 - Data exchange and traceability
 - Repositories
 - Analysis
- Input and output for analysis pipelines developed for phenotyping and genetic

Measures for interoperability of phenotypic data: minimum information requirements and formatting

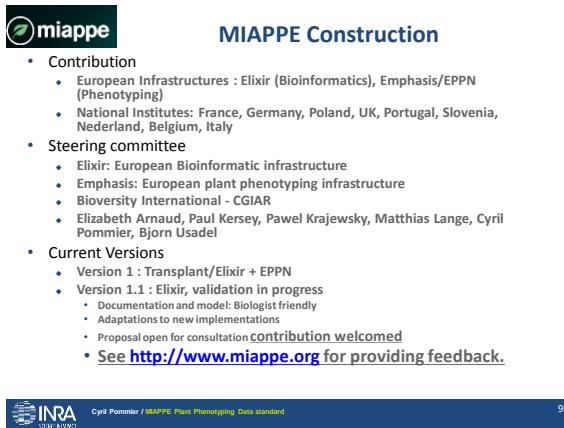
Hanna Chekli-Kupczik, Thomas Altmann, Daniel Arend, Elizabeth Arnaud, Dijun Chen, Guillaume Cornut, Fabio Fiorani, Wojciech Frohberg, Astrid Junker, Christian Klukas, Matthias Lange, Cezary Matusz, Anhita Nafisi, Pascal Neveu, Jan van Oeveren, Cyril Pommier, Hendrik Poorter, Philipp Rocca-Serra, Susanna-Assunta Sansone, Uwe Scholz, Marco van Schriek, Umit Seren, Björn Usadel, Stephan Weise, Paul Kersey and Paweł Krajewski

Plant Methods 2016; 12: 12.

Towards recommendations for metadata and data handling in plant phenotyping

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This Article
J. Exp. Bot. (2015) 66 (18): 5417–5430.
doi: 10.1093/jxb/erv271
First published online: June 4, 2015
This article is available in: [Electronic](#)

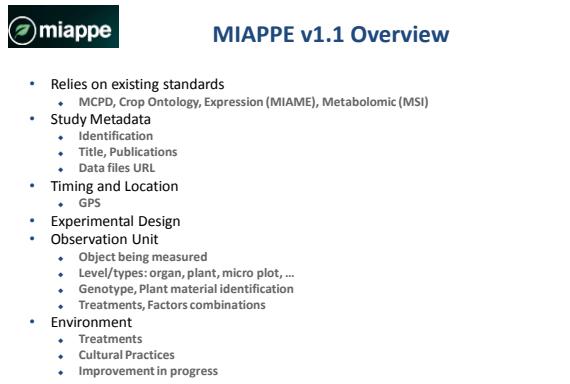


MIAPPE Construction

- Contribution
 - European Infrastructures : Elixir (Bioinformatics), Emphasis/EPPN (Phenotyping)
 - National Institutes: France, Germany, Poland, UK, Portugal, Slovenia, Nederland, Belgium, Italy
- Steering committee
 - Elixir: European Bioinformatic infrastructure
 - Emphasis: European plant phenotyping infrastructure
 - Bioversity International - CGIAR
 - Elizabeth Arnaud, Paul Kersey, Paweł Krajewsky, Matthias Lange, Cyril Pommier, Björn Usadel
- Current Versions
 - Version 1 : Transplant/Elixir + EPPN
 - Version 1.1 : Elixir, validation in progress
 - Documentation and model: Biologist friendly
 - Adaptations to new implementations
 - Proposal open for consultation contribution welcomed
 - See <http://www.miappe.org> for providing feedback.



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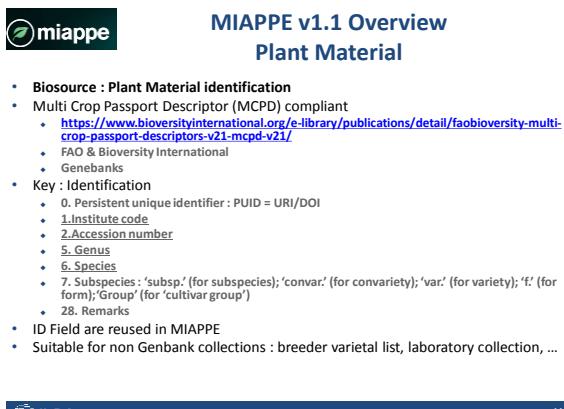


MIAPPE v1.1 Overview

- Relies on existing standards
 - MCPD, Crop Ontology, Expression (MIAME), Metabolomic (MSI)
- Study Metadata
 - Identification
 - Title, Publications
 - Data file URL
- Timing and Location
 - GPS
- Experimental Design
- Observation Unit
 - Object being measured
 - Level/types: organ, plant, micro plot, ...
 - Genotype, Plant material identification
 - Treatments, Factors combinations
- Environment
 - Treatments
 - Cultural Practices
 - Improvement in progress



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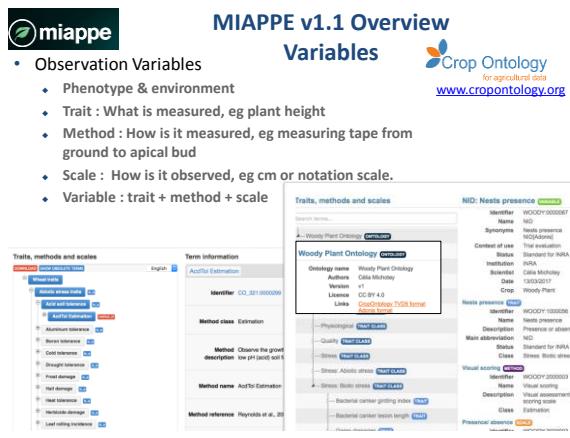


MIAPPE v1.1 Overview Plant Material

- Biosource : Plant Material identification
- Multi Crop Passport Descriptor (MCPD) compliant
 - <https://www.bioversityinternational.org/e-library/publications/detail/faobioversity-multi-crop-passport-descriptors-v21-mcpd-v21/>
 - FAO & Bioversity International
 - Genebanks
- Key : Identification
 - 0. Persistent unique identifier : PUID = URI/DOI
 - 1.Institute code
 - 2.Accession number
 - 5. Genus
 - 6. Species
 - 7. Subspecies : 'subsp.' (for subspecies); 'convar.' (for convariety); 'var.' (for variety); 'f.' (for form); 'Group' (for cultivar group)
 - 28. Remarks
- ID Field are reused in MIAPPE
- Suitable for non Genbank collections : breeder varietal list, laboratory collection, ...



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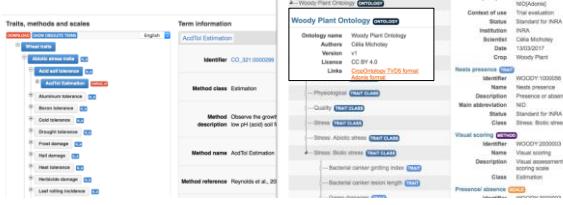
MIAPPE v1.1 Overview

Variables

www.cropontology.org

Observation Variables

- Phenotype & environment
- Trait : What is measured, eg plant height
- Method : How is it measured, eg measuring tape from ground to apical bud
- Scale : How is it observed, eg cm or notation scale.
- Variable : trait + method + scale



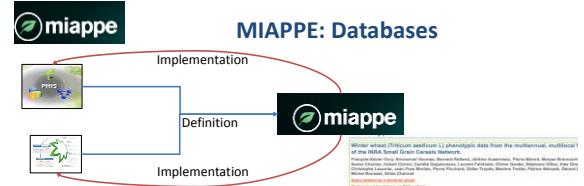
MIAPPE v1.1 Overview



IMPLEMENTATIONS



- Databases and repositories
- File archive
- Web services
- Semantic web and RDF



- Production databases
 - ◆ PHIS
 - Cleaned data publication repositories
 - ◆ GnpS
 - <http://dx.doi.org/10.15454/1.4489666216568333E1>
 - ◆ eDale
 - ◆ PlantPhenoDB
 - Implementation
 - ◆ Internal
 - ◆ Web services API



MIAPPE databases & FAIR

- Findable: Indexed metadata
 - Interoperable : Vocabularies/Ontologies, Plant material ID



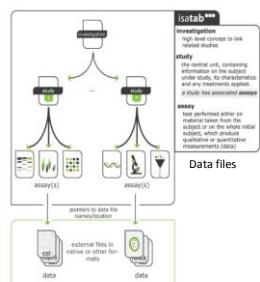
MIAPPE databases & FAIR

- Accessible
 - Reusable: License, File standards
 - Whole Phenotyping Network



MIAPPE File Archive

- **ISA Tab for Phenotyping**
 - ◆ Investigation/Study/Assay
 - ◆ Zip Archive
 - MIAPPE Metadata
 - Raw data
 - CSV
 - Images or binary files
 - Reference to image archive (URI/URL)
 - ◆ Elaborated data
 - CSV
 - Provenance



- International collaboration
 - Vision : To provide a standard Open API for easily, securely, and efficiently exchanging information between systems and applications that support breeding
 - MIAPPE BrAPI alignment and compliance



MIAPPE Web Service : Breeding API

- Resources
 - <http://brapi.org/>
- Collection of specifications for data retrieval and exchange
- Servers implementations
 - CGIAR International network
 - Integrated Breeding Platform
 - Elixir Ecelerate
 - Emphasis: PHIS
 - Germinate
 - Gnpis
- Clients implementations
 - Flapjack : genotyping data visualization
 - Gnpis
 - Ontology Widget
 - <https://github.com/gnpis/trait-ontology-widget>
 - R analysis pipelines



MIAPPE Semantic: Plant Phenotyping Experiment Ontology

- Joint initiative : Elixir, Emphasis, CropOntology, RDA
- Goals:
 - Enable computer interpretation of MIAPPE
 - Formally integrate MIAPPE and BrAPI
 - MIAPPE ontology
 - Provide context for publishing datasets in JSON-LD or RDF



MIAPPE Semantic: RDA RDFENO

- MIAPPE OWL Ontology
 - First draft
 - <https://github.com/MIAPPE/MIAPPE-ontology>
- BrAPI 2 MIAPPE RDF workflow
 - <http://www.wheatis.org> data standard page
 - <http://lst.blogs.inra.fr/wdi/phenotypes-as-rdf/>
- Agroportal
 - Agromony bioportal
 - <http://agroportal.lirmm.fr/ontologies/PPEO>
- Wheat dataset
 - <http://dx.doi.org/10.1545/1.4489666216568333E12>
 - Future Query: Impact of summer temperature on yield



Adoption

- Plant community involved
 - Elixir (European bioinformatic infrastructure)
 - Emphasis (European Phenotyping infrastructure)
 - Bioversity international CGIAR
- Breeding API is Elixir official Phenotyping standard web service
- MIAPPE and BrAPI high collaboration
 - adoption and compliance
- Data repositories and management tools
 - Gnpis <https://urgi.versailles.inra.fr/gnpis/>
 - eDali <https://edali.ipk-gatersleben.de/>
 - PlantPhenoDB at IPGPAS <http://cropnet.pl/plantphenodb/>
- In progress: COPD, Elixir plant databases (iBet, WUR, VIB, ...), Brassica Information Portal, ...



Perspectives

- Version 2 : Emphasis, Elixir, ...
 - Environment
 - Sensor tracability
 - PhenoHarmonis Workshop Montpellier may 2018
- Distributed search, MIAPPE enabled.
 - Data discovery
 - Elixir
 - WheatIS & Emphasis ?
 - Open source software
- Dataset Validation
 - Elixir
 - File archive (ISA Tab) and BrAPI based



Acknowledgment & Questions

- transPLANT exCelerate EMPLAIS BrAPI
- EMBL-EBI
 - Paul Kersey
- IPG PAS
 - Hanna Cwikl-Kupczynska
 - Pawel Krajewski
- INRA cirad EURLI PHENOME
 - Cyril Pommier
 - Anne Françoise Adam
 - Blondon
 - Guillaume Comut
 - Thomas Letellier
 - Céline Michotey
 - Pascal Neveu
 - Manuel Ruiz
 - Pierre Larmande
- iBET
 - Bruno Costa
 - Inês Chaves
 - Célia M. Miguel
 - Daniel Faria
- IGC
 - Cyril Pommier
 - Elisabeth Arnaud
 - Marie Angélique Laporte
- VIB
 - Frederik Coppens
- WAGENINGEN UNIVERSITY & RESEARCH
 - Richard Finkers
- EARLHAM INSTITUTE
- Mistea
 - Earlham Institute
- NIB

