

MIAPPE Plant Phenotyping Data standard

Minimum Information About Plant Phenotyping Experiment and its implementations

elixir, EMPHASIS, Bioversity International, Crop Ontology

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PLANT PHENOTYPING DATA STANDARD NEED

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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 Findable	A Accessible	I Interoperable	R Reusable
Ids Metadata Indexed	Open Protocols 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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International standards

National Networks

- ifit
- FRANCE GRILLES
- BFF

Global Networks

- WheatIS
- WHEAT INITIATIVE
- CGIAR

European Networks

- elixir
- EMBL-EBI
- EPPN
- EMPHASIS

International data standards

- BrAPI Web services
- RDA
- miappe Minimal information
- Crop Ontology by agricultural data
- Controlled vocabularies Trait dictionaries
- MCPD

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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 Cwik-Kupczyńska, Thomas Altmann, Daniel Arend, Elizabeth Arnaud, Dijun Chen, Guillaume Cornus, Fabio Fiorani, Wojciech Frohmberg, Astrid Junker, Christian Klukas, Matthias Lange, Cezary Mazurek, Cezary Neveu, Pascal Neveu, Jan van Deverren, Cyril Pommier, Hendrik Poorter, Philippe Rocca-Serra, Susanna-Assunta Sansone, Uwe Scholz, Marco van Schriek, Umit Seren, Björn Usadel, Stephan Weise, Paul Kersey and Pawel Krajewski III

Plant Methods 2016, 12: 1-12

Towards recommendations for metadata and data handling in plant phenotyping

Pawel Krajewski^{1,2}, Dijun Chen², Hanna Cwik¹, Aali D.J. van Dijk³, Fabio Fiorani⁴, Paul Kersey⁵, Christian Klukas⁶, Matthias Lange⁷, Augustyn Markiewicz⁸, Jan Peter Nap⁹, Jan van Oeveren¹, Cyril Pommier¹, Uwe Scholz¹, Marco van Schriek¹, Björn Usadel¹⁰ and Stephan Weise⁷

1. Exp. Bot. (2015), 66 (18): 5417-5427. doi: 10.1093/xmb/evv271
First published online: June 4, 2015

This article is available at www.tandfonline.com

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MIAPE 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
 - Biodiversity International - CGIAR
 - Elizabeth Arnaud, Paul Kersey, Pawel Krajewski, 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.miape.org> for providing feedback.

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MIAPE v1.1 Overview

- Relies on existing standards
 - MCPD, Crop Ontology, Expression (MIAME), Metabolomic (MSI)
- Study Metadata
 - Identification
 - Title, Publications
 - Data files 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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MIAPE v1.1 Overview Plant Material

- Biosource : Plant Material identification
- Multi Crop Passport Descriptor (MCPD) compliant
 - <https://www.biodiversityinternational.org/e-library/publications/detail/faobiodiversity-multi-crop-passport-descriptors-v21-mcpd-v21/>
 - FAO & Biodiversity 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 MIAPE
- Suitable for non Genbank collections : breeder varietal list, laboratory collection, ...

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MIAPE v1.1 Overview Variables

- 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

Woodsy Plant Ontology

Ontology name: Woodsy Plant Ontology
 Authors: Cella McInelly
 Version: v1
 License: CC BY 4.0
 Labels: [GO](#) [Plant Ontology](#) [POT](#) [POT:0000001](#)

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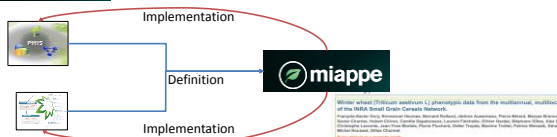
IMPLEMENTATIONS



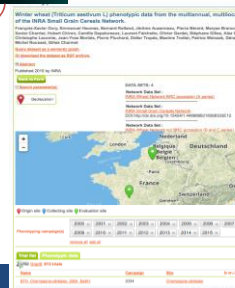
- Databases and repositories
- File archive
- Web services
- Semantic web and RDF



MIAPPE: Databases

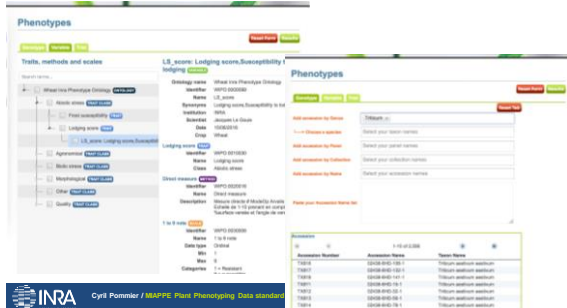


- Production databases
 - PHIS
- Cleaned data publication repositories
 - GnpIS <http://dx.doi.org/10.15454/1.44896621568333E12>
 - eDale
 - PlantPhenoDB
- Implementation
 - Internal
 - Web services API



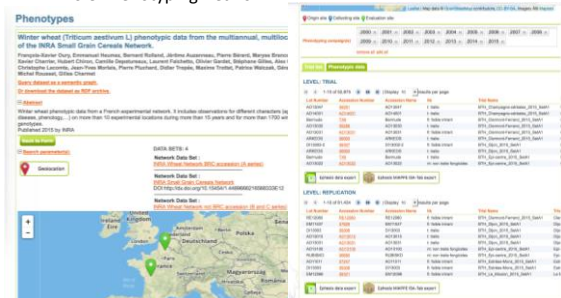
MIAPPE databases & FAIR

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



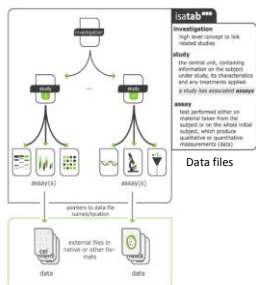
MIAPPE databases & FAIR

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



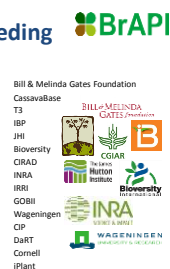
MIAPPE File Archive

- 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



MIAPPE Web Service : Breeding API

- 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 MIAAPE Web Service : Breeding BrAPI API

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

miappe MIAAPE Semantic: Plant Phenotyping Experiment Ontology

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

miappe MIAAPE Semantic: RDA RDFENO

- MIAAPE OWL Ontology
 - First draft
 - <https://github.com/MIAAPE/MIAAPE-ontology>
- BrAPI 2 MIAAPE RDF workflow
 - <http://www.wheatis.org> data standard page
 - <http://ist.blogs.inra.fr/wdi/phenotypes-as-rdf/>
- Agroportal
 - Agronomy bioportal
 - <http://agroportal.lirmm.fr/ontologies/PPEO>
- Wheat dataset
 - <http://dx.doi.org/10.15454/1.4489666216568333E12>
 - Future Query: Impact of summer temperature on yield

miappe Adoption

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

miappe Perspectives

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



miappe Acknowledgment & Questions