

Minimum Information About a Plant Phenotyping Experiment (MIAPPE)

Attributes (concepts, subconcepts - in terms of ontology) marked by asterisk (*) are essential for a description of experiment (e.g. by Poorter et al. [26]); the rest forms an extended description. For some attributes examples of possible values are listed.

Checklist section	Attributes	Source list / Biosharing ID / Reference	Recommended ontologies
General metadata	Unique identifier* Title* Description* Submission date Public release date Publications Laboratory address and contact details	Default ISA-Tab configuration [1]	OBI, Ontology for Biomedical Investigations [2] CRO, Crop Research Ontology [3]
Timing and location	Timing: Start of experiment (date)* Duration (days/months/years)* Experiment location: Geographic location* Latitude and longitude Altitude Inclination and aspect Habitat	Poorter et al. [4] Morrison et al. [5] CIMR [6]: Environmental Analysis Context [7]	OBI, Ontology for Biomedical Investigations [2] GAZ, Gazetteer [9]
Biosource	Organism (taxon)* Infraspecific_name* Infraspecific_rank Common name Genotype Organism age Life stage Seed preparation: Seed source* Pretreatments Conservation conditions	MIxS Plant-associated environmental package [10] Yilmaz et al. [11] FAO/Bioversity Multi-Crop Passport Descriptors V.2 (MCPD V.2) [12]	UNIPROT Taxonomy [13] NCBI Taxonomy [14]

<p>Environment</p>	<p>Growth facility* (growth chamber, GC / greenhouse, GH / open top chamber, OTC / experimental garden / experimental field)</p> <p>Aerial conditions*</p> <p>CO₂ for GC and GH: Controlled/uncontrolled Average CO₂ during the light and dark period ($\mu\text{mol mol}^{-1}$)</p> <p>Air humidity (moisture)* Average VPD_{air} during the light period (kPa) or Average humidity during the light period (%) Average VPD_{air} during the night (kPa) or Average humidity during the night (%)</p> <p>Daily photon flux (light intensity)* Average daily integrated PPFD measured at plant or canopy level ($\text{mol m}^{-2} \text{day}^{-1}$) Average length of the light period (h) for GC: Light intensity ($\mu\text{mol m}^{-2} \text{s}^{-1}$) Range in peak light intensity ($\mu\text{mol m}^{-2} \text{s}^{-1}$) for GH and OTC: Fraction of outside light intercepted by growth facility components and surrounding structures</p> <p>Light quality: for GC and GH: Type of lamps used R/FR ratio (mol mol^{-1})</p> <p>Temperature (°C)* Average day temperature Average night temperature Change over the course of experiment</p> <p>Rooting conditions* Rooting medium*: aeroponics / hydroponics (water-based, solid-media based) / soil type (sand, peat, clay, mixed, ...) For greenhouse: Container type*, Volume (L)*,</p>	<p>Poorter et al. [4] Hanneman et al. [15]</p>	<p>XEO, XEML Environment Ontology [16] ENVO, Ontology of environmental features and habitats [17] Crop Research Ontology [3]</p>
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Height,
 Other dimensions*,
 Number of plants per container*.

For field:
 Plot size*
 Sowing density*
 pH*
 Frequency and volume of replenishment or addition

Soil parameters:
 Soil penetration strength (Pa m^{-2})
 Water retention capacity (g g^{-1} dry weight)
 Organic matter content (%)
 Porosity (%)
 Rooting medium temperature

Nutrients
 For hydroponics:
 Composition*
 Concentration
 For soil:
 Extractable N content per unit ground area before fertiliser added*
 Type and amount of fertiliser added per container or m^2 *
 Concentration of P and other nutrients before start of the experiment
 Extractable N content per unit ground area at the end of the experiment

Watering
 Irrigation type: irrigation from top/bottom/drip irrigation*
 Volume (L) and frequency of water added per container or m^2 *
 For soil:
 Range in water potential (MPa)

Salinity
 Concentration of Na, Cl and Mg in the water used for irrigation
 For soils and hydroponics:
 electrical conductivity (dS m^{-1})

Aquatic environment

	<p>If sample was submerged and emerged</p> <p>Depth</p> <p>Time</p> <p>Water temperature</p> <p>Tidal phase</p> <p>Biotic environment</p> <p>Description of interacting organism (pathogens, mutualists, herbivores, endophytes, etc.)</p>		
Treatments	<p>Seasonal environment</p> <p>Air temperature regime</p> <p>Soil temperature regime</p> <p>Antibiotic regime</p> <p>Chemical administration</p> <p>Disease status</p> <p>Fertilizer regime</p> <p>Fungicide regime</p> <p>Gaseous regime</p> <p>Gravity</p> <p>Growth hormone regime</p> <p>Herbicide regime</p> <p>Mechanical treatment</p> <p>Mineral nutrient regime</p> <p>Humidity regime</p> <p>Non-mineral nutrient regime</p> <p>Radiation (light, UV-B, X-ray) regime</p> <p>Rainfall regime</p> <p>Salt regime</p> <p>Watering regime</p> <p>Water temperature regime</p> <p>Standing water regime</p> <p>Pesticide regime</p> <p>pH regime</p> <p>Other perturbation</p>	<p>MIxS Plant-associated environmental package [10]</p> <p>Yilmaz et al. [11]</p>	<p>XEO, XEML Environment Ontology [16]</p> <p>CRO, Crop Research Ontology [3]</p>
Experimental design	<p>Spatial coordinates</p> <p>Plant ID</p> <p>Plot ID</p>		<p>OBI, Ontology for Biomedical Investigations [2]</p>

	<p>Plot (x, y) coordinates</p> <p>Time coordinates Day Time</p> <p>Blocking Block ID Sub-block ID Sub-sub-block ID Superblock ID Row ID Column ID Other ID</p> <p>Replication Biological replication Technical replication</p> <p>Experimental unit</p>		<p>STATO, Statistics Ontology [18]</p> <p>CRO, Crop Research Ontology [3]</p>
<p>Sample collection, processing, management</p>	<p>Plant body of interest (organ)* Plant product Organism count Sample temperature Oxygenation status of sample Sample salinity Sample storage duration Sample storage location Sample storage temperature Sampling time</p>	<p>CIMR [6]: Plant Biology Context [8]</p> <p>Fiehn et al. [19]</p> <p>List exist for assays in CIMR, MIAPE, MIMARKS (ISA-Tab configurations) + new attributes for phenotypic assays</p>	

Observed variables	Phenotypic variables Trait* Method* Scale* Environmental variables Trait* Method* Scale* Data processing protocols	“Trait/Method/Scale” triplet approach applied by Generation Challenge Program, Crop Ontology [20] Shrestha et al. [21] Poorter et al. [4] Hanneman et al. [15]	TO, Plant Trait Ontology [22] PO, Plant Ontology [23] CO, Crop Ontology [20] PATO, Phenotypic Quality Ontology [24] XEO, XEML Environment Ontology [16]
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References*

- [1] ISA-Tab reporting guideline. <http://www.biosharing.org/bsg-000078>.
- [2] Ontology for Biomedical Investigations. <http://obi-ontology.org>.
- [3] Crop Research Ontology. http://cropontology.org/ontology/CO_715/Crop%20Research.
- [4] Poorter H, Fiorani F, Stitt M, et al. The art of growing plants for experimental purposes: a practical guide for the plant biologist. *Funct Plant Biol* 2012. 39:821–38.
- [5] Morrison N, et al. Standard reporting requirements for biological samples in metabolomics experiments: environmental context. *Metabolomics* 2007; 3:203.
- [6] Core Information for Metabolomics Reporting. <http://www.biosharing.org/bsg-000175>.
- [7] CIMR: Environmental Analysis Context. http://msi-workgroups.sourceforge.net/bio-metadata/reporting/env/reporting-requirements/ECWSG_reporting_requirements_v1.rtf.
- [8] CIMR: Plant Biology Context. <http://msi-workgroups.sourceforge.net/bio-metadata/reporting/pbc/doc.rtf>.
- [9] Gazetteer. <http://purl.bioontology.org/ontology/GAZ>.
- [10] Minimum Information about any (x) Sequence, reporting guideline. <http://www.biosharing.org/bsg-000518>.
- [11] Yilmaz P, et al. The genomic standards consortium: bringing standards to life for microbial ecology. *ISME Journal* 2011; 5:1565-1567.
- [12] FAO/Bioversity Multi-Crop Passport Descriptors, <http://www.bioversityinternational.org/e-library/publications/detail/faobioversity-multi-crop-passport-descriptors-v2-mcpd-v2>.
- [13] UNIPROT Taxonomy. <http://www.uniprot.org/taxonomy>.
- [14] NCBI Taxonomy <http://www.ncbi.nlm.nih.gov/taxonomy>.
- [15] Hannemann J, Poorter H, Usadel B, et al. Xeml Lab: a software suite for a standardised description of the growth environment of plants. *Plant Cell Environ* 2009. 32:1185–200.
- [16] XEML Environment Ontology. <http://purl.bioontology.org/ontology/XEO>.
- [17] Ontology of environmental features and habitats <http://purl.bioontology.org/ontology/ENVO>.
- [18] Statistics Ontology. <http://bioportal.bioontology.org/ontologies/STATO>. Accessed 30 March 2016.
- [19] Fiehn O, et al. Minimum reporting standards for plant biology context information in metabolomic studies. *Metabolomics* 2007; 3:195-201.
- [20] Crop Ontology Platform. <http://www.cropontology.org>.
- [21] Shrestha R, et al. Bridging the phenotypic and genetic data useful for integrated breeding through a data annotation using the CropOntology developed by the crop communities of practice. *Front Physiol* 2012; 3: 326.
- [22] Plant Trait Ontology. <https://bioportal.bioontology.org/ontologies/PTO>.
- [23] PO, Plant Ontology. <http://www.plantontology.org>.
- [24] PATO, Phenotypic Quality Ontology. <http://purl.bioontology.org/ontology/PATO>. Accessed 30 March 2016.

*Online resources accessed 30 March 2016.