Proteomic data from leaves of twenty-four sunflower genotypes under water deficit

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Abstract – This article describes a proteomic data set produced from sunflower plants subjected to water deficit. Twenty-four sunflower genotypes were selected to represent genetic diversity within cultivated sunflower. They included both inbred lines and their hybrids. Water deficit was applied to plants in pots at the vegetative stage using the high-throughput phenotyping platform Heliaphen. We present here the identification of 3062 proteins and the quantification of 1211 of them in the leaves of the 24 genotypes grown under two watering conditions. These data allow the study of both the effects of genetic variations and watering conditions. They constitute a valuable resource for the community to study adaptation of crops to drought and the molecular basis of heterosis.

Keywords: Helianthus / abiotic stress / proteomics / drought / heterosis


Mots clés : Helianthus / stress abiotique / protéomique / sécheresse / hétérosis

Subject area: Biology
More specific subject area: Proteomics
Type of data: Peptide and protein identification; protein quantification
How data was acquired: Mass spectrometry (LC-MS)
Data format: mzXML open format for raw mass spectrometry data; opendocument format for protein identification (.ods file); R data file for protein quantification (.RData file)
Experimental factors: 24 genotypes of Helianthus annuus in two environmental conditions (irrigated or not) with 3 replicates
Experimental features: Identification and quantification of sunflower leaf proteins
Data source location: The outdoor Heliaphen phenotyping platform at the Institut national de la recherche agronomique (INRA) station, Auzeville, France (43°31’41.8”N, 1°29’58.6”E)
Data accessibility: These data are publicly available in ProticDB with following DOI: https://doi.org/10.15454/TW59-P718
Related research article: Badouin et al., 2017; Blanchet et al., 2018

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Table 1. Parameters used for mass spectrometry analyses.

<table>
<thead>
<tr>
<th>Identification software</th>
<th>X'Tandem Piledriver (2015.04.01.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X'TandemPipeline 3.4.3 “Elastine Durcie”</td>
<td><a href="http://www.thegpm.org/">http://www.thegpm.org/</a></td>
</tr>
<tr>
<td>Filtering and inference software</td>
<td></td>
</tr>
<tr>
<td>X'TandemPipeline 3.4.3 “Elastine Durcie”</td>
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<tr>
<td>Filters</td>
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<tr>
<td>Proteins: log (e-value) &lt; -5</td>
<td></td>
</tr>
<tr>
<td>Proteins: minimum 2 peptides</td>
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</tr>
<tr>
<td>Peptides: e-value &lt; 0.01</td>
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<tr>
<td>Fixed</td>
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<tr>
<td>Carboxymethylation of Cys residues = +57.04</td>
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<tr>
<td>Possible</td>
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<td>Oxidation of Met and Trp residues = +15.99</td>
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<td>N-ter acetylation = +42.01</td>
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<tr>
<td>N-ter deamidation of Gln residues = -17.02</td>
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<tr>
<td>N-ter deamidation of Gln residues = -17.02</td>
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<tr>
<td>Loss of H₂O on N-ter Glu residues = -18.01</td>
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<tr>
<td>Deamidation of Gln and Asn residues = +0.98</td>
<td></td>
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<tr>
<td>N-ter Met excision</td>
<td></td>
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</tbody>
</table>

1 Specifications table

2 Value of the data

Climate change is a current issue of major concern because of its actual effects on biodiversity and the agricultural sector. A better understanding of the adaptation of plants to this recent phenomenon is therefore of major interest to crop science and society. Helianthus annuus L., the domesticated sunflower, is the fourth most important oilseed crop in the world (USDA, 2020). It is promising for agriculture adaptation to climate change as it can maintain yield better than most other crops in a wide range of environments, especially during drought stress (Debaeke and Bertrand, 2008; Debaeke et al., 2017). It constitutes an archetypical systems biology model, as response to drought stress involves many molecular pathways and subsequent physiological processes. In addition, heterosis is a phenomenon commonly used to improve yield in allogamous crops such as sunflower. To study its impact on the response to drought at the molecular level, we analysed the leaf proteome of twenty-four genotypes of cultivated sunflower at the molecular level, we analysed the leaf proteome that were either well watered or subjected to water deficit (WD) or well watered (WW) conditions with 3 replicates (two missing data).

Different ecophysiological traits were measured on these plants (Blanchet et al., 2018), making it possible to study the relationships between protein expression and plant traits as a function of water stress and heterozygosity.

3 Data

This dataset provides identification and quantification data for proteins of sunflower leaves from 142 plants distributed in 24 genotypes grown in water deficit (WD) or well watered (WW) conditions with 3 replicates (two missing data).

The raw data associated with this article (data from the mass spectrometer in mzXML format) as well as annotated spectra, identification and quantitative data can be found at the following link https://doi.org/10.15454/TW59-P718 or directly at http://moulon.inra.fr/protic/sunrise. Parameters used for mass spectrometry analyses are shown in Table 1.

4 Experimental design, plant material and growth conditions

One hundred and forty-four plants corresponding to 24 genotypes (four female lines [SF009, SF092, SF109 and SF109], four male lines [SF279, SF317, SF326, SF342]) and their 16 hybrids were grown under two treatment conditions (WW and WD), with three plants per genotype and per treatment.

The experiment design and plant material are fully described in Blanchet et al. (2018). Briefly, the experiment was performed in the outdoor Heliaphen phenotyping platform at the Institut national de recherche pour l’agriculture, l’alimentation et l’environnement (INRAE) station, Auzieville, France. The growth conditions were as previously described in Gosseau et al. (2019). In summary, seeds were germinated in Petri dishes for 78 h at 28 °C, then germinated plantlets were transplanted in 15 L pots in the Heliaphen platform. Pots were covered with a polystyrene sheet to prevent evaporation from the soil.

Pots were normally irrigated, according to Rengel et al. (2012), up to 38 days after germination (DAG; ~20-leaf stage corresponding to bud formation phase (Schneiter and Miller, 1981). At this stage, irrigation of WD plants was stopped. Soil evaporation was estimated according to Marchand et al. (2013). Both WW and WD plants were weighed three or four times per day by a robot to estimate transpiration (Gosseau et al., 2019). After weighting, the robot watered WW plants to maintain soil water at retention capacity, while WD plants were not watered. When the fraction of transpirable soil water reached 0.1 for a WD plant, a leaf sample was harvested both from this plant and from a WW plant. The harvested leaf was...
the leaf above the leaf that had reached its maximum size the most recently. Two plants (SF342 inbred line) died during the experiment and could not be harvested.

5 Proteomics

5.1 Protein extraction

Leaf proteins were extracted using the TCA-acetone protocol described in Méchin et al. (2007). Protein digestion was performed according to the liquid digestion protocol described in Hervé et al. (2016). Briefly, proteins of the TCA-acetone pellet were solubilized in a buffer containing urea, thiourea, dithiothreitol, Tris-Hel pH 8.8 and a zwitterionic acid labile surfactant (ZALSI). Proteins were alkylated by using iodoacetamide and digestion by trypsin was performed after dilution in an ammonium bicarbonate solution. Digestion was stopped by adding trifluoroacetic acid that also allowed ZALS cleavage. The resulting peptide mix was desalted by using C18 solid phase extraction. Eluted peptides were then speedVac dried.

LC-MS/MS was performed as described in Duruflé et al. (2017). Peptides (400 ng) were solubilized in a solution containing 2% acetonitrile and 0.1% formic acid. LC-MS/MS was performed by using an Eksigent nanoLC Ultra 2D nanoHPLC (SCIEX) coupled to a Qexactive mass spectrometer (Thermo, Waltham, MA, USA). After desalting on a trapcolumn, peptides were submitted to a gradient of 5 to 35% ACN that was carried out in 40 min. Data-dependent MS analysis was performed with full scans at a 75,000 resolution and MS/MS scans at a 17,500 resolution. The isolation window was set to 3 m/z. MS/MS was repeated for the eight most intense ions detected in full scan and dynamic exclusion was set to 40 s.

5.2 Identification of proteins by LC-MS/MS

Protein identification was made by searching the Heliagen database using genome HanXRQv1 (Badouin et al., 2017) with the X!Tandem search engine (Craig et al., 2004). Data filtering and protein inference were performed by using X! TandemPipeline 3.3.4 (Langella et al., 2017). Trypsin digestion was set with one and five possible miss cleavages in the first and refine pass, respectively. Only proteins identified with at least two different peptides in the same sample were considered (Valot et al., 2011).

5.3 Bioinformatics annotation of proteins and quantification

Quantification by integration of the extracted ion current (XIC) was operated using the MassChroQ software (Valot et al., 2011). Only proteins quantified with at least 2 specific peptides that were present in at least 90% of the samples were selected for analysis. A total of 1211 of the 3062 identified proteins met this criterion. Functional annotation of proteins is given according to the INRAE Sunflower Bioinformatics Resources (www.heliogene.org/HanXRQ-SUNRISE/).

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References


