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Metabolomics to Assess the Impacts of Nanopesticides on Crops

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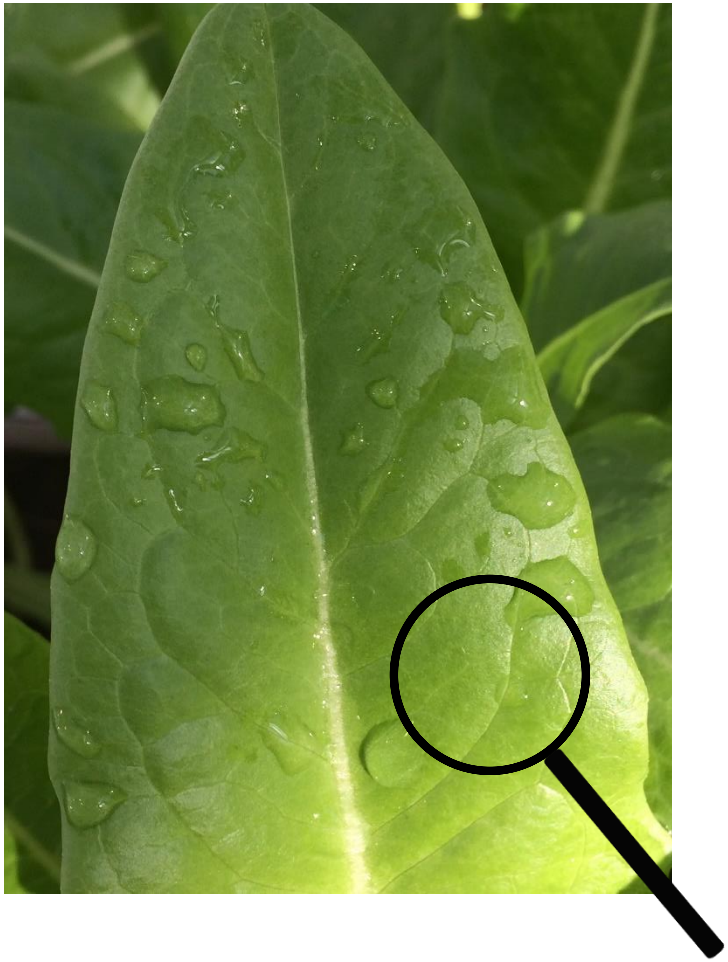
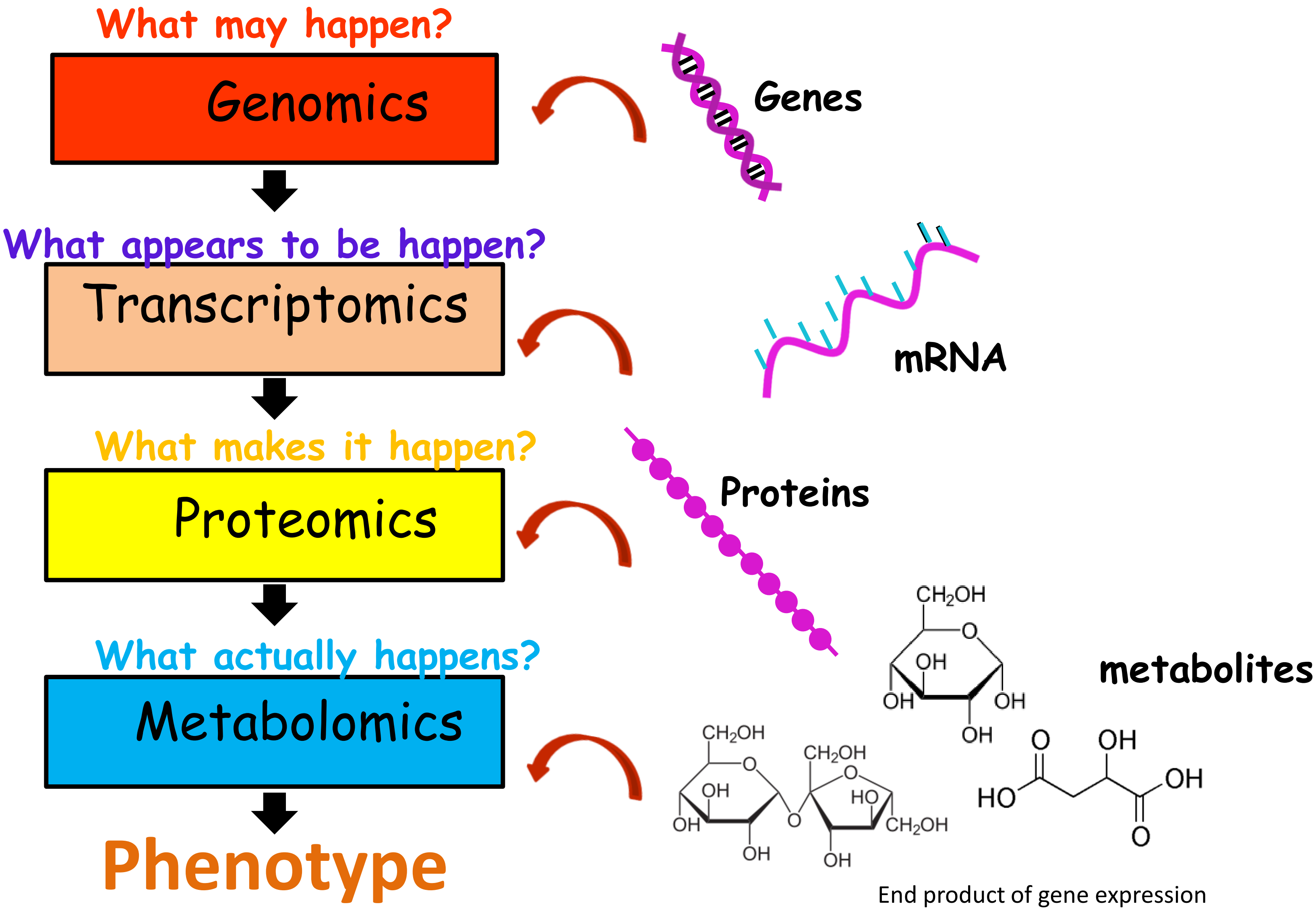
Background

Sources:
https://www.google.com/search?q=pesticide+spray&biw=1236&bih=636&source=lnms&tbm=isch&sa=X&ved=0CAYQ_AUoAWoVChMIhaSP0sT8yAIVRcljCh1joQ1F

What is the plants responses to stress induced by nanoparticles?



Using Omics to study the toxicity of nanoparticles to plants



Experimental Design

Control

Low
1050 mg/L

High
1555 mg/L

Cu$(OH)_2$ Nanopesticide: Kocide 3000 (Dupont)
Primary size: ~50 to >1000 nm
Hydrodynamic diameter is 1532 ± 580 nm
Zeta potential is -47.6 ± 43 mV

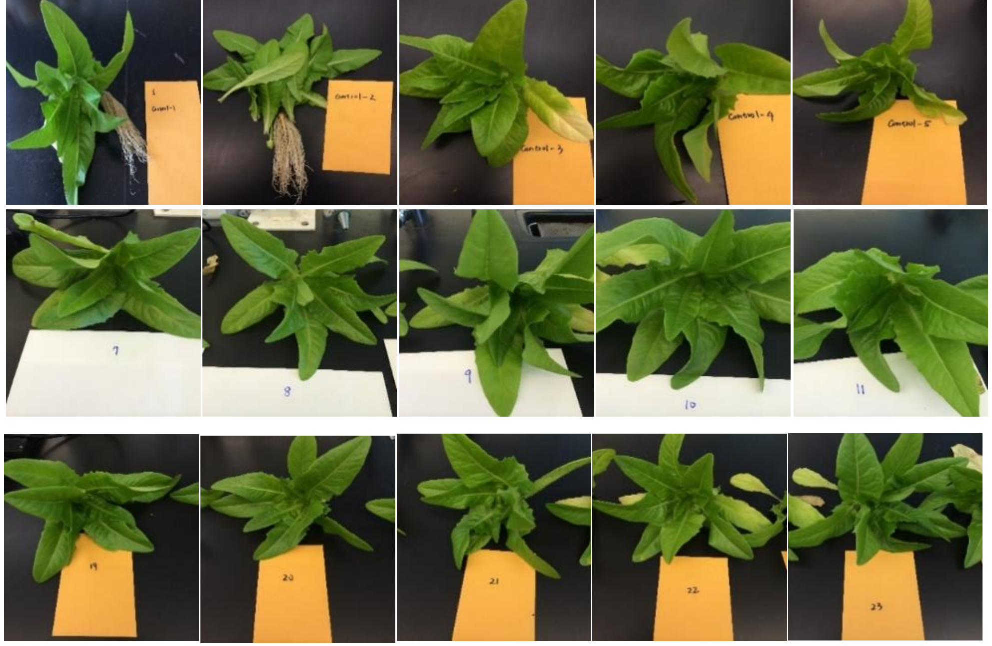
Exposure method: 24-day-old lettuce plants were foliar applied to Cu(OH)2 nanopesticides (0, 1050 and 1555 mg/L) for 4 weeks (2 times per week)

Instrument: ESEM, ICP-MS, GC-TOF-MS

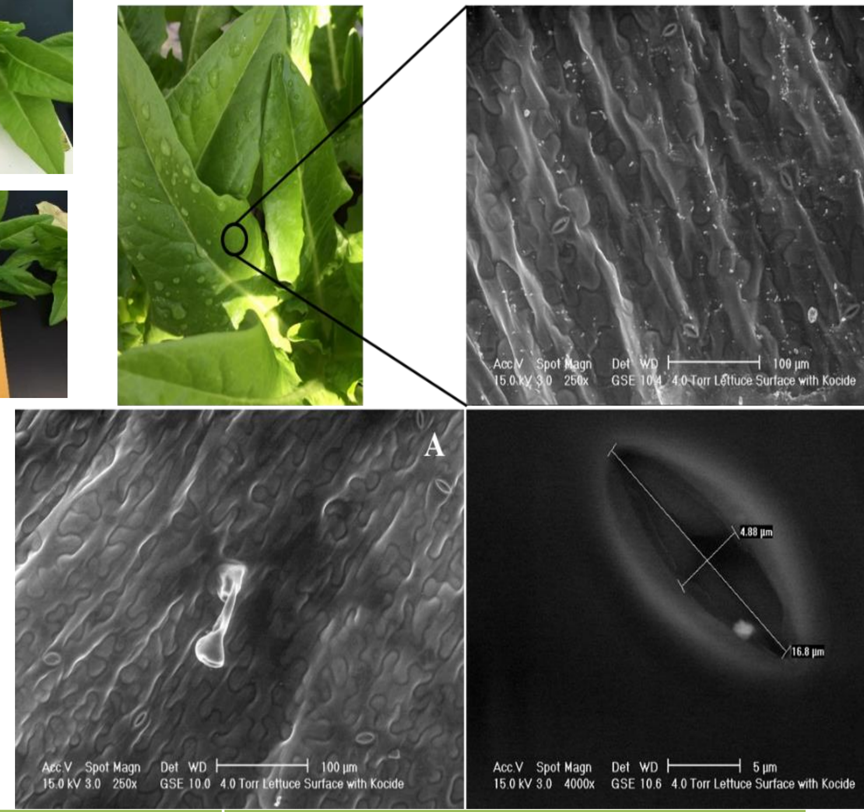
CNT

Low

High



ESEM



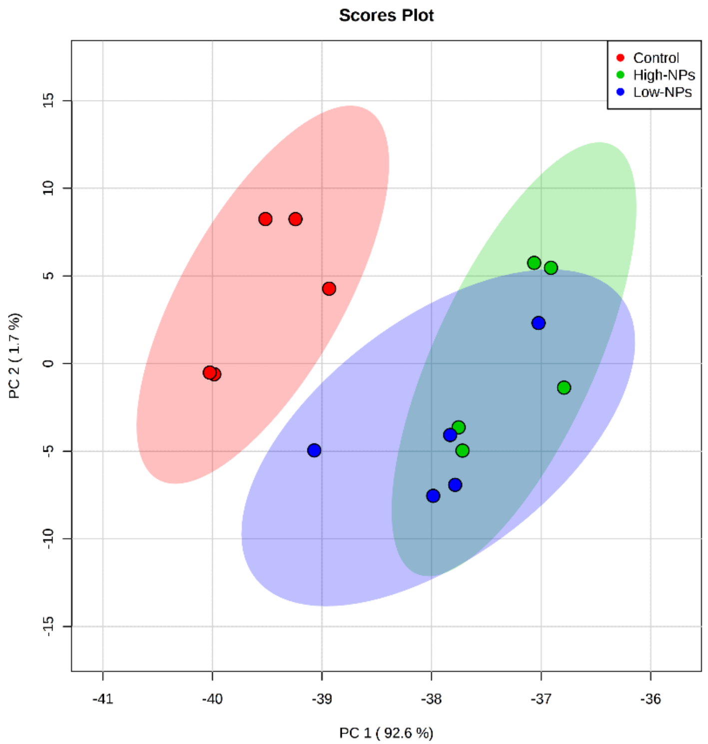
No visible toxic symptoms throughout the entire exposure period until harvest

	Leaf (mg Cu/kg dry weight)	Root (mg Cu/kg dry weight)
Control	13 ± 5.9	6 ± 2.8
Low	1353 ± 324	19.5 ± 3.8
High	2008 ± 438	17.5 ± 2

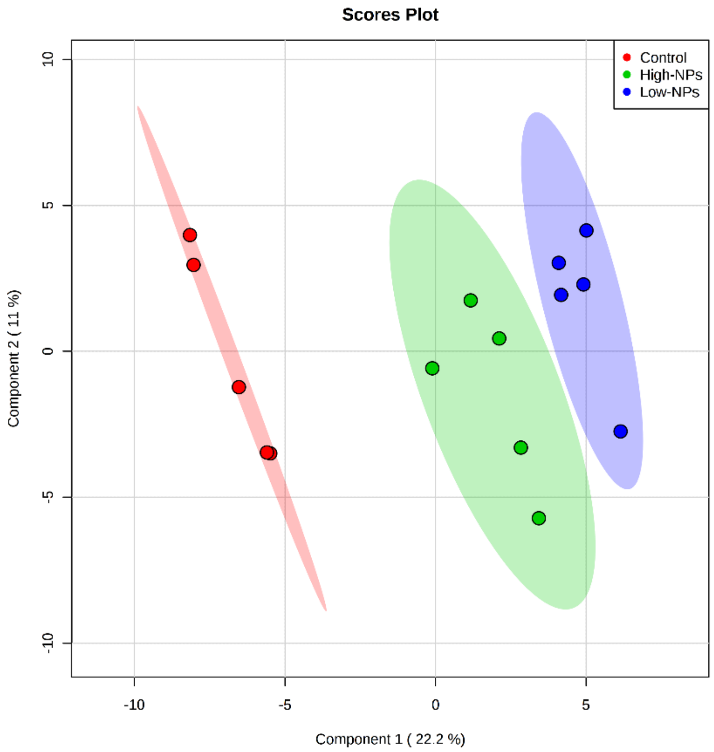
Metabolites Determination

- GC-TOF-MS (Genome Center Core Services, UC Davis)
- Agilent 6890 gas chromatograph
- A total of 352 compounds were detected and 159 was identified

Multivariate Analysis

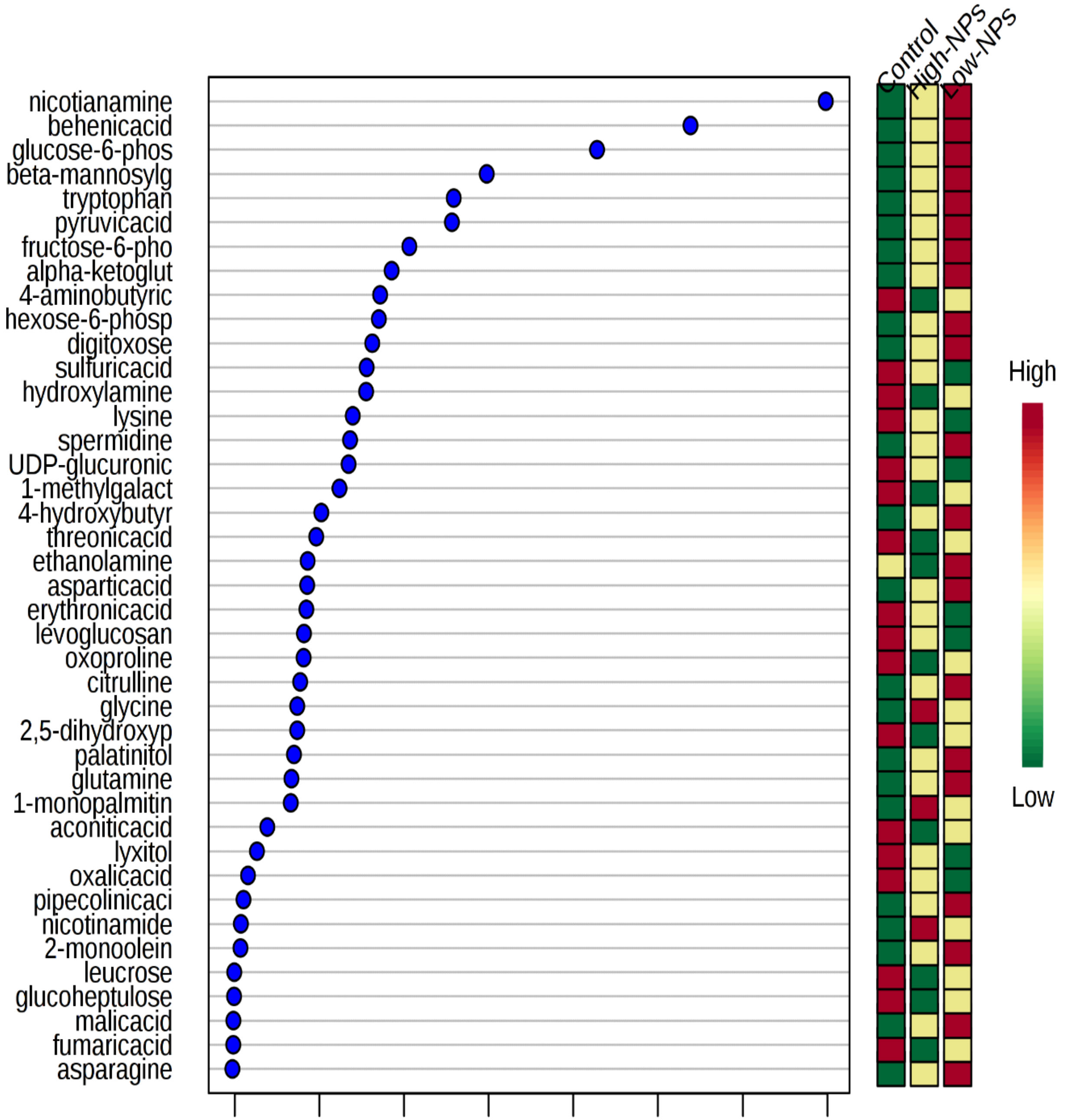


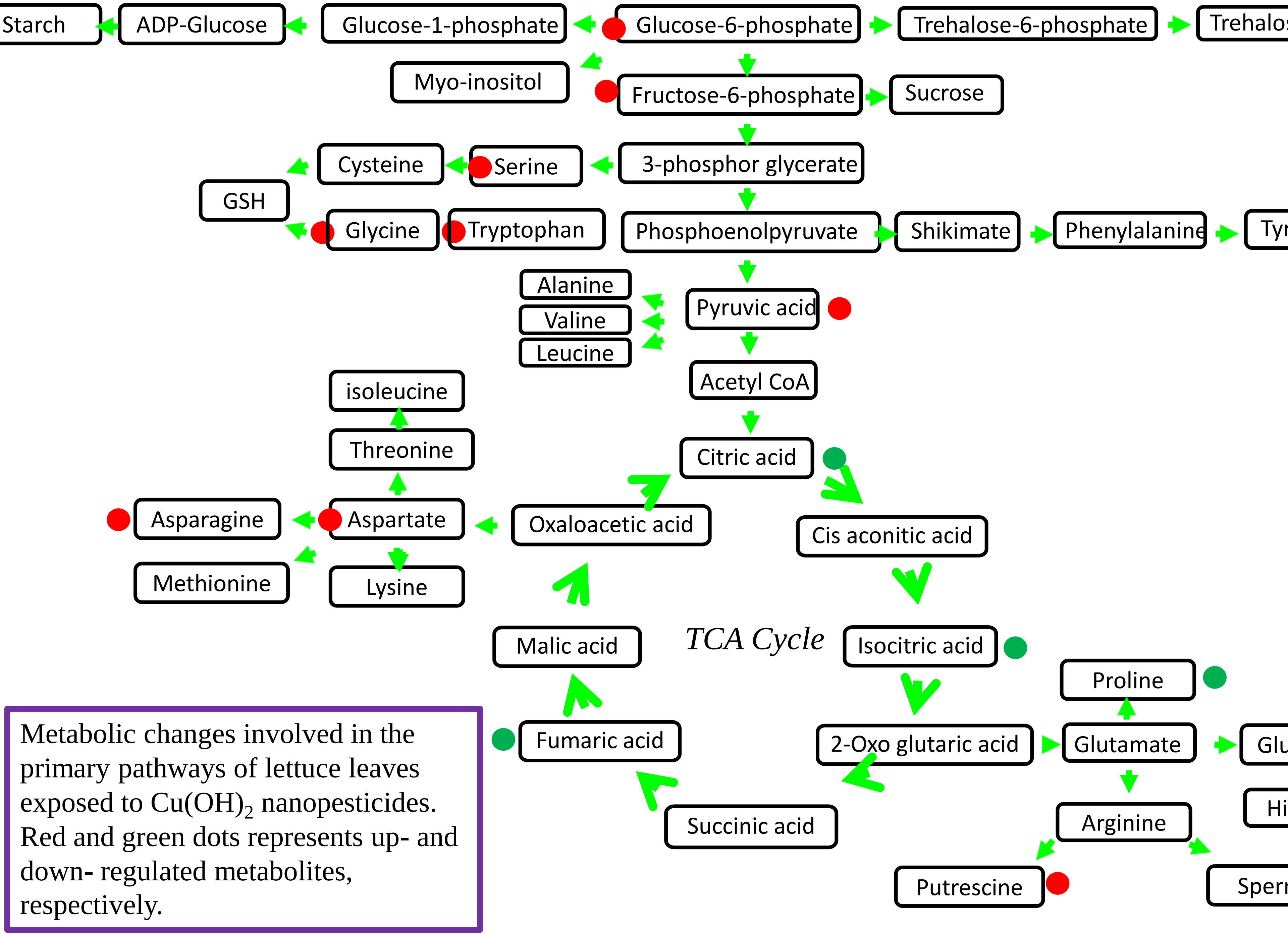
Principle component analysis (PCA)



Partial least-squares discriminant analysis (PLS-DA)

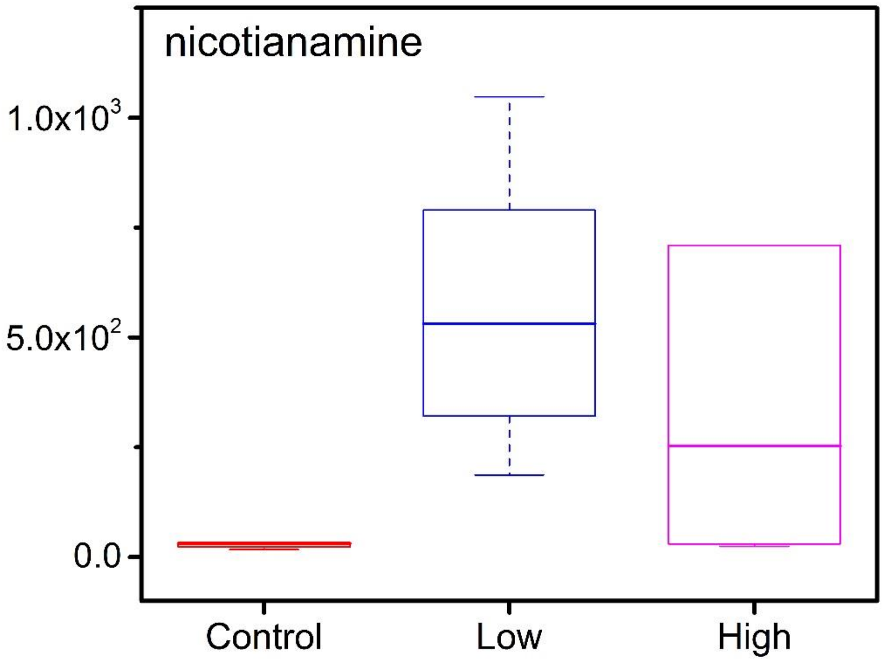
Discriminating metabolites induce group separation

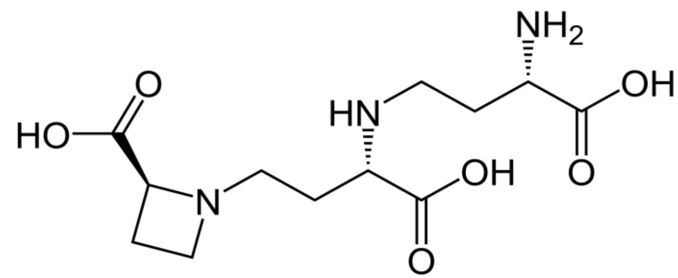




Metabolic changes involved in the primary pathways of lettuce leaves exposed to $Cu(OH)_2$ nanopesticides. Red and green dots represents up- and down- regulated metabolites, respectively.

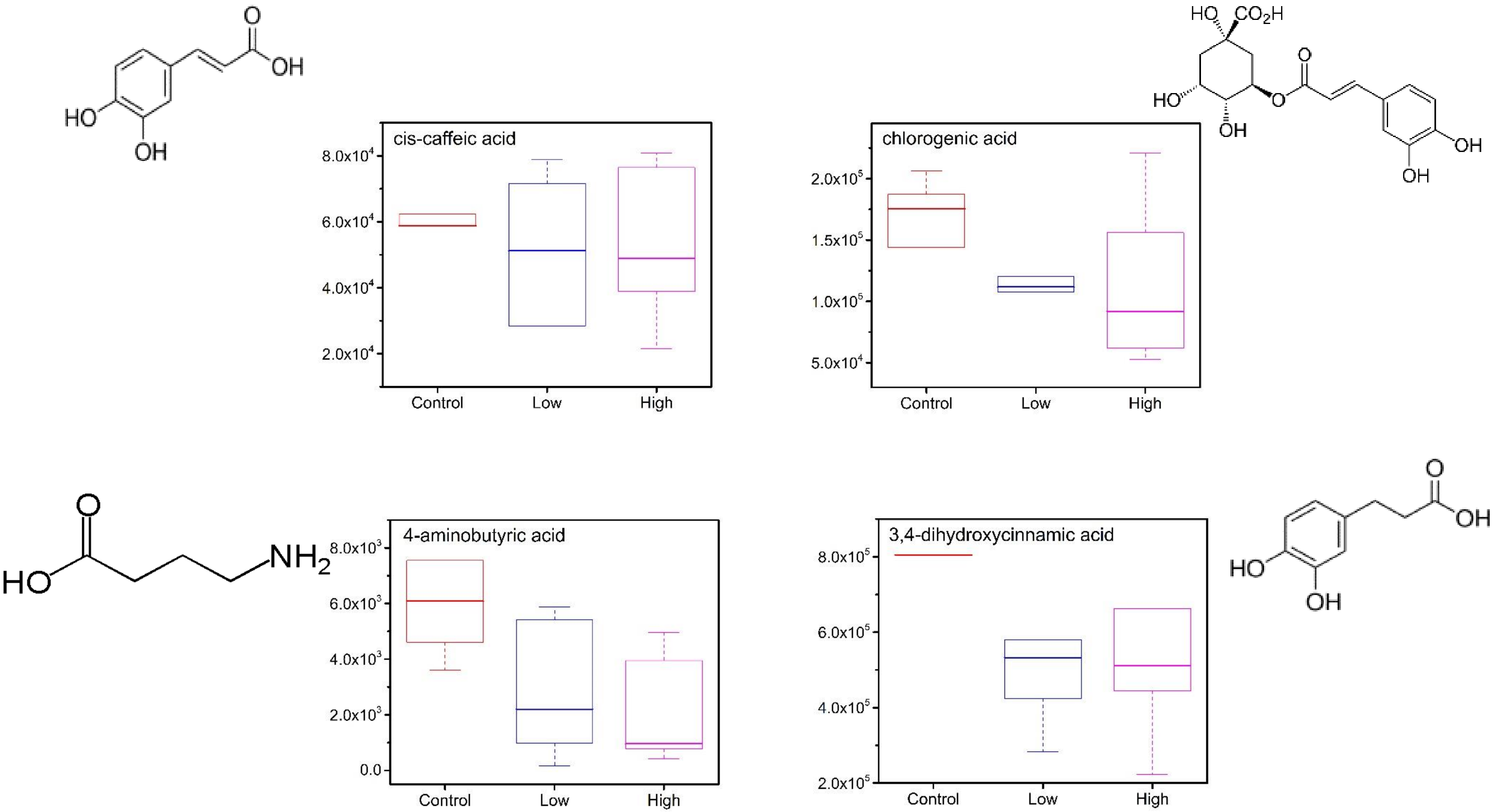
nicotianamine





Copper chelator

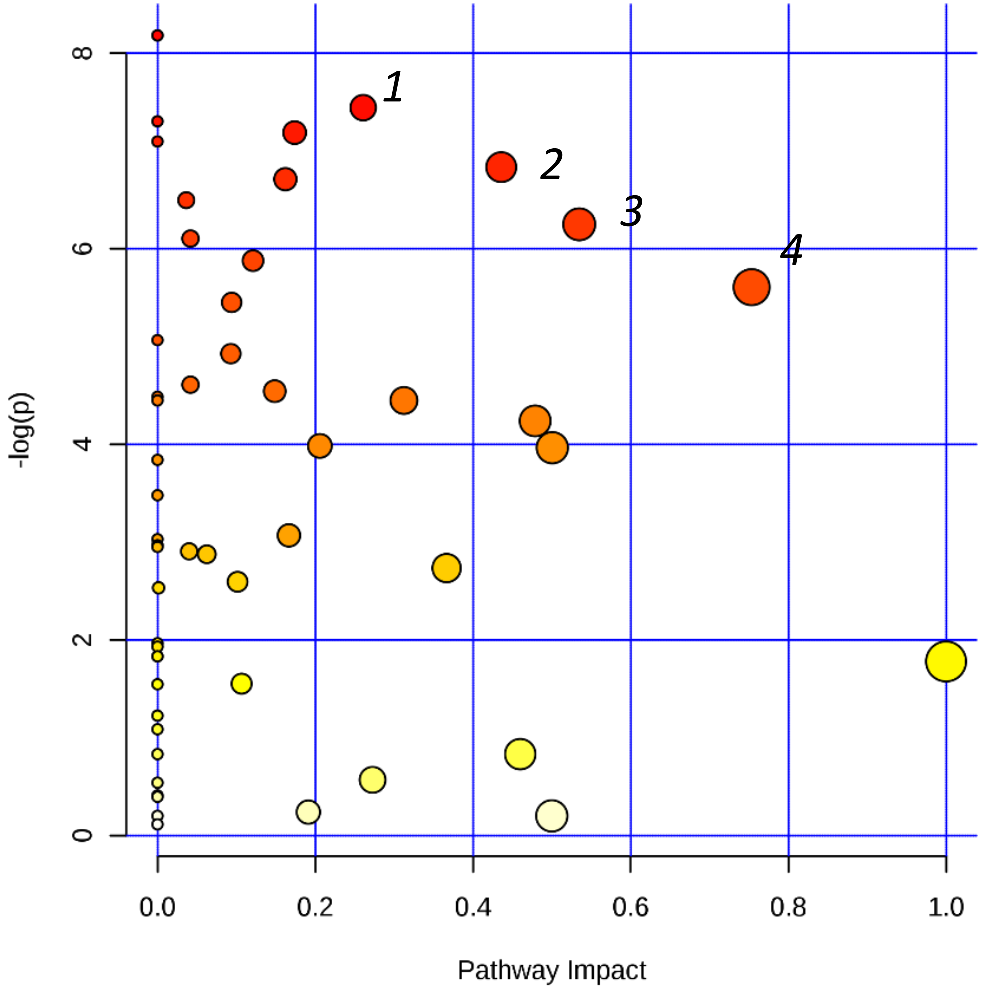
Antioxidants



ROS scavenger ↓

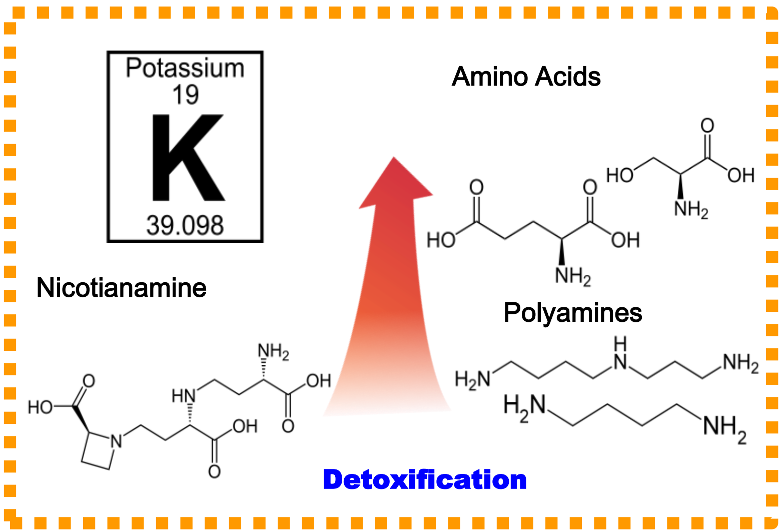
Chelating
Nicotianamine ↑
Histidine ↑
Glycine ↑
Tryptophan ↑
Asparagine ↑
Aspartic acid ↑
Enhance Tolerance
Spermidine ↑
Putrescine ↑
mannosylglycerate ↑
Potassium ↑
Antioxidants Defense
cis-caffeic acid ↓
Chlorogenic acid ↓
3,4-dihydroxycinnamic acid ↓
dehydroascorbic acid ↓
Proline ↓
GABA ↓
ROS

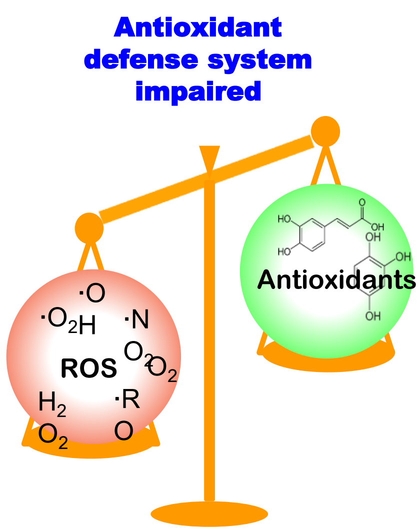
Summary of pathway analysis



Altered pathways in ***leaves***:

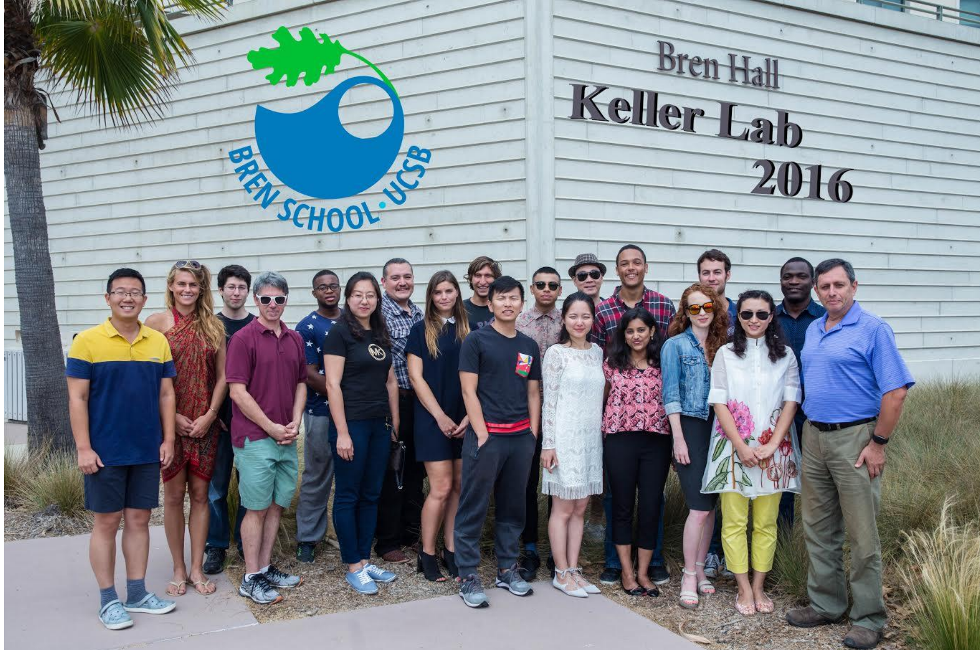
(1) Tricarboxylic (TCA) cycle;
(2) Beta-alanine metabolism;
(3) Glycine, serine and threonine metabolism
(4) Alanine, aspartate and glutamate metabolism





Conclusion:

- Despite no visible damage, metabolomics revealed Cu(OH)2 nanopesticide induced carbonhybohydrate and amino acids metabolism perturb. s
- The plants may be up-regulating some of the metabolites, e.g. K, Nicotianamine, polyamines, to increase the tolerance of plant to $Cu(OH)_2$ nanopesticide
- The decrease of antioxidants indicating the lettuce quality was impacted



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Lijuan Zhao, Yuxiong Huang, Cameron Hannah-Bick, Aaron N. Fulton, Arturo A. Keller. Application of Metabolomics to Assess the Impact of $Cu(OH)_2$ Nanopesticide on the Nutritional Value of Lettuce (Lactuca sativa): Enhanced Cu Intake and Reduced Antioxidants. ***NanoImpact***. 2016, 3-4, 58-66.

Acknowledgments

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Thank you

for your

attention!