

Metabolic Profiling of Corn (*Zea mays*) Roots by Mid-IR Laser Ablation Electrospray Ionization MS

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Introduction

- Pluripotent stem cells are located in the apical root meristem of the model plant *Zea mays* and have been reported to give rise to differentiated cells, which form the underground root systems of vascular plants.^[1]
- Laser ablation electrospray ionization (LAESI)^[2] mass spectrometry (MS) allows the direct sampling of endogenous metabolites in the native tissue (Fig. 1).
- *In situ* metabolic profiling of native state root tips promises to help understand cellular metabolism at various stages of differentiation (Fig. 2 and Fig. 4).
- Analyses of roots of different genetic variants of *Z. mays* shows the capability of exploring metabolic changes between variants (Fig. 3).

Methods

- *Z. mays* seeds were obtained from Carolina Biological Supply Company and Maize GDB^[3] and seedlings were grown for ~9 days with a 14 hour photoperiod at 23°C (see root tip in Fig. 1A).
- Mid infrared laser (Nd:YAG-OPO) pulses at 2.94 μm were coupled to the tissue due to strong absorbance by the native water content. LAESI ions generated by combining the laser ablation plume and electrospray were detected by a mass spectrometer (Fig. 1B).

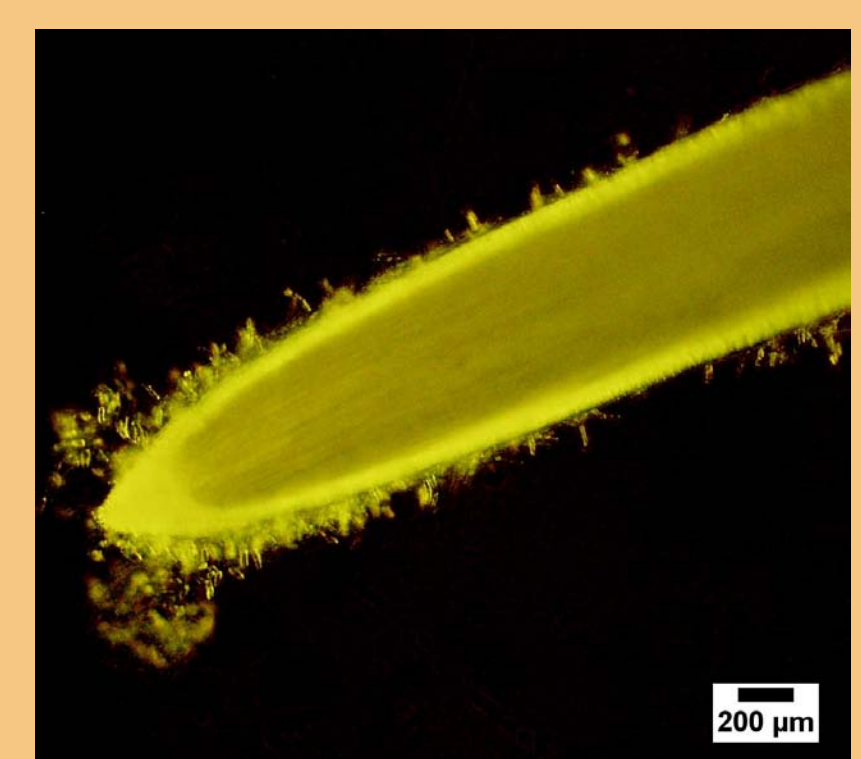


Fig. 1A. Fluorescent microscope image of *Z. mays* root tip.

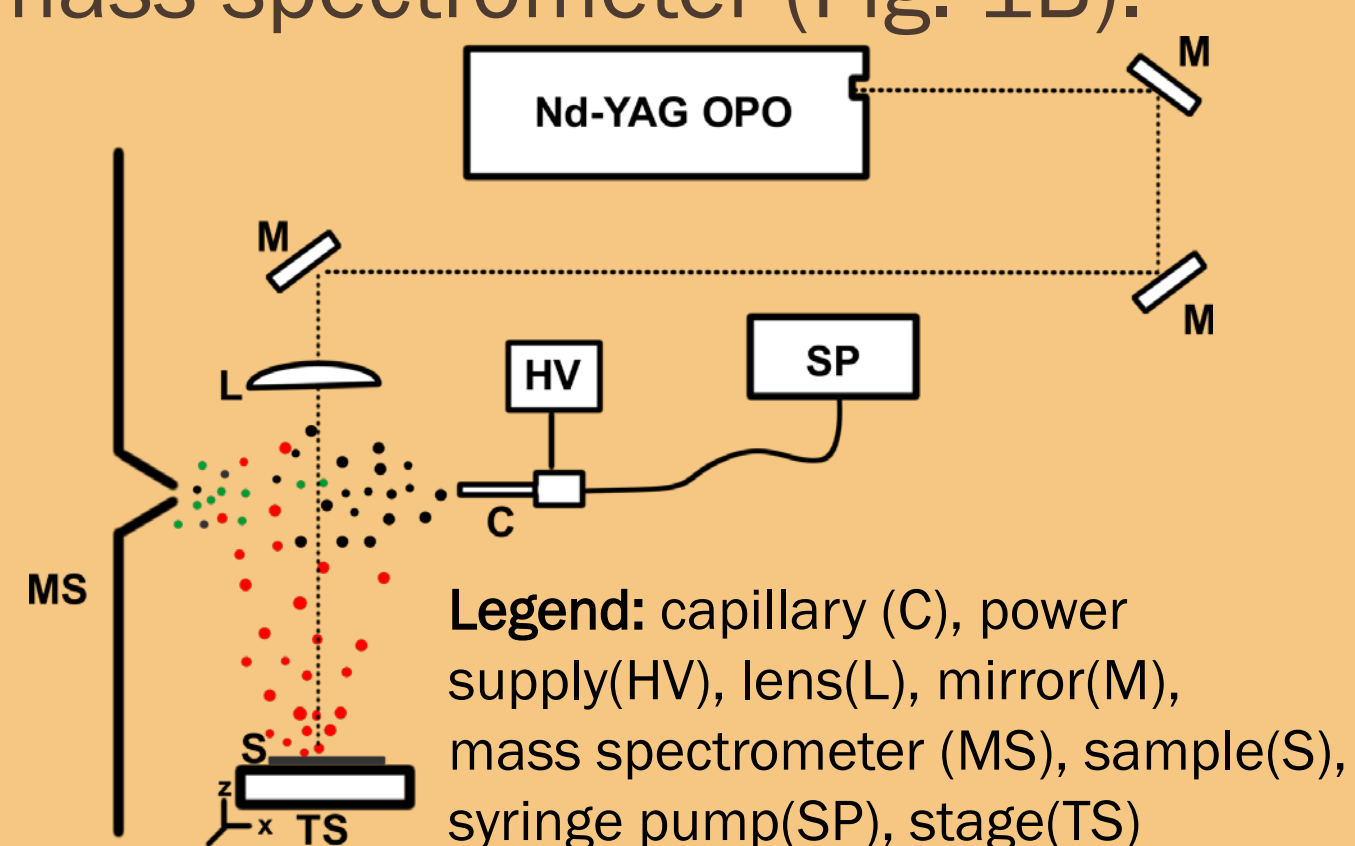


Fig. 1B. Schematic of LAESI-MS.^[4]

Field Corn Profiling

Fig. 2A. Ablation spot and LAESI mass spectrum from proximal root.

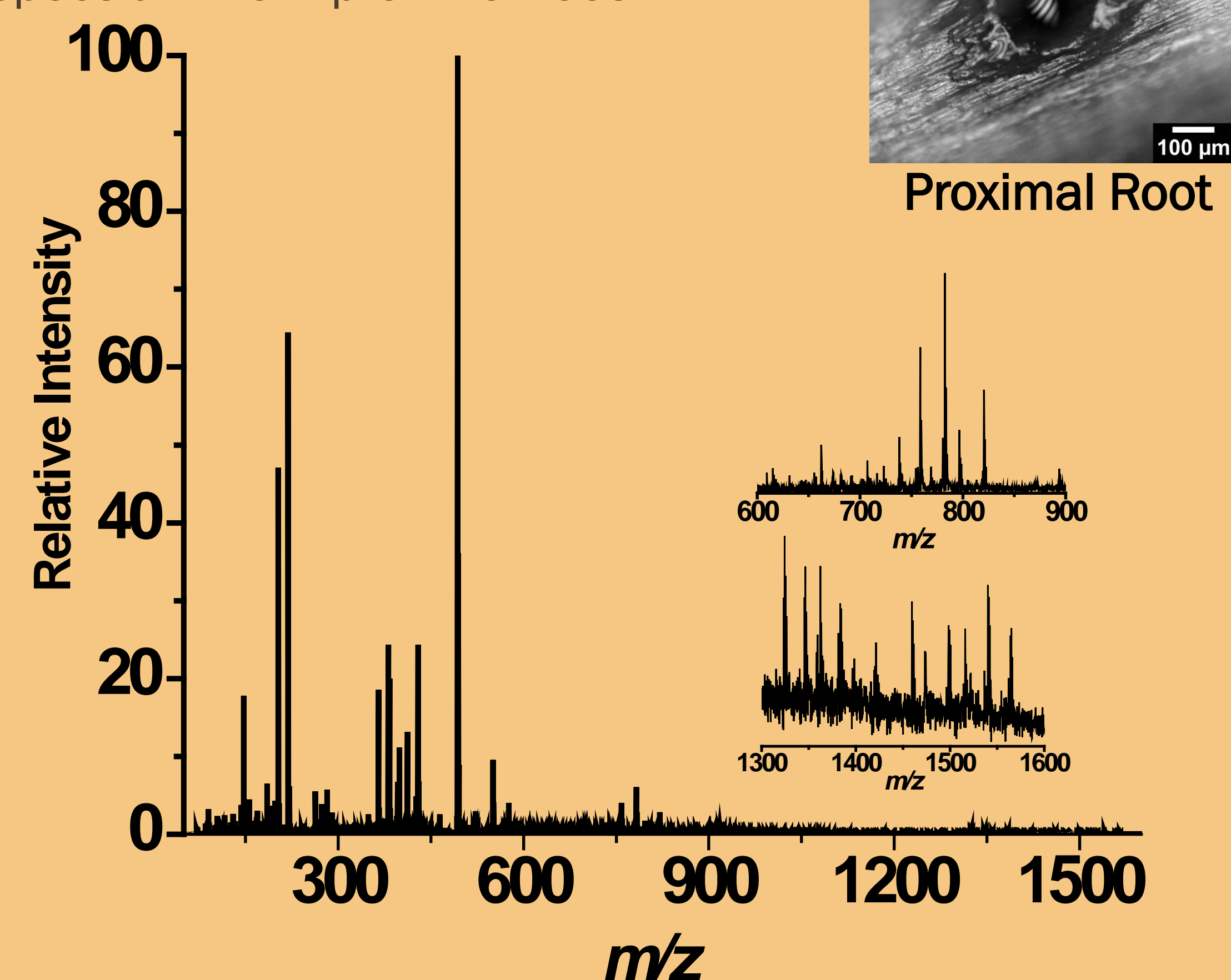
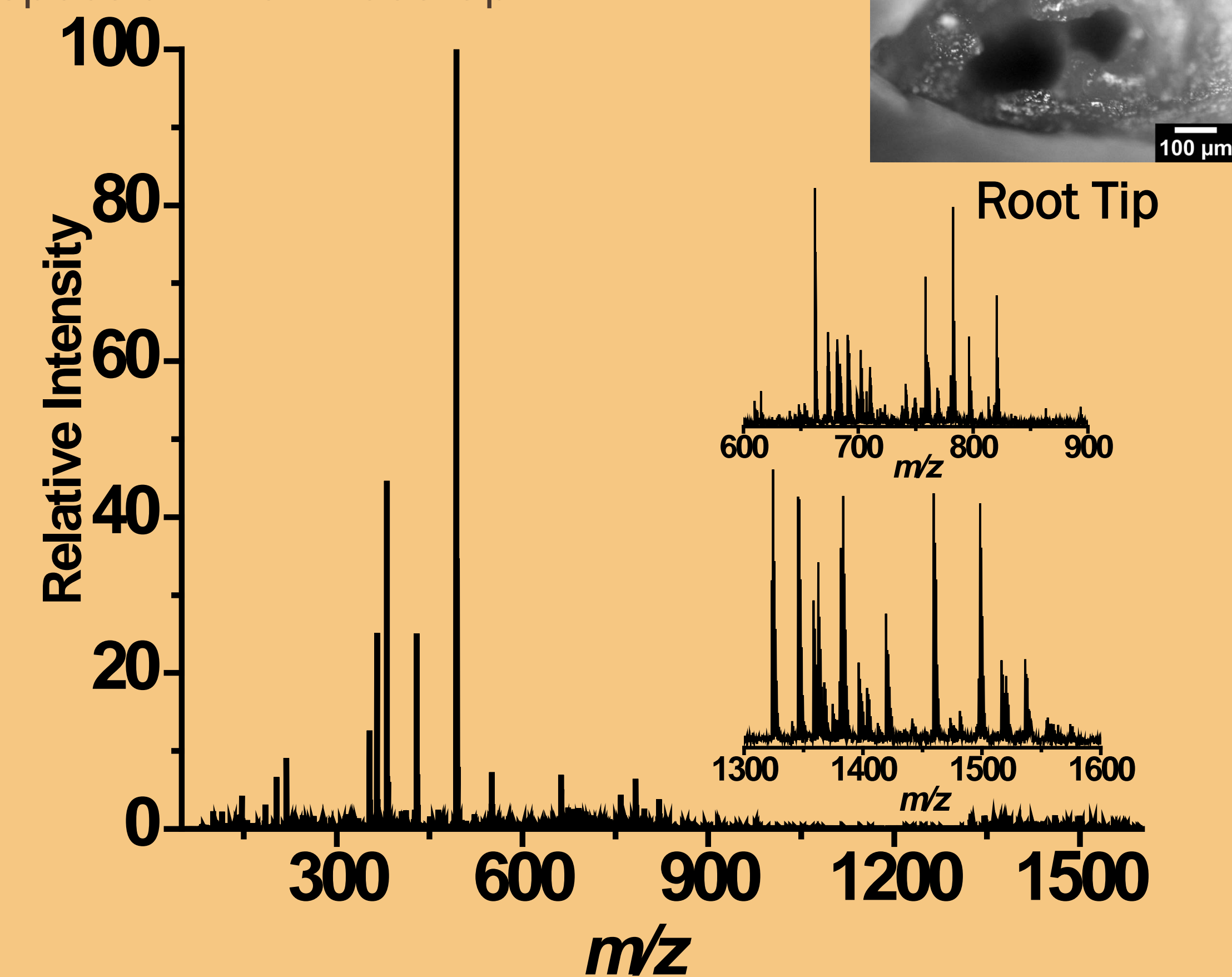


Fig. 2B. Ablation spot and LAESI mass spectrum from root tip.



Genetic Variants 3611E atc*-N2350, 3811N oy*-N2360A, and 3611A v*-N1434 of *Z. mays*

LAESI mass spectra from the root tips of the three genetic variants shows metabolic differences between them. For example, prominent changes appeared in the distribution of metabolites and lipids in the m/z 600-900 range (see Fig. 3).

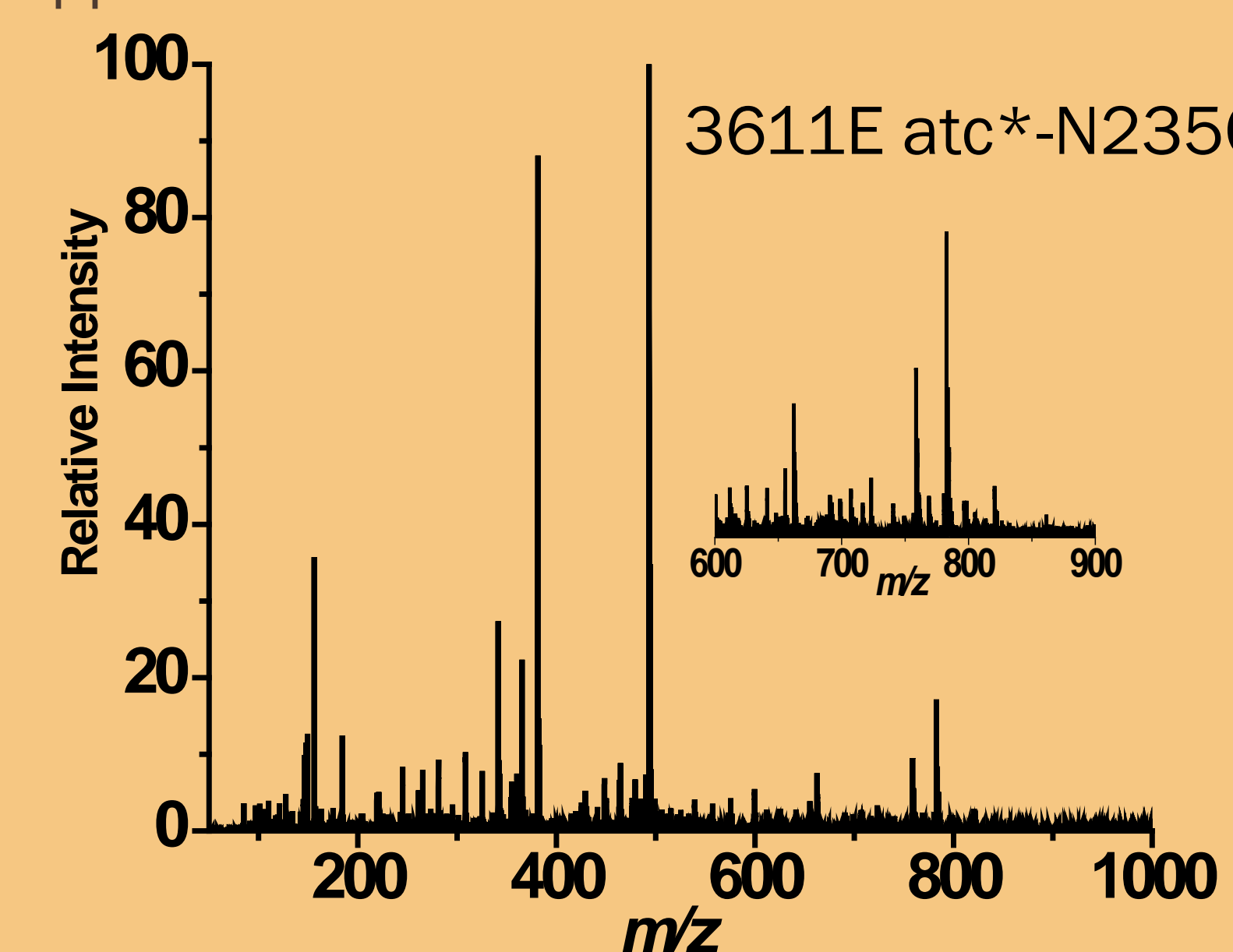


Fig. 3A. LAESI-MS from root tip of anthocyanin phenotype (3611E atc*-N2350).

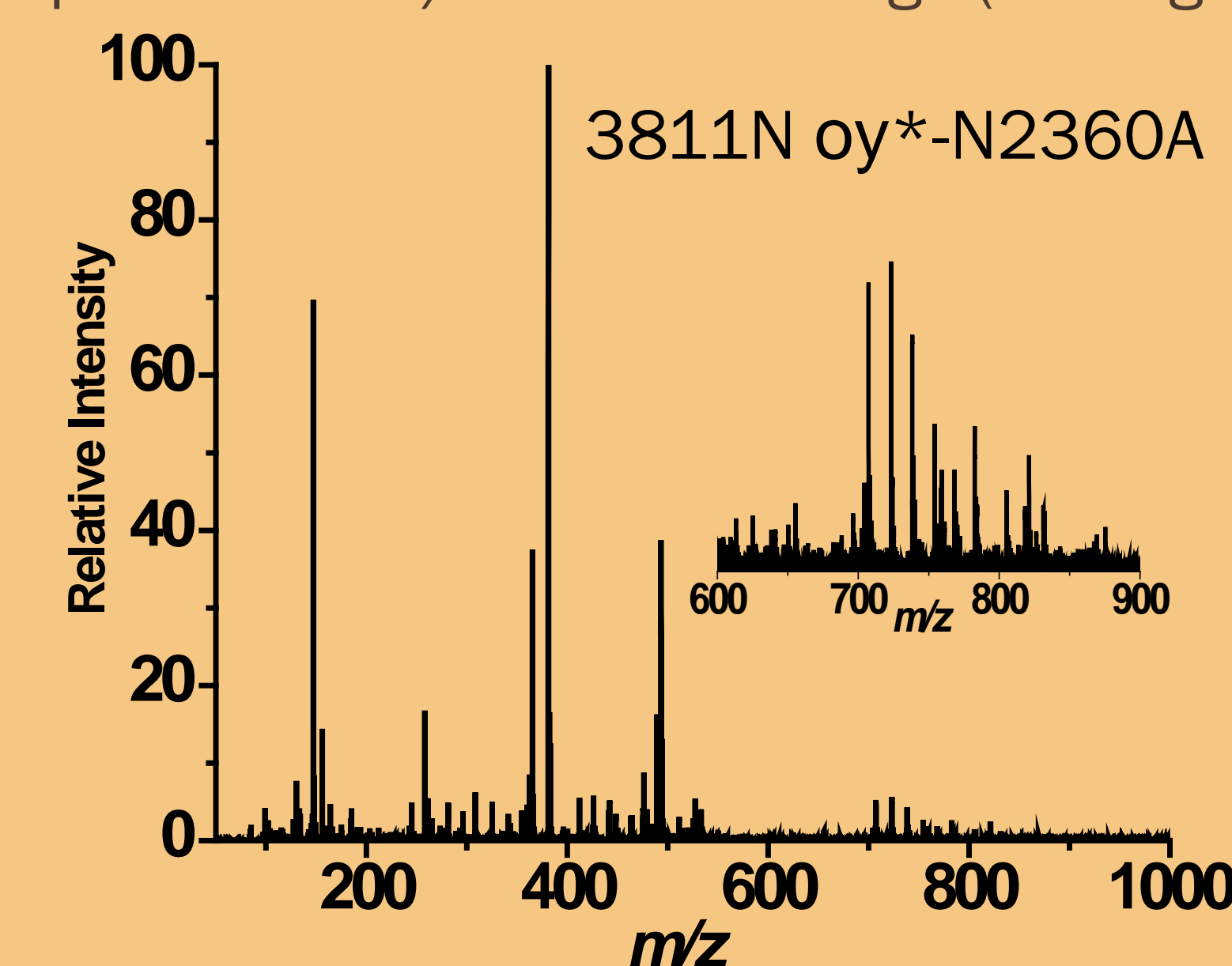


Fig. 3B. LAESI-MS from root tip of oil yellow plant phenotype (3811N oy*-N2360A).

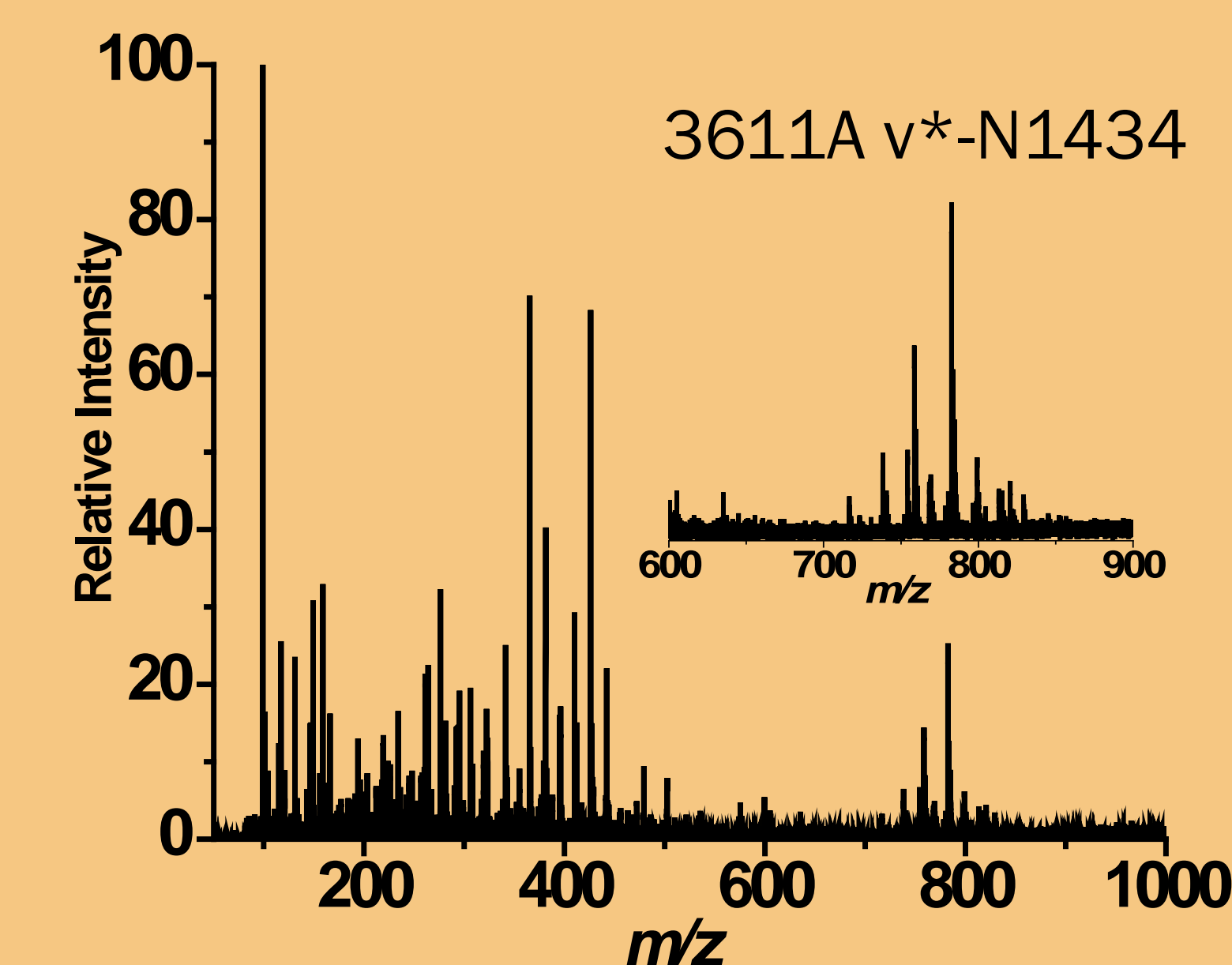


Fig. 3C. LAESI MS from root tip of virescent seedling phenotype (3611A v*-N1434).

Field Corn Profiling

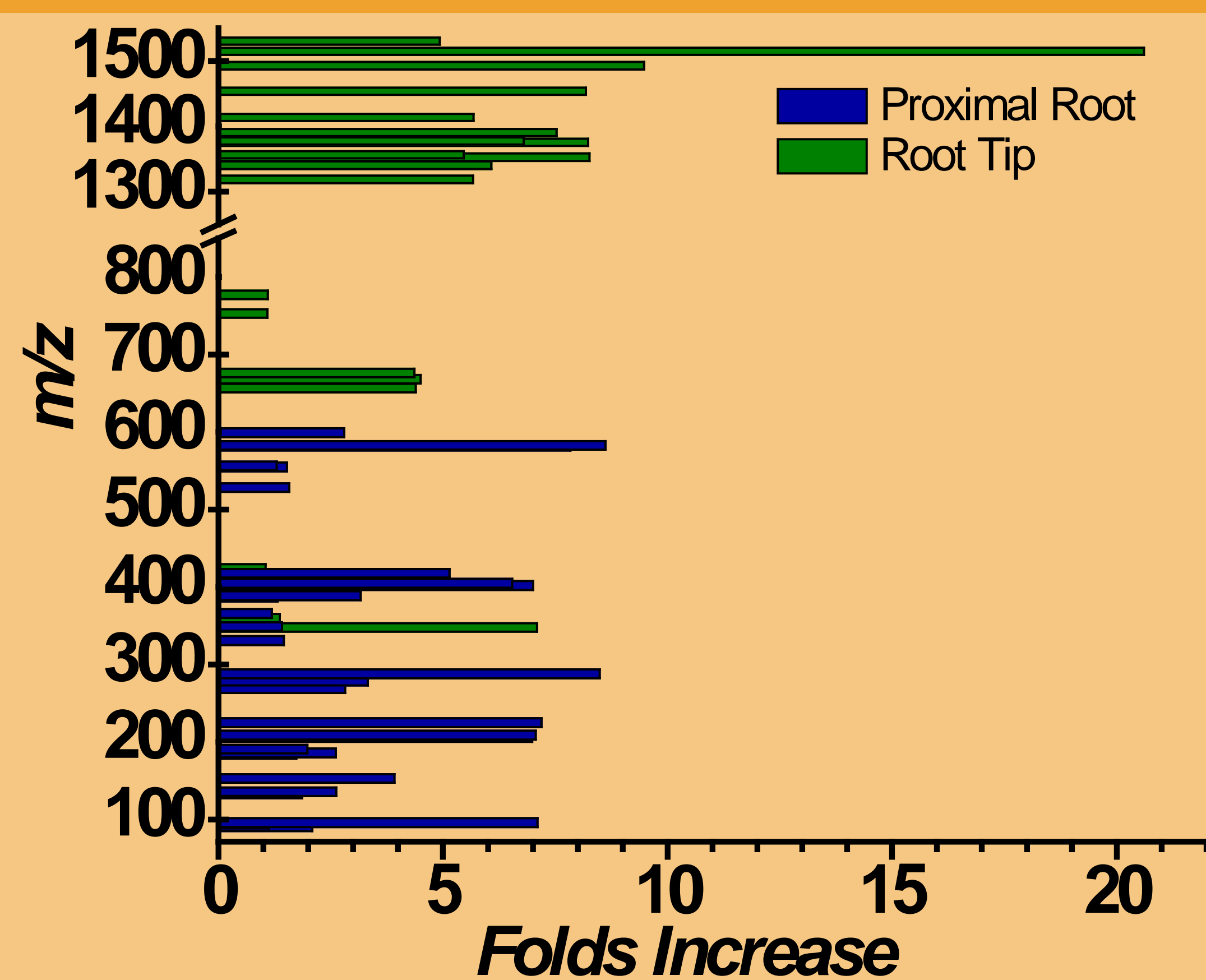


Fig. 4. Comparison of peak intensities reveal a differential distribution of certain ions between the two root regions. Ions in the region above m/z 600 tended to exhibit higher abundance in the root tip.

Conclusions and Future Directions

- LAESI-MS of the proximal root region and the root tip region revealed differential distribution of metabolites and other small molecules within *Z. mays* root (see Fig. 2 and Fig. 4).
- LAESI-MS of the root tip region of different *Z. mays* genetic variants reveal differential abundance of metabolites and other small molecules between stocks (see Fig. 3).
- LAESI-MS has the potential to explore the metabolic changes due to cellular differentiation and to the impact of genetic differences in plant roots.

Acknowledgements and References

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