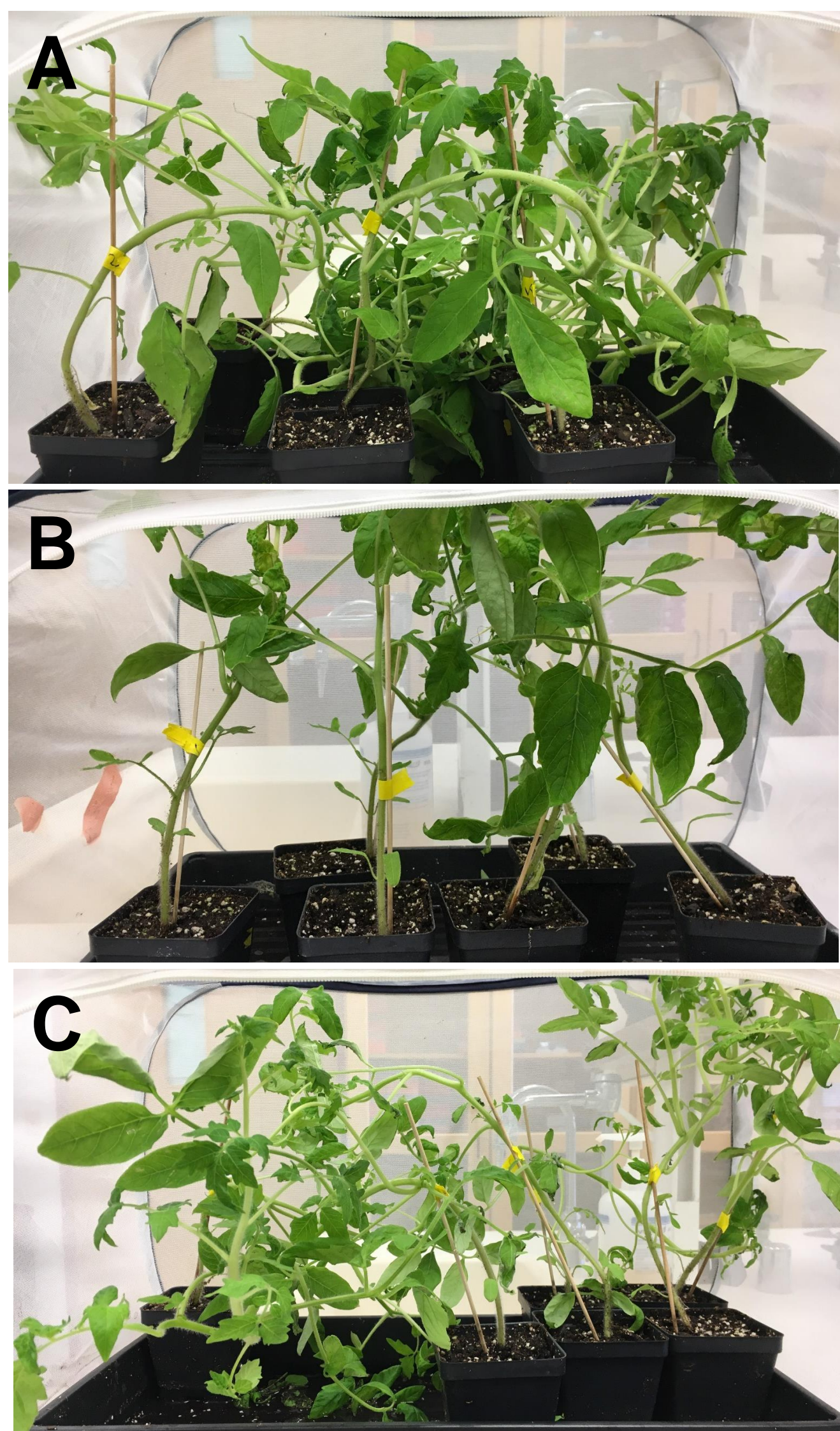
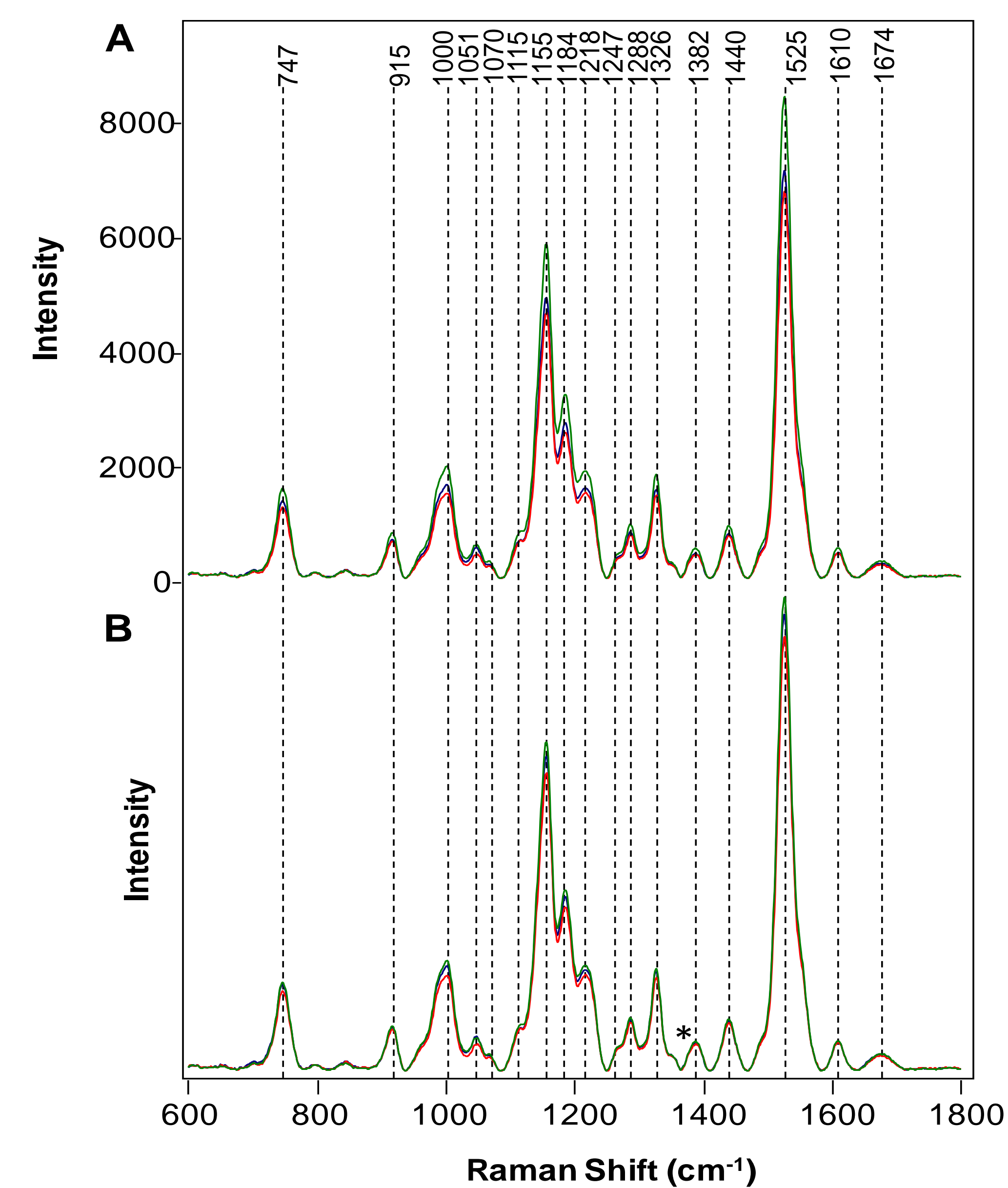
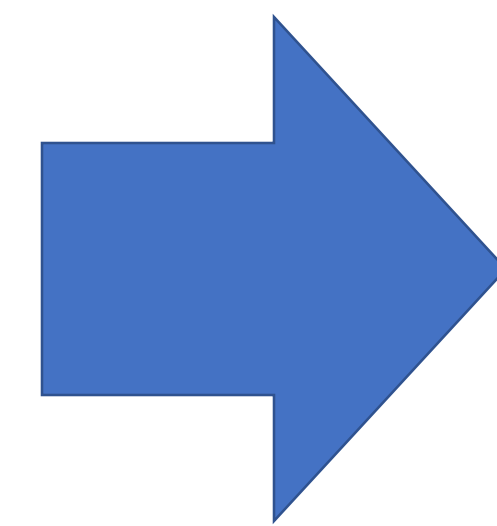


Abstract: '*Candidatus Liberibacter solanacearum*' (Lso) is a phloem-limited Gram-negative bacterium that infects crops worldwide. In North America, two haplotypes of Lso (LsoA and LsoB) are transmitted by the potato psyllid, *Bactericera cockerelli* (Sulč), and infect many solanaceous crops such as potato and tomato. Infected plants exhibit chlorosis, severe stunting, leaf cupping and scorching. Polymerase chain reaction (PCR) and potato tuber frying commonly used methods for diagnostics of the plant disease caused by Lso. However, they are time-consuming, costly, destructive to the sample and often not sensitive enough to detect the pathogen in the early infection stage. Raman spectroscopy (RS) is a noninvasive, nondestructive, analytical technique which probes chemical composition of analyzed samples. In this study, we demonstrate that Lso infection can be diagnosed by non-invasive spectroscopic analysis of tomato leaves three weeks following infection, before the development of aerial symptoms. In combination with chemometric analyses, Raman spectroscopy allows for 80% accurate diagnostics of *Liberibacter* disease caused by each of the two different haplotypes. This diagnostics approach is portable and sample agnostic, suggesting that it could be utilized for other crops and conducted autonomously.



Photographs of healthy (A), LsoA (B) and LsoB (C) infected tomato plants.



Averaged raw (A) and normalized (B) Raman spectra collected from leaves of healthy (green), LsoA positive (blue) and LsoB positive (red) tomatoes. Spectra normalized on 1382 cm^{-1} vibrational band, which were assigned to CH_2 vibration (marked by asterisk (*)).

	Members	Correct	Healthy	LsoA
Healthy	150	70.0%	105	45
LsoA	150	70.0%	45	105
Total	300	70.0%	150	150

	Members	Correct	Healthy	LsoB
Healthy	138	74.7%	112	26
LsoB	163	82.8%	38	125
Total	301	78.8%	150	151

PLS-DA confusion matrix of healthy vs LsoA spectra collected from leaves of tomato plants (left) and PLS-DA confusion matrix of healthy vs LsoB spectra collected from leaves of tomato plants (right).

- We demonstrated that RS coupled to advanced multivariate statistical analysis can be used for highly accurate diagnostics of LsoA- and B-infected tomatoes.
- We also showed that RS could be used to distinguish between LsoA- and LsoB- related diseases.
- Raman-based approach is fast and reliable, which is crucial for successful intervention and management of Lso disease in tomatoes.