Effect of UV Light on Plant Cells

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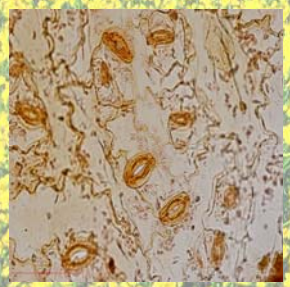
Background: High schools students wanted to examine damage to cells caused by ultraviolet light. We chose canola because it is an important agricultural plant and lush broad leaves might be more susceptible than grassy leaves of crops like wheat. Canola seedlings were grown exposed to UV light beside a control group. Single cell layers of canola did not remain alive under Mid-IR so vanilla and cactus plants were used on that beamline.

Optical Microscope

Control: The control plants were very healthy, and well developed. Leaf development was advanced with some having up to four leaves. The stems were firm and healthy. Microscopically, the cells were irregular shaped but distinguishable, and there was a high density of stomata. With the control group the stomata all were mostly closed.

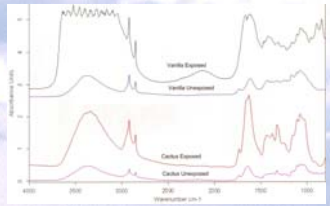
Exposed: The exposed plants were very unhealthy and poorly developed. They were pale green and leaf development was primitive, only a few had true leaves. At the cellular level the cells were irregular shaped with clear defined borders. There was a higher density of stomata which were mostly open.



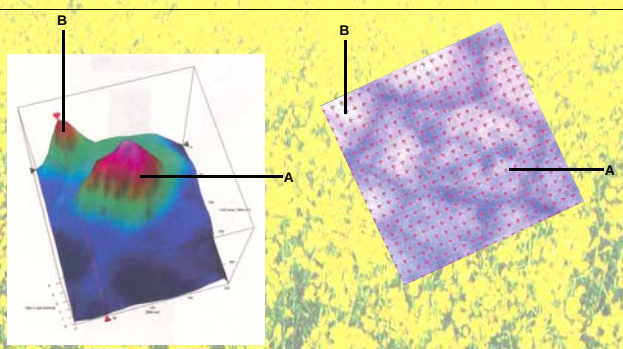
Conclusion

The exposed canola plants were less developed and shrivelled, clearly showing negative effects from the UV. Microscopically, the exposed plants had open stomata whereas the control did not. Their stomata are possibly open in an effort to continually exchange gas and complete photosynthesis because the plants are having such difficulty growing due to the UV damage. There may also be a loss of control to close the stomata.

Mid-Infrared Beamline



Single Spectrum Maps: of two vanilla plants, one exposed to UV light during growth, the other not, and two cactus plants, one exposed to UV light during growth, the other not. If you look at about 1350 wave-number the cactus already has the band of calcium oxalate that was found only in the vanilla plant exposed to UV light. This leads us to believe that when plants are exposed to UV light for long periods of time they try to build up a tolerance by producing calcium oxalate. The cactus plant may have done this over hundreds of years of evolution, that is why we found it in both the exposed and unexposed samples.



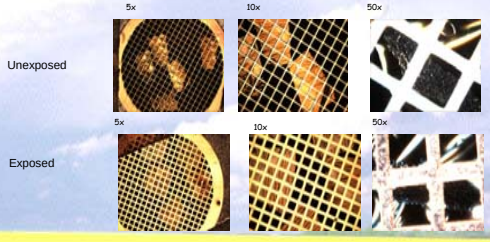
Calcium Oxalate: This is a Mid-Infrared scan of one cell of vanilla that was exposed to ultraviolet light during growth. The chemical band we found here, 1340 cm^{-1}, is calcium oxalate. The amplitude of the band has been mapped throughout the cell section. We did not find this band in the vanilla cells that were not exposed to UV light while growing. When looking at this you see that the peak is only in the center of the cell which means that there is no calcium oxalate in the cell wall.

Conclusions

Both of the cactus plants already had the calcium oxalate band that we found in the vanilla plant that had been exposed to the UV light. This is important because it means that in the exposed plant there was a chemical response to the UV light. Also we found that the Mid Infrared beam-line can distinguish chemical changes within individual cells.

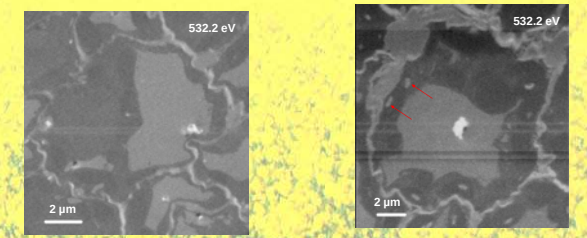
Spectro-microscopy

We started by taking both the exposed and unexposed plant cells sections and magnifying them as large as we could on the optical microscope so we could look at any physical differences.



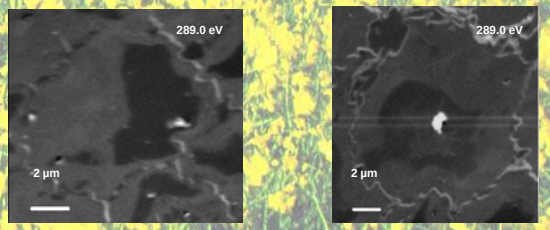
Next we wanted to compare the cells by measuring at the oxygen and carbon edges.

Unexposed **Exposed**



Oxygen edge: We observed that in the unexposed plant cells, the opening is near one end of the cell as opposed to the centre in the exposed cell. The opening is surrounded by protein like compound and was present as one region together in the unexposed cells. In the exposed cells, there were more openings surrounding a cell (indicated by arrows) and the protein region is disintegrated (bery clear from the carbon image below)

Unexposed **Exposed**



Carbon edge: we found that at the carbon edge, there is clear evidence of disintegration of protein like region surrounding the opening in the exposed cells.

Conclusion:

The UV light exposure causes both chemical and structural changes within the canola seedling cells.

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