Stress-induced VOC emissions

M. Miebach[1], J. Beauchamp[2], A. Hansel[2], A. C. Heiden[1], R. Jansen[3], J. Kesselmeier[4], E. Kleist[1], U. Kuhn[4], U. Roese[1], F. Steindel[4], R. Uerlings[1], A. Wisthaler[2] and J. Wildt[1]

[1] Institute Phytosphere, Forschungszentrum Jülich, 52425 Jülich, Germany
[2] Institute of Ion Physics and Applied Physics, Leopold-Franzens-University, 6020 Innsbruck, Austria
[3] Farm Technology Group, Wageningen University, 6708 PD, Wageningen, the Netherlands
[4] MPI for Chemistry, Biogeochemistry, 55128 Mainz, Germany

In order to test whether stress-induced BVOC emissions can be used to describe plant internal processes we investigated possible links between both. Stress was applied by ozone exposure or pathogen infestation and lead to induced emissions of a variety of BVOC originating from different biosynthetic pathways.

Following pulsed stress application induced BVOC emissions appeared also as pulses. These transient emissions were highly variable and covered a huge dynamic range from experiment to experiment. Using tomato (*Lycopersicon esculentum* cv. Moneymaker) as model plant a relationship was found between the emission strengths of BVOC from the octadecanoid pathway (LOX products) and activity of the lipoxygenase enzyme. This relationship indicated that LOX product emissions can be used to characterise LOX activity in tomato over a wide dynamic range of stress. For tomato we also found a relationship between emissions of methyl salicylate and plant internal concentrations of free salicylic acid. This relationship indicated that methyl salicylate emissions are usable to characterise accumulation of free salicylic acid in tomato, provided temperature and PAR remain constant.

Exposing plants to signal molecules such as methyl jasmonate or ethene and measuring their response in the form of BVOC emissions allows to check the role of such signals when applying stress to plants: One example of this is the induction of sesquiterpene emissions from ozone-exposed tobacco (*Nicotiana tabaccum* cv. Bel W3). These sesquiterpene emissions were quite well mimicked by exposing tobacco to ethene, showing that ethene is a major signal molecule in the case of ozone-exposed or pathogen-infested tobacco. The BVOC emission pattern observed for mildew-infested oak (*Quercus robur* L.) was mimicked by exposing oak to methyl jasmonate, indicating that jasmonic acid was the major signal inducing BVOC emissions from mildew-infested oak.

To check whether or not the plants exposure response to a signal molecule is species specific, we exposed individual plants of different species to methyl jasmonate. Although the pattern of induced emissions was very different for different species, the same isoprenoids were emitted in nearly all cases. This implied that the emissions of some of these compounds can be used to qualitatively show accumulation of jasmonic acid in plants. Differences in the emission patterns may be explainable by different temporal emission behaviours, as well as by interlinks between different biosynthetic pathways. In particular, processes downstream of the shikimate pathway are affected by exposures to methyl jasmonate acid as well as by ethene exposures.