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Indication of apple replant disease (ARD) in orchards at tree level

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Long-term monoculture has unfavourable effects on yield in crops. Fruit production is particularly vulnerable as production is generally confined to specific areas. Apple production areas in Europe have, for example, developed historically near urban areas in mostly densely used agricultural land with a low potential for expansion, plot exchange or set-aside. The unfavourable effect of repeated planting in the same field has become known as apple replant disease (ARD). The causal effects of ARD are not known up to now. Current research points out, that the cause of ARD is a complex phenomenon mainly due to soil-borne microorganisms. The impact of ARD on the functional capacity and productivity of soils in apple plantations is visible by specific plant characteristics, such as stunted growth, appearance and branching of roots as well as reduced increase of trunk circumference, and, effectively, yield. These effects on vegetative and generative performance of apple trees are differently pronounced within each individual tree in the orchard.

A methodological approach was developed to relate generative and vegetative growth effects, indicated by trunk circumference, with the abundance of fungi populations, indicated by one selected species (Alternaria). A case study in Brandenburg, Germany comprising two sites over two years showed that not only trunk circumference differed between individual trees, but also the fungal population of the Alternaria-group (Aa) in the immediate vicinity of 10 cm surrounding the stem. In principal, the higher the abundance of Aa, the smaller the trunk circumference (r^2=0,4). The results are interpreted not as a causal prediction of ARD, but as an indicator to describe an unknown causal effect on soil fertility. Furthermore, the trees were graded by abundance of Aa. In relation to trunk circumference the log of abundance of Aa resulted in a 10fold range from no replant to replant. The indicator showed an increase in four bounds which were further analysed by k-mean cluster analysis. This approach resulted in significantly different means of trunk circumference between groups. Thus, it is possible to calculate the relative impact of ARD as a change in soil fertility at tree level, and from there estimate the impact at field level.