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Patterns of glucose release and enzyme activity affected by crop rotation and plant senescence

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The rhizosphere is a dynamic region governed by the composition and pattern of root exudates, which in turn impact the beneficial or harmful relationships between the rhizosphere microbiome, which affect their function and plant performance. Successive wheat following wheat shows yield decline, hence, this rhizobox-study aims to illuminate and quantify the effects of subsequent wheat rotations for 3 years (W3) at different growth stages on glucose releasing rate and soil enzyme activity.

We hypothesized that the long-term wheat rotation leads to lower glucose release, which will result in lower microbial activity accompanied by the decline of enzyme production than the first year wheat rotation (W1) using soil samples collected from the experimental farm Hohenschulen, (CAU, Kiel) from 1st and 3rd wheat after break crop. Glucose Imaging was utilized for visualizing and localizing glucose exudation rate from wheat roots and β-glucosidase zymography, involved in the degradation of C substances, was applied for rhizoboxes at two growth stages (BBCH 31 (T1), BBCH 59(T2)).

Results showed that crop rotation affected glucose release from roots and β-glucosidase activity and this effect was more pronounced at the second sampling time at BBCH-59. The total hotspot area of enzyme activity declined at W3. Third wheat after break crop had the lowest hotspot percent for glucose release and β-glucosidase activity at BBCH-59 by 1.83 and 4.26 percent of total soil surface area, indicating 68.3 and 47 percent decline compared to W1, respectively. While rhizosphere extends for glucose release increased in W3 compared to W1 at the first sampling date, there was a strong decrease at the second sampling time by 60.2 percent. However, β-glucosidase activity extend around the wheat root at T1 had a decreasing trend from W1 toward W3 and there was a slight decrease at T2. Plants benefit from root exudates by stimulating beneficial microorganisms and improving nutrient acquisition. Decreasing glucose release, as a readily available energy source for microorganisms and declining C availability because of root senescence, leads to competition for C in rhizosphere among beneficial microbes and soil-borne pathogens. Continuous wheat cultivation accelerates root senescence, accompanied by more severe environment for soil microbes and higher abundancy of wheat pathogens which ultimately will affect wheat yield.