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Influence of Root Exudates on Soil Aggregation*

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Introduction

Root exudates are believed to control soil aggregation in the rhizosphere (Reid et al., 1982; Helal and Sauerbeck, 1986). However, most of the experiments conducted so far did not allow for a discrimination of specific effects due to exudates from overall effets due to root and microbial activities. This work was undertaken to determine the specific influence of freshly released root exudates on soil aggregation. Three steps were followed:

1. Rhizosphere and non-rhizosphere soils were collected respectively from 45-d old corn plants grown in the field and from nearby root-free zones. Percent of water stable aggregates in rhizosphere soil and non- rhizosphere soil samples were obtained with the method of Henin et al. (1958).

2. Root exudates were collected from nodal roots with the method of Morel et al. (1986). They were incorporated into a loamy-clay soil, and incubated for 42 d at 25°C. Evolution of CO_2 and water stable aggregates were measured (Habib, 1988).

3. Adsorption of the same root exudates on montmorillonite and kaolinite homoionic to calcium was established by shaking exudate solutions of increasing concentrations mixed with the same amount of clay. The organisation of the organo-mineral complexes was observed by scanning electron microscopy (Habib et al., 1990).

Results showed that, in the field, activity in corn rhizosphere resulted in a significant increase in percent of stable aggregates (Fig. 1) (Habib, 1988).

Incorporating fresh root exudates into a clay-loam soil brought about an immediate

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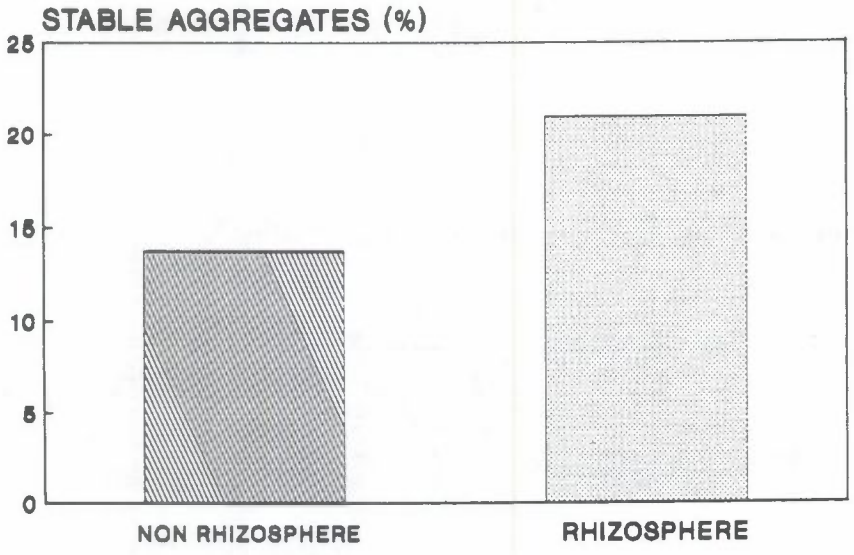

Figure 1. Effect of corn roots on soil aggregation rate.

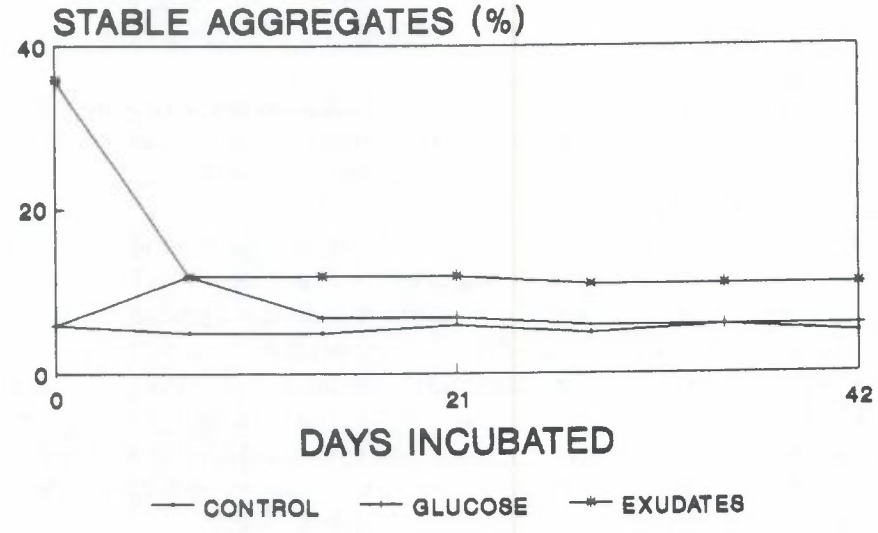

Figure 2. Evolution of stable aggregates in an exudate-amended soil.

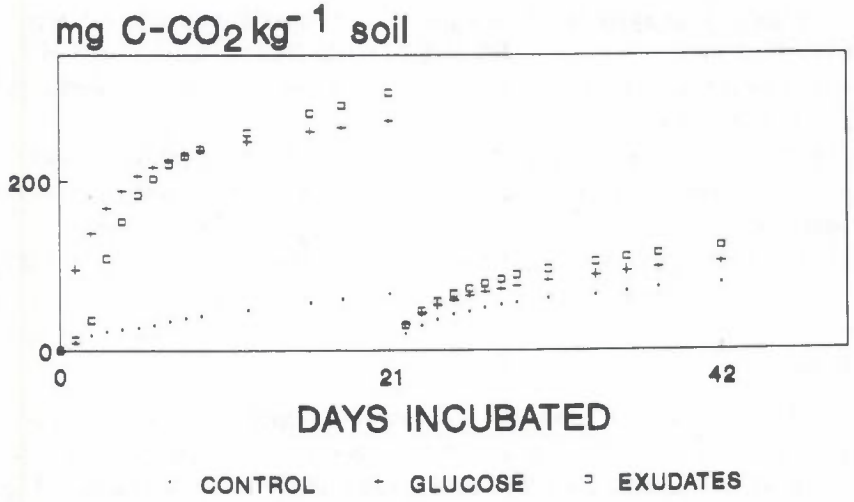

Figure 3. Cumulative CO_2 evolution from an exudate-amended clay loam soil.

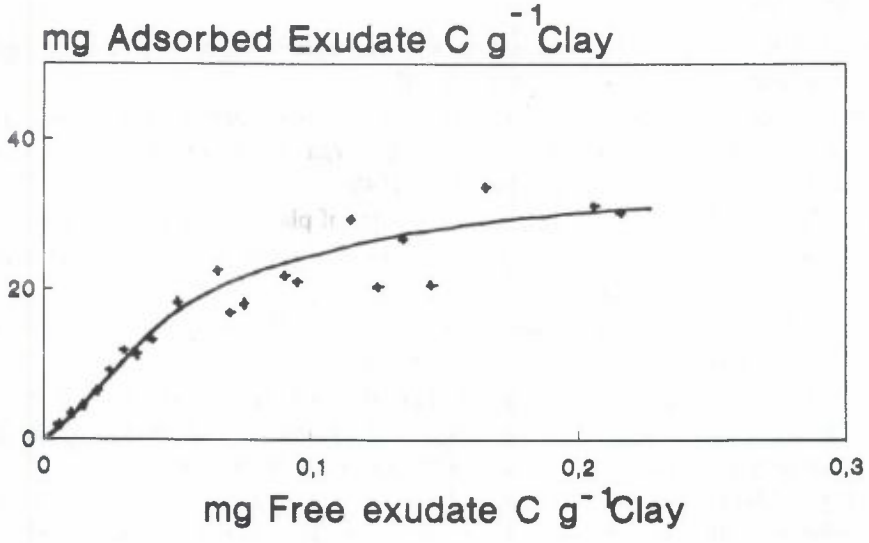

Figure 4. Adsorption of corn root exudates on montmorillonite homoionic to Ca.

and sharp increase in aggregate stability (Fig. 2). The stability decreased over time as a result of biodegradation of exudates (Fig. 3). However, stabilizing effects of exudates persisted until the end of the experiment. A drying-wetting cycle produced no change in the evolution of the aggregate stability.

Adsorption of exudates on clays depended on clay type and cation, and was higher with montmorillonite than with kaolinite (Fig. 4). Adsorption was the result of the polysaccharidic nature of exudates (Jones and Morre, 1967; Morel et al., 1987). Complexes appeared as micro-aggregates which could represent one of the early steps of soil aggregation in the presence of root (Habib et al., 1990).

Conclusion

In conclusion, this work produced evidence that aggregate stability is improved in presence of corn living roots. The increase in stability was shown to be the result of a "sticking effect" exerted by polysaccharidic exudates on soil particles. A general scheme describing the effects of exudates on soil aggregation in the rhizosphere is reported in a related work (Habib, 1988).

Aknowledgements

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