Achievement and Measurement of Soil Anaerobicity During Conduct of Anaerobic Transformation Studies

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Abstract

Aerobic and anaerobic studies are required for registration of agrochemicals and pharmaceuticals which are directly applied to soil, or which are likely to reach the soil environment (OCED 307 or OPTTS 835.4100/4200). These studies are typically performed either under aerobic or anaerobic conditions. Since a complete absence of oxygen rarely occurs in the natural environment, anaerobic conditions are defined in practice as conditions with redox potential of less than -100 mV. Such conditions are generated in laboratory settings by flooding test soil with nitrogen-purged water and are maintained by flushing the system with nitrogen gas. Achievement of anaerobic conditions is difficult due to the buffering effect of soils. The aim of this study was to evaluate ways of measuring anaerobic conditions (on open bench and in nitrogen-filled bag) and to assess the effect of alfalfa amendment on facilitating anaerobicity.

Methods:

Soil:

- Loam Sandy soil: Sand (83%), silt (9%), clay (8%) pH (5.1), organic matter (1.5%).

Experiment design:

- Maintained at 20 ± 2°C in dark for 120 days.
- Flooded by nitrogen purged water and/or amended with alfalfa after a 30-day aerobic incubation.
- Measured on an open bench (Fig 1) and in a N_2-filled bag (Fig 2).

Sample	Nitrogen purged water	Alfalfa amended	Measurement method
Control	Aeration	N	Open bench
w/o alfalfa w/o bag	Y	N	Open bench
with alfalfa with bag	Y	Y	In a N_2-filled glove bag
with alfalfa w/o bag	Y	Y	Open bench
w/o alfalfa with bag	Y	N	In a N_2-filled glove bag

Monitored parameters:

- Microbial biomass by $CHCl_3$ fumigation method at 1, 60 (30DAF), and 120 (90 DAF) after incubation
- pH, D.O. (dissolved oxygen content), TOC (total organic carbon), redox potential
- Sampling points: 1, 10, 30, 60, and 90 days after flooding (DAF)

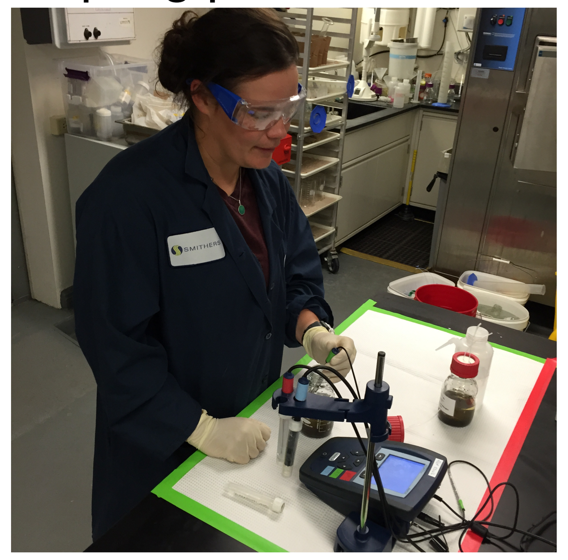

Fig 1. Measurement on an open bench

Fig 2. Measurement in a N_2-filled glove bag

Acknowledgments

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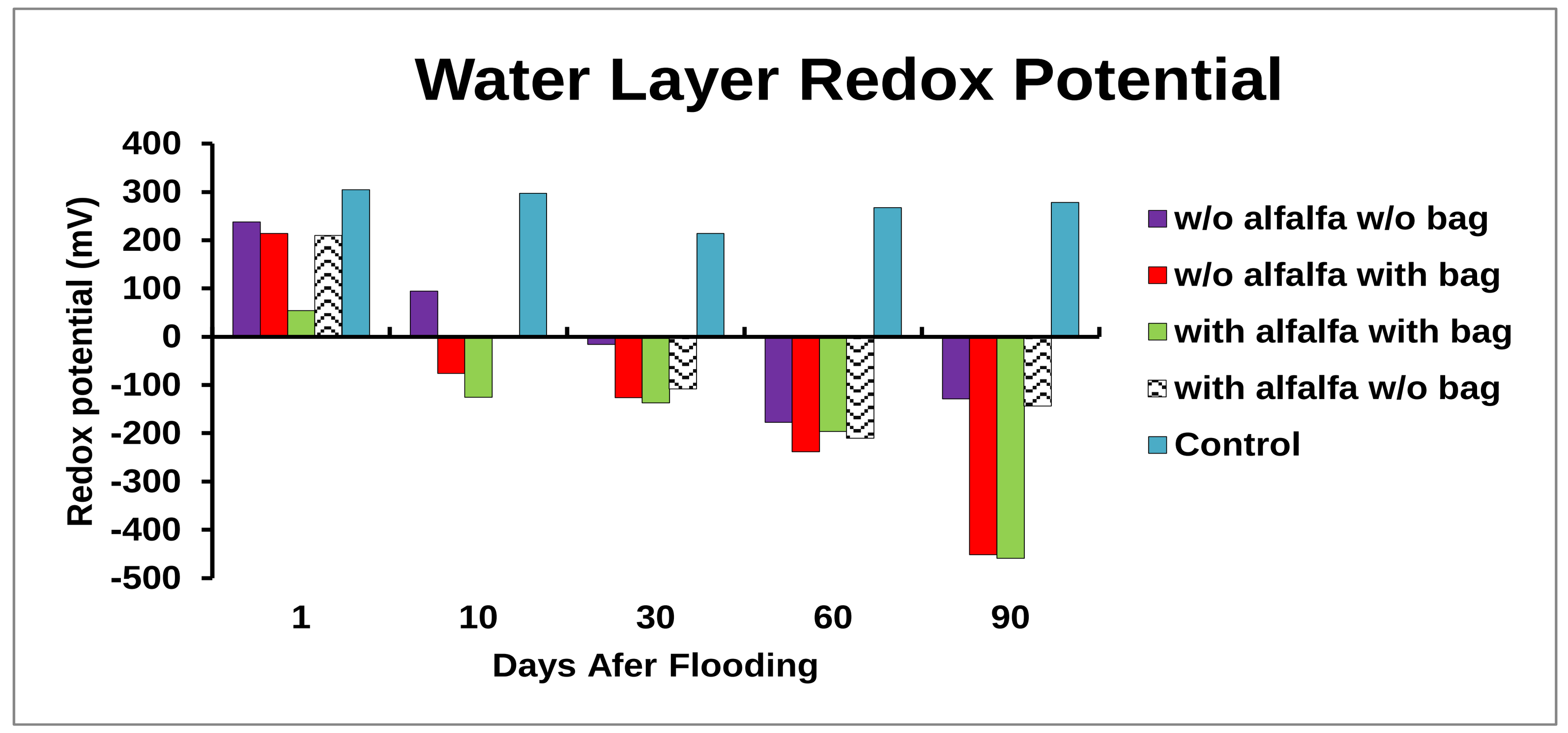
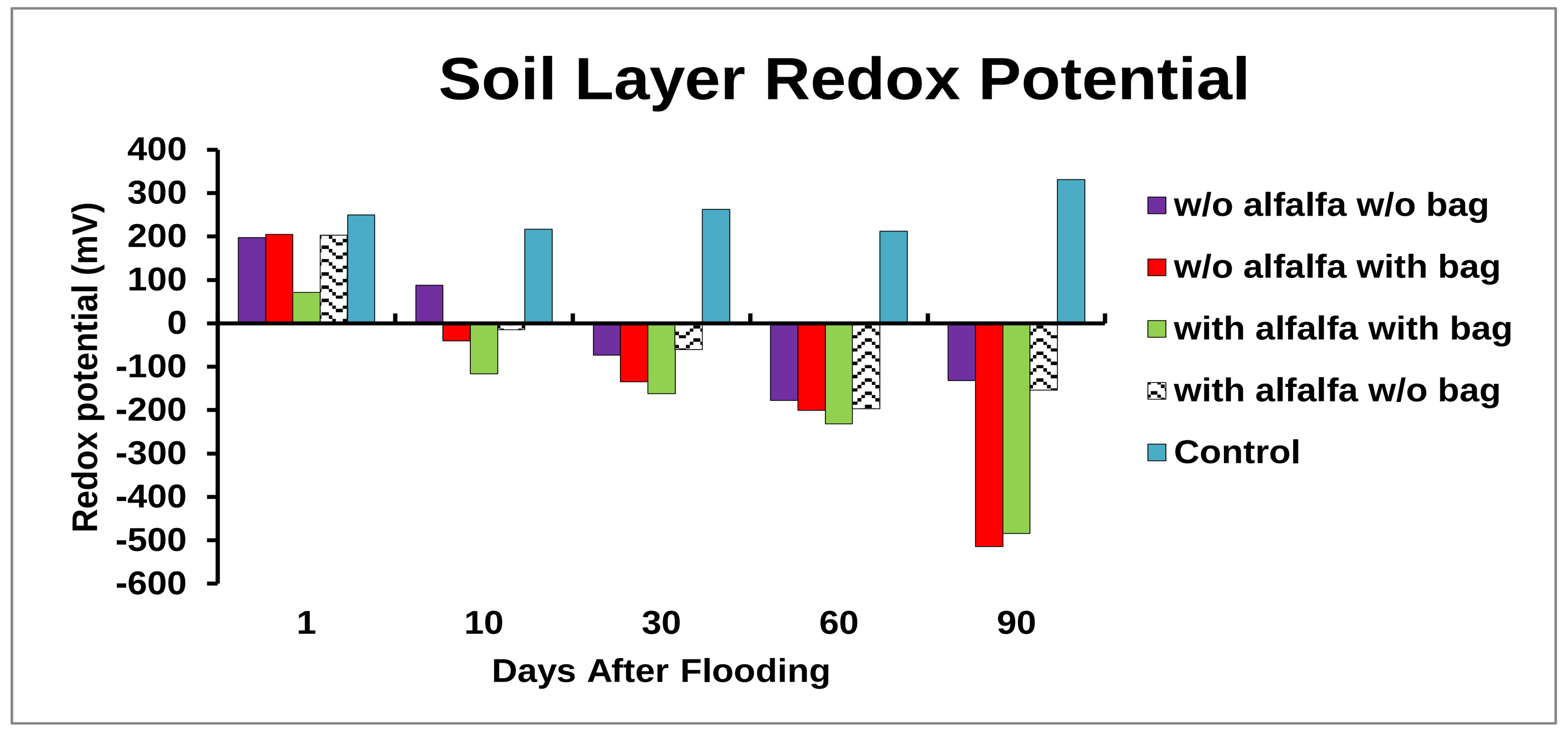
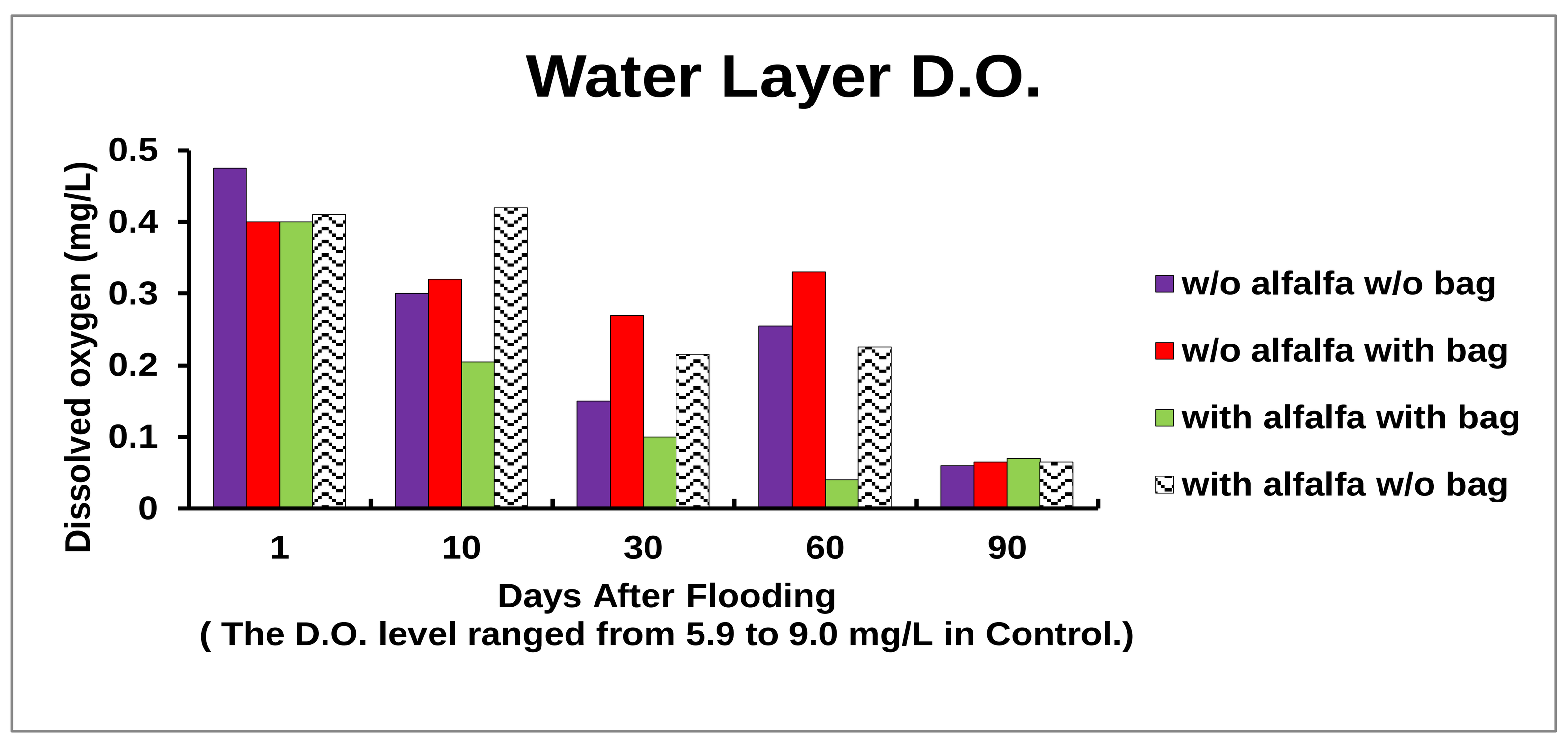
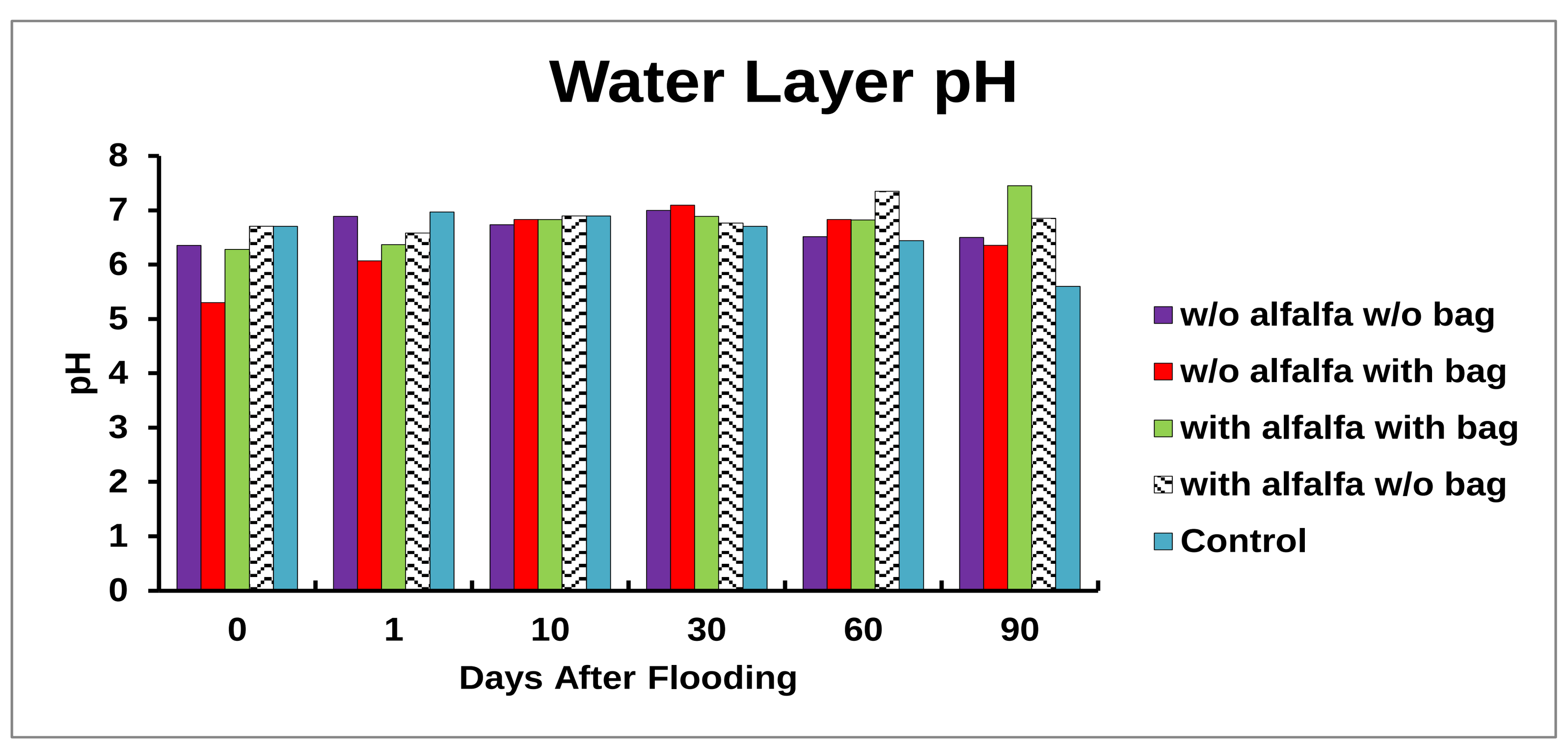
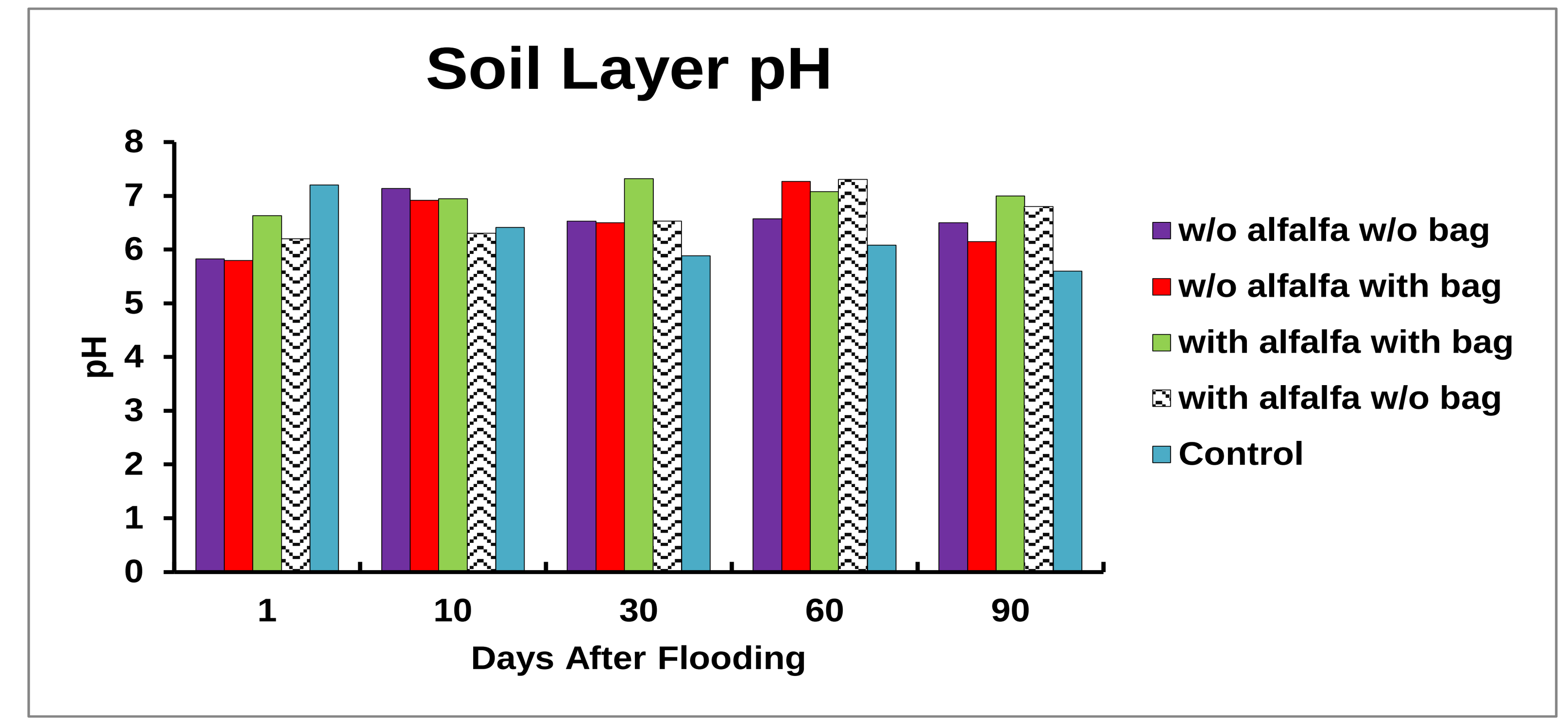
Results:











	Water TOC (mg/L)		Sediment O.M. (%)			Microbial Biomass (%)		
	Mid	End	Start	Mid	End	Start	Mid	End
Nitrogen purged	53	39	1.5	1.4	1.3	1.0	1.1	0.5
Nitrogen purged with Alfalfa	152	98	1.5	1.6	1.4	1.0	1.3	1.1
Control (aeration)	20	18	1.5	1.4	1.3	1.0	0.6	0.6

Conclusions:

- Lower redox potentials in water and sediment layers are typically measured in nitrogen-filled bag than on the open bench. The largest difference was observed on Day 90 after flooding in both water and sediment with a > -300mV difference.
- The effect of nitrogen-filled bags on measured redox potentials is generally more significant than alfalfa amendment.
- Alfalfa facilitates rapid reach of anaerobicity in water and sediment layers. The alfalfa effect on anaerobicity decreased significantly after Day 30 following flooding.
- Alfalfa dramatically increases TOC in water layer.
- The D.O. levels in water layers are all below 0.5mg/L and decreases over the course of the test.
- No obvious effects on pH values are observed from nitrogen-filled bags and alfalfa.
- Microbial biomass in the alfalfa amended/nitrogen purged water is maintained above 1% at the end of the study.

References

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