1 | INTRODUCTION

The Indicator of Reduction in Soils (IRIS) is one of three U.S.-approved techniques (NRCS, 2015) used to demonstrate soils are reducing (Berkowitz & Sallee, 2011; Castañeda, Luna, & Rabenhorst, 2017; Hodges, King, Pett-Ridge, & Thompson, 2018). Iron-oxide IRIS rely on iron reduction (Jenkinson & Franzmeier, 2006; Castenson & Rabenhorst, 2006). Iron-oxide IRIS tubes are prepared by applying an ~40:60 iron-oxide suspension of ferrihydrite (F) and goethite (G) to the surface of a polyvinyl chloride (PVC) pipe. The tubes are then inserted into the soil, and, if soils are reducing, the iron-oxide coating is converted to soluble ferrous iron (Fe^{2+}), leaving the tube white. IRIS tubes remain in the ground for a period of approximately 4 wk before removal and inspection (Vasilas et al., 2013). Manganese-oxide IRIS function similarly but allow detection of more mildly reducing conditions (Dorau, Eickmeier, & Mansfeldt, 2016; Rabenhorst & Persing, 2017).

We present an extension to IRIS that uses an in situ camera to monitor metal-oxide reduction with clear-IRIS tubes. The main advantage of clear-IRIS is the ability to observe iron reduction over time. We painted minirhizotron tubes, which are used to nondestructively monitor roots in situ in upland (Hendrick & Pregitzer, 1996) and wetland (Iversen et al., 2012) environments. We hypothesized that the clear-

Abbreviations: BGS, below ground surface; IRIS, Indicator of Reduction In Soils; PVC, polyvinyl chloride.

Core Ideas

- Clear-IRIS tubes perform the same as PVC IRIS tubes.
- Microbial biofilms did not form on metal-oxide surfaces.
- Soil saturation determines the rate of IRIS reaction.