Hyperspectral bioindicators for remote detection of environmental contaminants

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Abstract:

Nuclear facilities release both radioactive and non-radioactive contaminants into their local environments. When plants are exposed to these pollutants, they may respond with physiological or chemical changes that are detectable using hyperspectral remote sensing. Identifying hyperspectral bioindicators for relevant contaminants could leverage large scale, high-frequency, and nondestructive vegetation monitoring to detect pollutants associated with nuclear activities. Bioindicators might also provide early warning in case of accidental releases or assist in hazard mitigation.

Hyperspectral remote sensing (imaging spectroscopy) provides optical imagery across a continuous range of wavelengths. Such contiguous narrowband (~3-20 nm) data offer greater diagnostic capabilities than multispectral imagery due to the presence of distinct absorption features associated with chemical constituents. Spectroscopy is already widely used to measure agricultural productivity and plant functional traits.

Operationalizing this technology requires that we: (i) quantify the physiological and chemical changes that contaminants induce in plants; (ii) differentiate between stress responses induced by contaminants versus other environmental stressors; (iii) assess the interactive effects between multiple environmental stressors; (iv) characterize species-specific interactions with contaminants.

I report results from a field experiment, conducted in conjunction with US National Lab partners, in which pots of tall fescue were exposed to various levels of chromium, copper, and drought.