Invisible Blues (Novel Device for Detection and Measurement of Nitrogen Traces in a Sample)

Bhaskar, Aditi (School: Wilsonville High School)

Surplus nitrogen's runoff causes numerous environmental hazards, such as algae blooms, which endangers marine wildlife. Currently, farmers use 60-cent single-use test strips (returns qualitative 'good' or 'bad') to confirm levels of nitrogen in their soil. I aspired to design & build a device - more accurate, cost-effective, reusable, time-efficient, and sustainable - to detect nitrogen concentration in the soil. (a)Through iteration, I designed a spectrophotometer (my 'darkbox') to fit a cuvette and positioned receivers & emitters (LEDs - 615nm & 850nm) in their optimal positions. (b)I made circuits (transistors, voltage dividers) & custom C++ logic in the microcontroller to handle connections to multiple LEDs in rapid succession. My code processes the data (averages, etc), returning a relatively error-free value. (c)Through experimentation with various nitrogen sample solutions (after copper-electrolysis; 5min) - made of NH4OH, Mg(NO3)2, inorganic fertilizer, organic potting soil, or combinations) I produced a linear relationship between received absorbance intensity & molarity. After calibration and fine tuning, my devices: 1) detected traces of nitrogen in forms of ammonium & nitrate, 2) disregarded both sulfate's & turbidity interference: all corner-cases passed! My device meets all design criteria: $20 initial investment (lower cost than current after 30 uses), reusable, time efficient, and sustainable beyond current practices. Accuracy: can identify the significance [surplus; shortage; optimal] & molarity [with vs without sulfur, accurately predicts: ammonium (99.79%) & nitrate (92.94%)]. Usage: To test an electrolyzed sample, (1)place it into the 'darkbox', (2)read the molarity of the sample off the LCD board within 20 seconds!

Awards Won:
Third Award of $1,000