2023 International Conference on Integrative Precision Agriculture – Local Solutions Though Global Advances

Developing a Mathematical Model for detecting Aflatoxin hotspots in peanut fields

S. KUKAL, T. BOURLAI, R. KEMERAIT, A. PEDUZZI, C. PILON, G. VELLIDIS,
University of Georgia, Tifton, GA 31793.

Abstract

The U.S. peanut industry is struggling with the problem of aflatoxin, a carcinogenic toxin produced by the soil borne fungi Aspergillus flavus and Aspergillus paraciticus (hereafter both referred to as A. flavus) under hot and dry conditions growing conditions. Aflatoxin contamination of peanut kernels has caused huge losses to the industry in terms of revenue and market share. The goal of this project is to develop a mathematical model to predict the likelihood of the occurrence of aflatoxin hotspots within peanut fields. Those areas can then be segregated during harvest. To train the model, we collected spatially explicit data sets of ECa, soil texture, soil moisture, elevation, spectral response of the plant canopy, plant physiological measurements including leaf temperature, stomatal conductance, and chlorophyll a fluorescence, precipitation, ambient and soil temperature, humidity, and solar radiation in rainfed peanut fields with high spatial variability of soils and terrain. Soil moisture was measured continuously from planting to harvest with a soil moisture sensor network. We collected hyperspectral imagery and lidar data derived from UAV platforms to identify sections of the electromagnetic spectrum that detected vegetation changes caused by A. flavus and to generate micro-relief elevation models. Beginning at 90 days after planting and on a biweekly schedule, we collected physiological measurements and plant samples on a dense sampling grid. Peanut kernels from the plant samples were analyzed for aflatoxin concentrations. A random forest machine learning model was developed which was designed to determine indicators of Aflatoxin presence from the pool of remotely and proximally collected field parameters. The model outputs a preliminary complex equation that roughly estimates Aflatoxin concentrations in the field. The deliverable of the project is that the model

predicts the probability of the occurrence of aflatoxin hotspots within a peanut field with an accuracy of >75% after Year 1 and an accuracy of >95% after Year 3.

Keywords: Peanuts, Aflatoxin, Machine Learning, Remote Sensing, Spatially Explicit Data, Vegetation Indices.