Using Advanced Technological Methods for Correlating Weather Events and Productivity/Quality Across Georgia's Peanut Growing Regions

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Layman's Summary

Peanut growers in Georgia have seen a dramatic increase in acreage and yield over the last 10 years with the introduction of new cultivars like Georgia 06G and Georgia-12Y. Although many growers have observed record yields over the last decade, weather extremes have caused significant yield loss across many of the growing regions in Georgia. With this in mind, there is a need to find new and innovative methods to better understand the impacts of weather variations on peanut productivity across the many different micro-climates in Georgia, and how management can alter crop response to weather. The objectives of this study are to i) compile and process previously-collected geospatial field survey data from Georgia peanut growers, ii) retrieve and process geospatial environmental (soils and weather) open-source data connected to survey fields, and iii) predict peanut yield and grade in space and time using machine learning models. Surveys were conducted in the state of Georgia where each field was surveyed on agronomic data like yield and grade and management data like variety, use of irrigation, row pattern, rotation, tillage method, field coordinates, and saved seeds. A total of 339 fields were surveyed representing 41 peanut growing counties in Georgia for the years 2017, 2018 and 2019. Open-source climatic and soil data during the peanut growing season was retrieved. Weather data on a daily scale was retrieved for each site related to day length (h), solar radiation (MJ/m^2), temperature, and vapor pressure (Pascal). Soils data on a field scale from four different depths (0-2 inch, 2-6 inch, 6-12 inch, and 12-24 inches) were retrieved for clay (%), sand (%), silt (%), organic matter (%), bulk density (g/cm^3), pH, pore size and distribution. Growing degree days (GDD) was derived on a daily scale assuming a base temperature of 55 °F. GDD, planting and digger dates were then used to segment the peanut growing season on each field into three developmental stages of interest: emergence (0-136 GDD), vegetative (136-336.5 GDD), and squaring (336.5 GDD until digger). To characterize the environments in relation to yield and grade, conditional inference trees were utilized with all 89 summarized variables used as explanatory variables. Irrigation was the most important variable for predicting peanut yield. Soil silt percentage, minimum temperature recorded in the reproductive stage and mean temperature recorded in the emergence stage were also important. Highest peanut yields were observed in irrigated fields when the silt soil percentage between 12 and 24 inches were higher than 10.9%. Irrigation was the most important variable for predicting peanut quality. Reproductive stage duration, minimum temperature recorded in the vegetative stage, and soil pH were also important. Highest peanut quality values were observed in irrigated fields when the duration of reproductive stage was greater than 121 days and the soil pH value was higher than 5. Lowest peanut quality values were observed in irrigated fields when the duration of reproductive stage was greater than 121 days and the soil pH value was lower than 5, and in non-irrigated fields when the minimum temperature during the vegetative stage was lower than 69 °F. For yield, weather variables explained the most variation (52%), followed by management (31%), and soil (18%). For grade, weather explained the most variation (74%), followed by soil (15%), and management (11%). Georgia peanut growers can use this information to better understand the main drivers of peanut yield and grade, and manage their fields for improved agronomic outputs.