Fertigation of Orchards - Spatial Variability in N Usage and Losses

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Abstract

Monthly ground measurements of leaves N content and soil properties are combined with multi-sensor areal imagery (thermal, multi-spectral, RGB) to identify spatial variability in the N content of orange trees in four neighboring orchards. Initially, stratified random design (SRD) model with topographic data and existing soil maps, was used in the to select 12 random sampling trees in each of the four orange plots. The sampling trees managed to identify the spatial variability in the trees N ststus in each plot. The collected data was clustered into three to six site specific management (SSM) zones using multivariate spatial clustering model.

Keywords: Nitrogen, stratified-random-design, areal-imagery, site-specific-management-zone

1. Introduction

Permanent crops agriculture cover 1.2% of the global land area (FAOSTAT, 2018) and demand the supplement of nitrogen (N) to sustain commercial viability. Enhancement of the nitrogen use efficiency (NUE) is achieved via knowledge of the N uptake curve, and adjustment of the plant nutrient status throughout the growing season to fit that curve. However, due to lack of knowledge and technology, to date orchards are fertilized without accounting for the spatial variability in the hydro-physicochemical properties of soils or in the vegetative status of the trees. This leads to huge spatial variability in N losses below the root zone that can vary over 3 to 4 orders of magnitude (Baram et al., 2016). It has been shown that ground measuerments and areal imagery can be combined to generate site-specific management (SSM) zones. This in turn may be used to enhance the sustainability of agriculture (Svoray et al., 2015; Paz-Kagan et al., 2016).

2. Methods

Initially, available information (topographic map and existing soil maps) was used in the stratified random design (SRD) model (R software) to select 12 random sampling trees in four orange plots. Initial leaves and soil samples were collected from each sampling tree. The gathered data was then used to classify each plot into three to six SSMs using fuzzy logic algorithm. Porewater samplers were installed next to each monitored. Every month an areal image with a thermal (Tir), multi-spectral (400 nm to 840 nm including RGB, Red Edge and NIR (MSP)) and a high-resolution RGB camera with height was taken together with leaf and water samples.

3. Results

The initial SRD model managed to identify the spatial variability in the four plots. A very good fit was observed between the collected leave data (N content) and the areal imagery. Using multivariate spatial clustering model, the ground collected data together with the areal imagery were clustered into three to six SSMs representing the plot’s spatial variability. Every month the collected data will be used to refine the model and to identify trends in the spatial variability of the N status of the trees.

4. Conclusions

We show that by combing ground measurements with areal imagery the spatial variability in the N status of the various trees in an orchard can be identified. The collected data can be clustered into SSM zones using multivariate spatial clustering model. By adoption of SSM zones and utilization of slow-release fertilizers we hope to improve the nitrogen use efficiency, increase the yield and reduce the losses. The project is scheduled to run for three more years.

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