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Impact of Field Topography and Soil Characteristics on the Productivity of Alfalfa and Rhodes Grass: RTK-GPS Survey and GIS Approach

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Abstract: Understanding the spatial pattern of soil chemical properties along with the topologic indicators is essential for site-specific agriculture management. A study was conducted on a 50 ha field to investigate the effect of selected topographic indicators, including elevation (DEM), slope (SL), flow accumulation (FA) and Topographic Wetness Index (TWI) on forage crop production. The soil samples and yield data were obtained from the field inventory. Topographical parameters of elevation and slope were estimated with the use of a real-time kinematic global positioning system (RTK-GPS), and then the DEM was generated. The collected soil samples were analyzed for pH, EC, nitrogen and soil organic carbon. Sentinel-2 images were for the creation of yield maps of alfalfa and Rhodes grass. Subsequently, on the basis of DEM, the generated elevation, slope and FA model were then compared with the yield and soil chemical properties. Statistical analysis revealed that the SL, FA and TWI, which are associated with water distribution, were significantly related to crop yields. The FA showed a medium-to-non-significant correlation with the productivity of both alfalfa (R^2 = 0.586; p = 0.015) and Rhodes grass (R^2 = 0.578; p = 0.01). A significant inverse correlation was recorded between the SL and the yield of both crops (R^2 = −0.591 to −0.617; p = 0.01). The yield map revealed that the majority of the area (37.56%) of the experimental field was occupied by the medium-yield class, followed by the high-yield class (33.03%).

Keywords: alfalfa; Rhodes grass; RTK-GPS; kriging; topographic indicators

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1. Introduction

Topographic variability is one of the main factors affecting soil properties and crop production [1]. Information on the influencing factors of spatiotemporal variability in crop yield is essential for the optimized use of agricultural inputs and increased profits [2]. Understanding the spatial pattern of soil chemical properties (SCP) along with topography indicators (TI) is essential for field management [3]. Site-specific-agriculture deals with field topography and soil characteristics exploring the temporal and spatial changes in enhanced crop production. It also plays a key role in the spatial distribution of soil particles, moisture content, organic matter, and nutrients throughout agricultural fields [4–6]. Understanding the relationship between topographic indicators and crop yield variability helps to improve crop management [7]. The topography of agricultural fields is described by several indicators, including the relative elevation, slope, surface curvature, upslope length or contribution area and flow accumulation [8,9]. The effect of those topographic indicators on crop yield was analyzed. The most important topographical and hydrological attributes, which are considered to induce a significant impact on crop production, include the slope,