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ASSESSMENT OF SOIL COMPACTION UNDER CENTER PIVOT IRRIGATION SYSTEMS AND ITS EFFECT ON CROP PERFORMANCE

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ABSTRACT

A field study on two 12.5 ha plots cultivated with wheat and alfalfa was conducted to determine Soil Compaction (SC), its spatial variability and its effect on crop performance under center pivot irrigation systems. Considering compaction at two tested soil depths, results revealed that the soil of the alfalfa plot exhibited significantly ($p<0.01$ and $p<0.05$ for 0 to 10 cm and 0 to 30 cm soil depth, respectively) higher compaction values (an average of 1730.328 and 2329.604 kPa, respectively) compared to those exhibited by the soil of the wheat plot (averaging at 1339.685 and 2088.903 kPa, respectively). Significant spatial variation of SC was observed within each of the tested plots. SC around pivot wheel tracks was also investigated at a soil depth of 0 to 30 cm for 5.5 m wide strips on both sides of the tracks. Results revealed that the Coefficient of Variation (CV) of the SC around the tracks was 9.33 and 16.53% for alfalfa and wheat plots, respectively, suggesting that the SC was not laterally influenced by the wheel tracks. The effect of SC on crop performance, expressed as the Normalized Difference Vegetation Index (NDVI), was investigated on the two plots. Results showed that the NDVI was, in general, inversely proportional to the SC. For both crops, the NDVI was more affected by SC at the top soil layer (0-10 cm depth). Moreover, the alfalfa crop was shown to be significantly influenced by the SC (an average R^2 value of 0.3165 and P value of 0.0287), unlike the wheat crop (an average R^2 value of 0.0725 and P value of 0.4646).

Keywords: Precision Farming, Soil Compaction, NDVI, Center Pivot Irrigation, Mapping, Saudi Arabia

1. INTRODUCTION

In the kingdom of Saudi Arabia, most commercial crops are grown on fields of large areas (vary from 15 to 50 ha) and irrigated using center pivot irrigation systems. These fields of such large areas were observed to have spatial variability in soil properties and crop yield. Understanding and assessing the spatial variability of soil characteristics, such as soil compaction and their effect on yield is a crucial step towards the appropriate application of precision agriculture technology.

Soil compaction, which refers to the reduction in soil macro-pores and the increase in both soil density and soil strength, is characterized as one of the key land degradation processes. It imposes detrimental effects on crop production as it creates a poor environment for root growth, reduces water infiltration and increases runoff, hence, soil erosion. Richard *et al.* (1999) reported that soil compaction caused by the passage of vehicles resulted in important economic and ecological consequences, such as poor crop productivity due to problems of crop establishment and root growth and excessive soil erosion due to reduced water infiltrability. According to Bober *et al.* (1996), wheel traffic from heavy vehicles can compress soils to varying degrees throughout the plant root zone, often causing increased mechanical strength and decreased air and water permeability. This condition can impede root elongation and significantly reduce crop growth and yield. The detrimental effects of soil compaction on crop performance have been reported