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Investigating the response of soil and vegetable crops to poultry and cow manure using ground and satellite data

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ABSTRACT

Based on the massive production of cow and poultry manures, farmers in Saudi Arabia are moving towards the application of organic fertilizers in their farms. Therefore, the present work was conducted to study the response of soil and selected vegetable crops to poultry and cow manures, using ground data and Landsat-8 and Hyperion images. The studied vegetable crops are cabbage, cauliflower, broccoli, and lettuce. A total of 100 t ha^{-1} organic manures were applied as a pre-planting treatment. A 12.5 ha field in Tawdeehiya Farms, 200 km southeast of Riyadh, was earmarked for this study. The field was divided into sectors cultivated with the above-mentioned vegetable crops. Soil characteristics, including the soil pH, the electric conductivity (EC), the nitrogen (N), the phosphorus (P) and the potassium (K), were examined before the application of manures and 25 days after the transplanting process. Observations on crops chlorophyll content, number of leaves, the diameter of merchantable products and yield were also investigated. Furthermore, the relationship between the crop performance and yield was investigated through the satellite images generated vegetation indices (VIs). This study revealed the better performance of poultry manure compared to cow manure in terms of development and production parameters of the experimental crops. Dynamics of the chlorophyll content across the crop growth period revealed that all the tested crops responded significantly ($R^2 = 0.69$; $P = 0.001$) to the poultry manure treatments. Among the tested crops, the chlorophyll content, curd or head sizes and crop yields were quite better in poultry manure applied plots. The investigation of crop yield was significant with poultry manure ($R^2 = 0.64$; $P = 0.001$) than cow manure ($R^2 = 0.57$; $P = 0.001$) using the OSAVI and mNDVI, respectively.

1. Introduction

Agricultural land is the most valuable resource for food and fiber production required to meet the human and animal needs. Vegetable crops, however, are of utmost importance in terms of health because they are a rich and relatively cheaper source of vitamins and a range of foods necessary for a balanced diet (Robinson, 1990). In Saudi Arabia, an area of about 106,176 ha was under vegetable crops in 2013–2014, with a recorded total yield of 2,731,370 tons (GAS-KSA, 2015). In order to meet the productivity of a crop, the usage of agro-chemicals is common practice. However, optimum usage of maintenance of crop and agricultural land is essential. Most farmers use large quantities of inorganic fertilizers (such as superphosphate, urea sulphate, and ammonium nitrate sulphate) to enhance crop production, resulting in high soil acidity, high amounts of nutrient losses through leaching and soil erosion, in addition to high radiation levels due to the increased chemical contents in the soil (Ndukwe et al., 2012; Alharbi, 2013).

Soil degradation due to biochemical materials are considered less hazardous compared to that caused by inorganic fertilizers and pesticides, as they are directly linked to environmental degradation and health risks (Peyvast et al., 2008). Inorganic fertilizers, which are less complex and have high nutrients concentrations, are formulated to provide specific plant nutrients. However, for organic fertilizers which are naturally derived from living substances including bat and bird excrement, animal manure or vegetable matter (e.g. compost and crop residues), nutrients are released more slowly, and therefore takes more time to supply nutrients to plants than inorganic fertilizers.

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