COMPARING PLANT YIELD AND COMPOSITION WITH SOIL PROPERTIES USING CLASSICAL AND GEOSTATISTICAL TECHNIQUES

by

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Declaration

I, the undersigned, hereby declare that the work contained in this thesis is entirely my own original research, except where acknowledged, and that it has not at any time, either partly of fully, been submitted to any University for the purposes of obtaining a degree.

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ABSTRACT

Plant nutrient management plays a vital role in the success or failure of modern lucerne production. In South Africa, lucerne is produced under a wide range of climatic conditions, under dryland and irrigation and in some areas throughout the year. This means that there is a continuous demand for nutrients under a wide range of environmental conditions. The most important factors affecting the nutrient requirement of lucerne is yield, the cutting schedule, climate and management practices. To enable site-specific crop requirements, the spatial variation of soil and plant properties within a field can be managed with the use of geostatistical techniques. Some work has also been done to evaluate the use of geostatistics in the design of agricultural field experiments to provide better field characterization and improve plot layout. The aim of this study was to compare plant yield and composition with soil properties using both classical and geostatistical techniques. The study was conducted from June 2001 to February 2002 on an 18 ha lucerne stand in the Brits district in the North West Province. A rectangular area of 160 m X140 m was demarcated as the study area and comprised of two soil units (Hutton and Shortlands forms). Seventy-two sampling points (nodes) were laid out on a 20 m square grid, with an additional 90 sampling points laid out on a 2.5 m square grid at six randomly selected node points. Soil (0 – 300 mm) and plant samples were taken within a 0.6 m square at each of the sampling points for chemical analysis. Starting in June 2001, yield sampling was done on six occasions, at approximate intervals of 5 weeks. A randomized complete block design trail layout was superimposed on the geostatistical grid design and consisted of seven pseudo treatments, replicated four times. Basic statistical analyses were performed and spatial presentations of the variation of the plant and soil properties and lucerne yield were made using geostatistical analyses. Analyses of variance were used to test for differences between pseudo treatments for all plant and soil properties. The two soils on the study site, exhibited differences in certain properties, which caused a bi-modal population in the data. Poor correlations were found between plant nutrient uptake and soil properties as well as yield, with little or no resemblance when comparing their spatial distribution. This emphasizes the fact that the uptake of elements is not solely dependant on the concentrations thereof in the soil solution, but on other factors. Temporal variations in lucerne yield were also observed. Although there were large differences in spatial variation of lucerne yields across harvesting events, similar spatial patterns were evident. From

an analysis of variance of the RCB design it was concluded that the experimental field was homogeneous enough to lay out a standard block design experiment. However, scrutiny of the structure of spatial variability of pH(H_2O) revealed that the standard RCB designs did not provide homogeneous blocks with respect to soil variability. The consequent redesign of the experiment whereby all plots were randomly allocated to treatments and replications, led to dramatically different results: significant differences were obtained for plant and soil properties as a function of the pseudo treatments. From this study it is clear that spatial variability of soil and plant properties can jeopardize the results of a standard block design field experiment and it is therefore recommended that the layout of field experiments should be designed to the cognizance of the spatial variation of a soil property that correlated highly with a chosen response variate.