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**EFFECT OF CULTIVATION ON MAIZE RESPONSE
TO NITROGEN FERTILISER**

A thesis presented in partial fulfillment of the requirements for the
degree of
MASTERS IN APPLIED SCIENCE
in Soil Science

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SULHADIANA MUNIR

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ABSTRACT

EFFECT OF CULTIVATION ON MAIZE RESPONSE TO NITROGEN FERTILISER

Continuous cultivation of arable soils results in the decline of 'soil quality' in terms of structural degradation and nutrient depletion. It decreases soil organic matter content, induces the leaching and gaseous losses of N through enhanced nitrification and denitrification, resulting in the depletion of nitrogen content of the soils. This will affect N availability, soil moisture retention, soil aeration and the activity of soil microorganisms. The objective of this study is to examine the effect of cultivation on the response of maize to N fertiliser.

A glass house experiment was conducted using four soils. The soils included a permanent pasture soil and three maize / barley grown soils which have been cultivated for 6, 17 and 34 years. Maize plants were grown at six levels of N applied as urea (0 – 500 kg N/ha).

The dry matter yield response to N application indicated higher maize growth for the pasture soil than for the cultivated soils at all levels of N application. Even at the highest level of N application (500 kg N/ha) the maize dry matter yield for the cultivated soil did not reach that for the unfertilised pasture soil. This indicates that N alone was not limiting the dry matter yield among the cultivated soils. It was hypothesised that the differences in the physical conditions among these soils may also be responsible for differences in dry matter yield.

In the second experiment, pasture and the 34 year cultivated soils were incubated with poultry manure for eight weeks. The addition of poultry manure was to improve the physical conditions of the soil. A glasshouse experiment was then conducted to examine the effect of poultry manure addition on the growth of maize at five levels of N (0-400 kg N/ha) applied as urea.

There was a clear visual indication of an improvement in the structure of the cultivated soil due to the incorporation of poultry manure. Addition of poultry manure increased the dry matter yields of maize plants both in the cultivated and the pasture soils. The dry matter yield of plants in the cultivated soils (in the presence of manure addition) was higher than the pasture soils at low levels of N application and similar yields were obtained at the higher rates of N application. Oxygen diffusion rate (ODR) values were higher for the pasture soil than the cultivated soil. The addition of poultry manure in the initial stages, however, decreased the ODR values in both soils which is attributed to the increased consumption of oxygen by the easily decomposable organic carbon in the poultry manure. With increasing time after incubation the ODR values slowly increased in the poultry manure treated soils indicating an improvement in soil structure. The study clearly demonstrated that the impact of cultivation on maize yield was partly due to poor soil physical conditions.

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CHAPTER 1

INTRODUCTION

Proper cultivation has a beneficial influence on the yield and quality of the arable crops. The primary purposes of cultivation are destruction of weeds and production of a fine tilth. It loosens the surface of the soil by admitting air. In the cultivated soil, however, the destruction of aggregates and subsequent soil compaction can result in a rapid decrease of soil organic matter and turnover of the microbial biomass (Landina et al., 1984). Also continuous cropping with maize tends to deteriorate the physical conditions of the soils, and encourage weed growth to serious proportions (Berger, 1962). Cultivation is the principle agent promoting soil structure modification and increasing potential soil organic matter loss by erosion and biological decomposition (Carter et al., 1994).

Continuous cultivation of arable soils results in the decline of 'soil quality' in terms of structural degradation, soil organic matter loss and nutrient depletion. Cultivation has also been shown to induce the leaching losses of nitrogen (N) through enhanced nitrification.

Maize production is limited by N deficiency more often than by that of any other nutrient. The recommended level of N application for maize in New Zealand is 200 kg N/ha applied at three split doses (50 kg N pre-planting; 100 kg each at 60 and 180 days after sowing. For a maize crop of 6.3 tons/ha including stover, N uptake of 167-241 kg N/ha is required (Smith, 1952 as cited by Berger, 1962).

In New Zealand, conversion of pasture land to cropping by cultivation and reversion back to pasture for replenishment of nutrients and organic matter is a common practice. However, in the Manawatu region, some heavier textured soils are used for continuous (medium-to long-term) cropping. Such operations are not sustainable because continuous cropping of these soils causes a decline in soil physical and biological

properties (Saggar et al., 1998). Consequently, soil fertility is decreased and maize yields are reduced. The poorly structured soils become compacted and difficult to cultivate (Shepperd et al., 2000). Changes in soil organic matter also result in the depletion of nutrient reserves, such as soil N. To maintain the maize yield farmers have to apply additional inorganic N fertilisers. However, it is not known if increased N fertilization alone is sufficient to maintain maize yields in these long-term cultivated soils of poor structure.

Since the crop production in these soils is limited by both chemical fertility (poor N status) and physical conditions (poor soil structure), there is a need to assess the extent to which each of these two influence the maize production. Therefore, the objectives of this study were:

1. To examine the effect of cultivation on N response of maize under glasshouse condition.
2. To assess the effect of incorporating poultry manure (PM) and N addition on maize growth and soil physical condition.

The overall structure of thesis is given in Figure 1.

Chapter 1 gives the background to the present study which was designed to examine the effect of cultivation on maize response to N fertiliser under glasshouse conditions.

Chapter 2 presents a literature review on the effect of cultivation on soil properties and briefly outlines maize response to N fertiliser in cultivated soils.

In **Chapter 3**, the results of a glasshouse experiment (Experiment 1) are discussed. The aim of this glasshouse experiment was to examine the growth response of maize to increasing levels of N in four soils (three maize soils cultivated for different periods and one permanent pasture soil).

Chapter 4 describes the results obtained for the second glasshouse experiment (Experiment II). The aim of this experiment was to improve the physical conditions of the soil with addition of PM and then to examine its effect on the maize growth response to N.

From these glasshouse trials it was concluded (**Chapter 5**) that the decline in maize yield with cultivation was due partly to the structural degradation of the soil. It is possible to improve the physical conditions through incorporation of poultry manure.

Figure 1. Diagram of the logical structure of the thesis

