SOME CONSEQUENCES OF MOLE DRAINING A YELLOW-GREY EARTH UNDER PASTURE

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ABSTRACT

Although subsurface drainage of pasture soils is widely practiced in New Zealand there is little information available which details the likely benefits of such drainage schemes. As drainage is becoming increasingly expensive there is a need for more quantitative data on which to base assessments of the likely cost-effectiveness of proposed schemes.

The effect of subsurface drainage on certain soil and plant properties was investigated at a research site on a sheep and beef farm 6 km from Palmerston North. The soil type was a yellow-grey earth, with poor drainage due to water perching on the fragipan. Of nine plots, each 0.4 ha in area, three were left undrained and six were mole drained. Three of the drained plots had conventional pipe collecting drains and the other three used major mole channels as collecting drains. The research site was grazed as part of the normal farm rotation. Data were collected in 1981 prior to the installation of drains, then from 1982 to 1984.

Watertable levels were monitored in a series of four groundwater observation wells on each plot and the gravimetric water content of the top 30 mm of each plot was determined on a regular basis from soil cores. Soil temperature measurements were made at 50 mm depth on a pipe-mole and undrained plot, using thermistor thermometers, and at 100 mm depth on all the pipe-mole and undrained plots using mercury-in-glass thermometers.

Pasture growth rates were measured in caged areas using a capacitance pasture meter and by mowing. Residual pasture left by the grazing animal was determined using small quadrats, the pasture meter and by visual assessment. Botanical composition was determined by point analysis and dissection of samples removed from the caged areas. Available

soil nitrogen, phosphorus and sulphur in the top 75 mm of each plot, and the total levels of these three nutrients in grass and clover grown on the plots, were measured using standard procedures. Two radioactive isotopes (^{32}P and ^{35}S) were used simultaneously to study the plant root activity on the undrained and pipe-mole plots.

Data from groundwater observation wells showed that mole drainage was very effective at lowering the watertable following heavy rain in winter or spring. There was no significant difference between watertable depth on the pipe-mole and mole-mole plots. The close proximity of the watertable to the surface on the undrained plots was reflected in high soil water content values for the top 30 mm of soil.

Differences in water content of the surface soil between drained and undrained plots did not affect the levels of extractable phosphate, sulphate, ammonium or nitrate or the pH in the top 75 mm of soil. Soil temperature measurements at 50 and 100 mm depth showed that drained plots did not warm any more quickly in spring than did undrained plots. A simple mathematical analysis confirmed that the lowering of the soil heat capacity by drainage would not be expected to affect soil temperature significantly in a yellow-grey earth under pasture.

There was little difference in pasture growth rates and utilisation during the very dry winter and spring of 1982, but during mob grazing in the wetter winter of 1983 utilisation was approximately 25% greater on drained than undrained plots. Subsequently, utilisation of pasture by sheep which were set stocked in spring continued to be poorer on the undrained plots, with approximately 35% more residual dry matter remaining on the undrained than on the drained plots. From the time of mob grazing in July until the end of spring both mowing and the pasture meter data showed that growth rates were approximately 30% greater on the drained plots.

Point analysis at the end of spring revealed that on the undrained plots there was a 3-fold increase in the incidence of weeds, a 4-fold increase in the incidence of bare ground and a 2-fold decrease in the incidence of clover compared with the drained plots. Almost identical results were obtained from herbage dissections.

There was also a decrease in the concentrations of N, P and S in the dry matter of grass and clover grown on the undrained plots compared with that grown on the drained plots. These differences were for the most part small and ephemeral.

Isotope uptake studies showed that in winter drainage enabled both grass and clover roots to extract both sulphate and phosphate from a greater depth, with approximately 6% of the relative root activity occuring at 40 - 80 mm depth on the undrained plots compared with approximately 15% on the drained plots. In spring, approximately 16% of the relative root activity was at 80 - 200 mm depth on the undrained plots compared with approximately 26% on the drained plots.

The benefits of drainage became apparent only after grazing on a wet soil and were probably due to the effect that drainage had on the water content and so strength of the surface soil. Drainage increased the bearing strength of the surface soil, minimizing treading damage to both the sward and the soil structure and therefore enhancing both pasture utilisation during grazing, and subsequent regrowth.

A simple mathematical model was developed, which used weather data to predict the watertable levels in both drained and undrained soil. By varying certain soil properties and drainage design parameters within the model, the limiting steps in the drainage process in the Tokomaru silt loam were investigated. The model was also designed to calculate the number of days over the winter-spring period on which the surface soil would be so wet that grazing would have the adverse consequences described above. In a year of average rainfall, mole drainage reduced the number of such 'unsafe' grazing days from 69 to 10. By comparing the number of 'unsafe' grazing days for different rainfall regimes some idea of the cost-effectiveness of drainage may be ascertained.

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