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RELATIONSHIP BETWEEN SOIL FERTILITY AND THE COMPONENTS OF AND SEASONALITY OF FORAGE SUPPLY OF A HILL PASTURE

A thesis presented in partial fulfilment of the requirements for
the degree of Master of Agricultural Science
in Soil Science at Massey University, New Zealand

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November 1994

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ABSTRACT

Seven hill country sites, covering a range of soil fertility were studied with the objective of examining the relationship between soil fertility indices and the components of and seasonality of forage supply of a hill pasture under continuous grazing.

The seven sites varied from an undeveloped, unfertilized hill pasture, containing only low fertility adapted grasses and weeds to a highly productive sward dominated by high fertility responsive grasses and white clover. The differences between sites were the consequence of different fertilizer application, position on the landscape and accumulation of nutrients from dung and urine. The total C content of the soils varied from 4.7 to 7.2%, N content varied from 0.43 to 0.70% and P content from 517 to 1361 mg L^{-1}. Soils were sampled biweekly and analyzed for mineral N and Olsen and Resin P for 12 months starting in January 1993. In each season microbial C, N and P were also measured. Pasture growth and components at each site were assessed under biweekly and 4-weekly cutting regimes throughout the 12 months of the experiment. Nitrogen and P concentration of mixed pasture samples from each cut were also determined.

There was a wide range in the values of the three soil fertility indices measured (mineral N, Olsen P and Resin P). Ammonium was the dominant form of soil mineral N at all but the highest overall soil fertility site. Differences in mineral N between sites were mainly due to NO_3^- content. The seasonal pattern was similar for all sites with the lowest soil mineral N content in winter and the highest in summer. In contrast both soil P indices had smaller variation throughout the year and no clear seasonal pattern. Olsen P values at the seven sites ranged from 7.7 to 46.3 and Resin P values from 12.2 to 76.7. Microbial C and N content of soil showed little seasonal variation or differences between sites. In sharp contrast, Microbial P was higher in spring and summer than in autumn and winter and this difference decreased as the fertility of the seven sites increased. The Microbial C:P ratio decreased as fertility increased.

Annual pasture production varied more than 5-fold across the 7 sites, ranging from 3300 to 17000 kg DM/ha/year. There was little effect of cutting frequency on pasture production. Grasses adapted to low fertility environments were the dominant botanical fraction of pasture at all sites with the exception of the highest production site. High fertility responsive grass production followed the same trend as total pasture production and weeds the opposite trend. The seasonal pattern of pasture production was similar at all sites with spring and summer production accounting for more than 70% of annual production. Seasonality of pasture growth was not affected by soil fertility or cutting frequency. Nitrogen and P concentration of pasture followed the same trends of pasture production being the highest in the high production sites and extremely deficient in the low production sites. Differences in P uptake by pasture were far greater (nearly 10-fold) than differences in pasture production.

There were strong relationships between the three soil fertility indices studied and pasture growth. Monthly and seasonal mineral soil N values had a strong linear relationship with seasonal and annual pasture production indicating that N was limiting pasture growth over the range of soils studied. Spring and summer estimates of mineral N were the most reliable predictors of annual pasture production. Monthly and seasonal values of soil P fertility indices (Olsen and Resin P) were strongly related to pasture production although pasture growth appeared to be reaching a plateau at high P levels, specially in spring and summer. Due to the small variability of these indices throughout the year, relationships between Olsen P and Resin P and total pasture production were independent of sampling time, with the exception of the sampling immediately following P fertiliser application.

Estimated P levels for 95% of maximum growth were extremely high (103 and 187 μg/cc for Olsen P and Resin P, respectively). These indices are much greater than the commonly used critical level for Olsen P in these soils (20 μg/g). However, the shape of the response curve in this study may be affected by the combined effect of available P and N at the high fertility sites. Indices of P fertility were also related to pasture composition, with a strong positive linear relationship with high fertility responsive grass production, a quadratic relationship with white clover production and a negative relationship with weeds production and content.

This study suggests that in hill country pastures Olsen P and Resin P values may be satisfactory indicators of pasture productivity for animal production models. However, pasture production will continue to increase to much higher P levels than are normally associated with maximum production in conventional P fertiliser trials. This is because of the linkage of N and P in animal excreta resulting in a high nitrogen status in those areas of hill country that also have high P.

ACKNOWLEDGEMENTS

To Dr. A. Mackay for his continuous guidance, encouragement, patience and friendship during my study.

To Dr. R.W. Tillman for his supervision, guidance and some valuable suggestions.

To Drs. D.J. Barker, P.E.G. Gregg and M.H. Hedley for valuable discussions.

To the AgResearch for providing the experimental site.

To Vanessa Pokaia for her help in field and laboratory work.

To members of the AgResearch hill country research group, particularly D. Costall, P. Budding and B. Devantier for their help in conducting the field experiment.

Members of the dissection Laboratory of Crown Research Institute, particularly Y. Gray, C. van Meer and M. Grieg for their help in laboratory work.

To J. Evans for the acetylene reduction measurements.

Members of Soil Science Department, particularly B. Toes and I. Furkert for their help in laboratory work.

To Landcare Research NZ Limited, particularly Dr S. Saggar for the microbial biomass analysis and some valuable discussion.

To the Government of New Zealand for the financial support of a O.D.A. Award that made possible this study.

DEDICATION

to my mother Marina

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