PHOSPHORUS CYCLING
IN
GRAZED, STEEP HILL COUNTRY

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ABSTRACT

Measurements of P uptake by pasture and P return in pasture litter and dung were made on two intensively grazed, north- and south-facing paddocks in steep hill country with soils of moderate to high P status. Both P uptake and more particularly the return of P in dung by grazing sheep, was high on the relatively level campsite areas but decreased sharply as ground surface slope increased. A high grazing pressure ensured that P return via litter was low relative to plant uptake.

A net P balance derived for differing paddock strata showed a large net annual gain of P on campsites (50.1 and 119.8 kg ha^{-1} on north and south aspects, respectively) but a considerable net P loss from both 25^{o} slopes (19.5 and 10.0 kg ha^{-1} on north and south aspects, respectively) and 45^{o} slopes (15.3 and 13.8 kg ha^{-1} on north and south aspects, respectively). Differences between aspects in the net P balance could be explained by the overall difference in the topography of the two paddocks as it affected relative camping and grazing pressure on each stratum.

Subsequent simulation studies were conducted using a mathematical model based on field data from the north-aspect paddock and validated against results from the south-aspect paddock. Results obtained from the model indicated that the quantity of P transfer from slopes increased at a greater than directly proportionate rate as stocking rate increased and was also directly related to pasture P content.

Determination of relative root activity using ^{32}P showed that approximately 90% of P uptake by pasture in spring occurred from within 7cm of the soil surface. The greater proportion of this occurred within the 0-3cm soil depth. No significant P uptake occurred from depths greater than 30cm. Although the extent of P uptake from 0-3cm depth soil was

similar both upslope and downslope from a P source, the direction of predominant root activity at greater depths was affected by the steepness of slope, tending to be at an angle between vertical and that normal to the soil surface.

A technique was developed to characterize short term plant-available P, using both ^{32}P and ^{33}P. Results indicated that the $^{32}P/^{33}P$ ratio of the water-extractable P fraction more closely resembled that in the plant than was the case for the Olsen P extract. Both ryegrass (Lolium perenne) and white clover (Trifolium repens) apparently utilized P from the same soil pool, the measured higher P content of ryegrass in this study being due only to a more extensive and rapidly developing root system than that of clover.

The addition to soil of P extracted by water from litter, dung, and superphosphate sources showed that all forms had similar effects in increasing the water-extractable and Olsen P levels in the soil. Thus it could be expected that P from these three sources would have a similar availability to plants. The results of these and also P desorption experiments were qualitatively similar to those derived from a simple Langmuir model, suggesting that sorption and desorption of P in the soil from the field area occurred at sites on the solid phase with predominantly uniform sorption characteristics.

Marked and largely unexplained variations in several soil parameters monitored over a year obscured the effects of P addition as a maintenance fertilizer application and also the net P transfer by grazing animals. In this and related situations, soil P analysis may not provide a sensitive measure of P status, except in the longer term. A more detailed examination is required to assess the usefulness of routine soil P analysis of hill soils for advisory purposes. The significant net P transfer from slopes by grazing animals suggests that the complementary roles of grazing management and fertilizer requirements in hill country should also be examined further.

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