LIMITATIONS TO NITROGEN FIXATION IN WHITE CLOVER DAIRY PASTURES

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The south-west region of Victoria is nationally significant because of its large volume of milk production. There is increasing interest in nitrogenous fertilisers to further boost dairy output. In order to make rational decisions regarding nitrogen fertiliser rates, time of application and effects on pasture composition, information on inputs from biologically fixed nitrogen need to be taken into consideration. This information is not available for any of the major dairy production regions of Australia.

MATERIALS AND METHODS

In spring 1994, a survey was undertaken of nitrogen fixation by white clover within commercial dairy pastures in south-western Victoria. Most of the farms involved were within a 45 km radius from Timboon and the annual rainfall varied between 620 and 1940 mm. Sites were selected on a stratified basis using soil pH, phosphorus and aluminium as factors to correlate with nitrogen fixation, measured by ^{15}N natural abundance methods. Soil and pasture samples were collected at each of the 71 sites and farm management data was obtained from each farmer. Botanical composition was assessed by hand sorting a herbage sample. Soil physical and chemical characteristics, rhizobia numbers and effectiveness, herbage crude protein, digestibility and the proportion of legume nitrogen derived from atmospheric nitrogen were subsequently measured.

RESULTS AND DISCUSSION

The proportion of legume nitrogen derived from nitrogen fixation ranged between 0-100%, with an average of 77%. At six sites less than 50% of the legume nitrogen was derived from fixation. Soil total nitrogen, available sulphur and available phosphorus concentrations were significantly related to nitrogen fixation and explained 21% of the variation. The ranges and mean values (in bold) for these factors were, total nitrogen 0.300-1.280, 0.609%; available sulphur 5.0-62.0, 18.4 μg/g (CPC method) and available phosphorus 7.6-79.0, 23.2 μg/g (Olsen) respectively. Factors not measured, including insect and nematode damage to plants, fungal and viral diseases, defoliation intensity, and plant and rhizobia genetic differences, may account for unexplained variation in nitrogen fixation. Other soil chemical characteristics, rainfall, and quantities of recently applied fertilisers were not significantly related to the proportion of nitrogen fixed in white clover. The crude protein levels in the white clover and perennial ryegrass were negatively related to soil pH and positively related to phosphorus concentration. The digestible dry matter contents of both plant species were positively related to soil sulphur concentrations. The legume content of the pastures ranged from 8.4% to 51% with a mean of 27%. The seasonal dry matter production of legume in the pasture, together with the proportion of nitrogen obtained by rhizobial fixation will largely control the quantity of nitrogen subsequently available for use by companion grasses. Future research aims to quantify the total amount of nitrogen fixed in white clover based pastures at four dairy farms.

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