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**PHYSIOLOGICAL AND MORPHOLOGICAL RESPONSES OF
TALL FESCUE (*Festuca arundinacea* SCHREB.) AND
PERENNIAL RYEGRASS (*Lolium perenne* L.) TO
DEFOLIATION**

A thesis presented
in partial fulfilment of the requirements
for the degree of Doctor of Philosophy (Ph. D.) in
Pasture Ecology and Physiology
Department of Plant Science
Massey University

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1993

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ABSTRACT

Tall fescue (*Festuca arundinacea* Schreb.) has been suggested as an alternative to perennial ryegrass, particularly in conditions of moisture limitation, but there is little comparative information on the plant characteristics influencing regrowth in the two species, particularly under continuous stocking. The objectives of this study were to :i) examine the response of tall fescue to continuous stocking in terms of tillering activity, leaf growth and competition, and ii) determine which physiological or morphological factors are important in influencing regrowth after defoliation, using perennial ryegrass as a reference standard. Experiments were undertaken in field, glasshouse and controlled environment conditions.

In the field sown swards of tall fescue (*Festuca arundinacea* Schreb. cv. 'Grassland Roa') and white clover (*Trifolium repens* L. cv. 'Grassland Tahora'), with volunteer grasses mainly consisting of perennial ryegrass (*Lolium perenne* L. cv. 'Grassland Nui') were continuously stocked with varying numbers of sheep to maintain sward surface heights 90-100 mm (Lax, L), 50-60 mm (Medium, M) and 30-40 mm (Hard, H). Measurements were made on areas with and without clover by removal of white clover with clopyralid. Tiller population density, tiller weight, and leaf growth and productivity of tall fescue were all reduced under hard grazing. Tall fescue was susceptible to competition from companion species, particularly perennial ryegrass, and tended to be replaced by other species under hard grazing.

Under glasshouse conditions individual plants of tall fescue and perennial ryegrass were defoliated to stubble heights of 100 mm (Lax, L), 60 mm (Medium, M), 30 mm (Hard1, H1) and 30 mm (Hard2, H2) 9 times with 5 day intervals over a period of 45 days. Treatments L, M, and H1 were initiated at an average of 11 tillers per plant for each species; treatment H2 commenced at 6 tillers per plant. Both species showed sensitivity to severe cutting treatments by reduction in tiller number, tiller weight, leaf growth and less shoot and root growth. Tall fescue showed lower leaf growth, tillering activity and herbage harvested per plant than perennial regress, but it produced larger tillers.

The comparative response of tall fescue and perennial ryegrass to leaf defoliation was studied under controlled environment conditions at both the vegetative and reproductive stages of growth. The oldest leaf lamina was defoliated regularly to maintain four, three, two or only one live leaf per tiller for six or seven leaf appearance intervals. In both species repeated removal of older leaves had little effect on tiller production, tiller weight, leaf growth rate and consequently total accumulated shoot and root weight, and mean shoot and root relative growth rates. Removal of all fully expanded leaves resulted in significant reduction in the above components, though leaf elongation rate was little affected. Leaves were shorter, narrower and lighter under hard defoliation, but leaf appearance rate was not affected. Hard defoliation affected tall fescue tiller weight more than perennial ryegrass. Water soluble carbohydrate concentrations in stem bases of plants decreased with increasing severity of defoliation especially for tall fescue. Leaf photosynthetic capacity per unit area was not influenced by defoliation intensity, but photosynthetic capacity per unit leaf weight increased under hard defoliation. Hard defoliation decreased the proportion of root mass to shoot mass, and increased the proportion of leaf mass to shoot mass. Plants showed relatively similar sensitivity to defoliation at vegetative and reproductive phases of growth. At both phases tall fescue again produced larger tillers with longer leaves and had a longer leaf life-span than perennial ryegrass, but it had lower leaf growth and appearance, and produced fewer tillers per plant. Photosynthetic activity per unit leaf area was similar for the two species, but tall fescue often had lower photosynthetic rate per unit leaf weight than perennial ryegrass.

In conclusion, hard defoliation intensity reduced both tiller population density and tiller weight and consequently decreased pasture regrowth through a reduction in LAI, life-span of leaf area, photosynthetic efficiency, and shortage of carbohydrate reserves. The factors that resulted in the regrowth of tall fescue being less responsive to hard defoliation than perennial ryegrass were slower leaf turnover, slower leaf appearance rate, lower tillering capacity and longer leaf life-span. These resulted in lack of plasticity in tiller population density of tall fescue in response to hard defoliation.

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