# SOME EFFECTS OF DROUGHT ON PERENNIAL **RYEGRASS** SWARDS

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#### Abstract

Herbage production and tiller dynamics were measured in "Grasslands Nui" perennial ryegrass (Lolium perenne L.) swards for 3 months during summer, under conditions of either irrigation or water stress. Measurements continued through winter and early spring when both treatments were well supplied with water.

At the end of the stress period tiller densities were 11000 and 4000 tillers/m² in the irrigated and the stressed plots respectively. Lack of moisture stopped tiller emergence but had little effect on the relative death rate of tillers formed before water stress. During the stress period, herbage production was greater in the irrigated than in the stressed plots, average accumulation rates of 68 and 21 kg DM/ha/day respectively being recorded. After re-watering, there was compensatory growth by the previously stressed swards resulting in a higher accumulation rate, the average accumulation rates were 24 and 15 kg DM/ha/day for the previously stressed and irrigated plots respectively. The higher accumulation rate was due mainly to a greater rate of tillering in the previously stressed plots. Differences between treatments in herbage production and tillering were significant up to 3 months after rewatering. The results are discussed in relation to pasture management.

Keywords: Nui, Perennial ryegrass, drought, tiller density, irrigation.

## INTRODUCTION

In many parts of New Zealand pasture and animal production is greatly reduced by drought during the summer months. A better understanding of what happens to ryegrass during drought may enable farmers to improve summer production and also reduce the effects of drought on subsequent pasture production.

Although it is well known that lack of soil moisture reduces plant growth, relatively little information on the physiology of water stress under field conditions is available (Leafe et al 1977). The objective of the experiment described in this paper was to obtain detailed information on the tiller dynamics of perennial ryegrass swards growing under well irrigated and drought conditions.

During summer drought, tiller density and growth are normally greater in irrigated than in drγland swards (Garwood & Williams 1967) but when moisture becomes available again in autumn, there may be some compensatory growth (Chu 1979; Horst & Nelson 1979). Autumn tiller density also depends on drought severity since prolonged drought can result in death of ryegrass plants (Harris 1971) and the recovery of depleted ryegrass swards would be expected to be limited (Sheath et al. 1976).

### METHODS AND MATERIALS

The experiment was conducted at Massey University between 19 December 1978 and 7 September 1979 on an area of Ohakea silt loam (Cowie 1974). Plots (2 m x 5 m) of "Grasslands Nui" perennial ryegrass (*Lolium perenne* L.),

that had been mown at approximately 3 weekly intervals for the previous 26 months, were used for the experiment. Poa annua L. was the main species in swards besides ryegrass, white clover (*Trifolium repens* L.) having been eliminated by herbicide.

During the experiment compound fertiliser (NPK: 12: 10:10) was applied twice and nitrolime 7 times, giving a total input of 47.8 kg N/ha, 14.0 kg P/ha and 14.0 kg K/ha. The insecticide Oximal was used regularly to control Argentine stem weevil (Hyperodes bonariensis).

Two moisture treatments, irrigated and stressed, were maintained between 19 December and 14 March. The irrigated plots (5 replicates) were spray irrigated to "saturation" whenever the amount of moisture in the top 15 cm of soil fell to 20% of the dry soil weight. This corresponded to a moisture deficit of approximately 45 mm. Rainfall was prevented from falling on the stressed plots (3 replicates) between 19 December and 14 March using timber frames with clear plastic covers.

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At the end of the treatment period, both irrigated and stressed plots were irrigated to "saturation". Herbage production and tiller dynamics measurements continued until 7 September 1979.

During the experiment plots were mown at approximately 3 week intervals with a reel mower for herbage production determinations. Clippings from the whole plot were used for measurement.

Ryegrass tiller dynamics were measured in 4 randomly placed circular fixed frames (10.2 cm diameter) per plot. All ryegrass tillers in each frame were marked with coloured plastic rings at the start of the experiment. After each mowing new ryegrass tillers were marked and rings from dead tillers removed.

Potential soil water deficit was determined from the difference between potential evapotranspiration (0.75 of raised pan evaporation, Scotter et al. 1979) and rainfall or irrigation water. The actual soil water deficit for the top 30 cm of soil was measured gravimetrically. Leaf water potentials were measured at 4 hourly intervals during daylight hours, with a pressure chamber (Boyer, 1969). on 2 occasions (3 and 12 weeks after commencement of the stress treatment).

## RESULTS

### Soil Moisture

Fig. 1 shows the moisture deficit for the top 30 cm of soil in both irrigated and stressed plots. Irrigated plots did not fall below 30 mm deficit during the experiment while stressed plots reached 86 mm deficit by 14 March.

#### Herbage Production

Before the moisture treatments were imposed all plots had similar herbage production (Fig. 2, a). As expected, during the treatment period (19 December to 14 March), herbage production was markedly reduced by drought. Over this period the irrigated and the stressed swards yielded the equivalent of 5700 and 1800 kg DM/ha which represented 78 and 21 kg DM/ha/day respectively. During the first 3 weeks after the end of the stress period, the previously irrigated plots continued to grow at a considerably higher rate than those that were previously stressed (79 and 34 kg DM/ha/day respectively) (Fig. 2,1). However, over the following 6 weeks (5 April to 28 May) the trend was reversed, average accumulation rates of the previously stressed plots reached 53 kg DM/ha/day, whereas those of the previously irrigated plots were reduced to 34 kg DM/

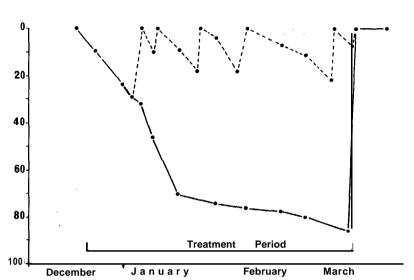


Fig. 1 Moisture deficit (mm) in the top 30 cm of soil for Irrigated (-----) and stressed (------) plots.

ha/day. The treatments had no significant effect on herbage production between the 2 swards after 28 May.

#### Tiller Dynamics

Ryegrass tiller density (Fig. 2, b) was not significantly affected during the first 3 weeks of the moisture treatment. However, as soil moisture decreased, tiller density was markedly reduced in the stressed plots, this was the result of a very low tiller appearance rate (Fig. 2, c). By March 14, the irrigated plots had 3 times more tillers-than the stressed plots (Fig. 2,b).

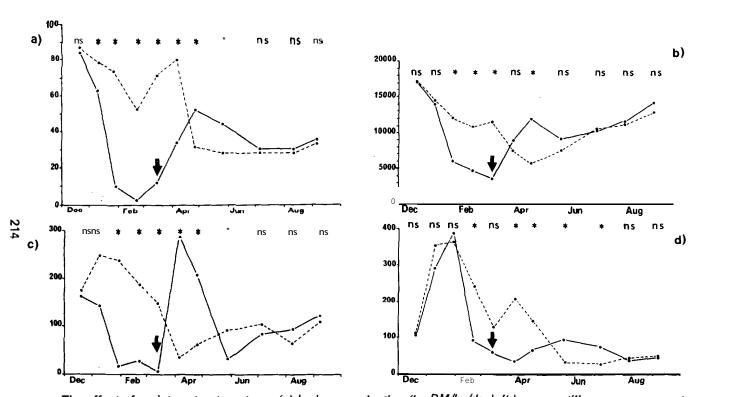
The higher tiller death rate, between February and May, in the irrigated plots (Fig. 2,d) was due primarily to the higher tiller density in the irrigated plots.

(Fig. 2,d) was due primarily to the higher tiller density in the irrigated plots. The tillers that were marked at the start of the moisture treatment (19 December) died at similar rates in both irrigated and stressed swards. The relative tiller death rates calculated between 19 December and 14 March, were 0.029 and 0.024 tiller/tiller/day for the irrigated and stressed swards respectively. Whereas for tillers emerged and marked 3 weeks after the start of the moisture treatment (9 January), the relative tiller death rates, calculated between 9 January and 14 March, were 0.027 and 0.034 tiller/tiller/day for the irrigated and stressed swards respectively.

Once all the plots were irrigated on 14 March, tillering became more rapid in the previously-stressed plots (Fig. 2,c), and by 26 April a considerably higher density was recorded in the previously stressed swards than those that were irrigated (Fig. 2,b). Differences in tiller density and tiller appearance rate became smaller subsequently and by 28 May were no longer statistically significant.

### DISCUSSION

Under field conditions the detrimental effects of drought on pasture pro-



duction can be considered in 2 phases. First, the period of drought when lack of moisture limits plant growth, and second, the subsequent period when adequate moisture becomes available but lack of tillers limits recovery growth.

During the first phase moisture stress reduced herbage production initially through a reduction in tiller weight, and subsequently through a reduction in tiller density. For example, on 9 January the 20% reduction in herbage production in the stressed plots compared with the irrigated plots (Fig. 2,a) was mainly due to a reduction in tiller weight (15%). rather than tiller density (5% reduction, Fig. 2,c). In contrast, by 14 March when herbage production was reduced by 86% in the stressed plots (Fig. 2,a), there was markedly lower tiller weight (52%) and tiller density (70%) in the stressed relative to the irrigated plots. The reduction in tiller weight during moisture stress is due to a reduction in the rate of leaf expansion, resulting in smaller leaves, a slower rate of leaf appearance and an accelerated rate of leaf senescence (Leaf et al. 1977; Chu 1979). The reduction in tiller density was mainly due to cessation of tiller emergence under moisture stress (Fig. 2,c), rather than a faster rate of tiller death (Fig. 2,d).

Grazing management during drought is unlikely to increase pasture growth since plants avoid drought by reducing leaf area and entering "dormancy". As in many other species (Begg & Turner 1976), the reduction in leaf expansion and tillering by ryegrass during drought can be considered as mechanisms of adaptation which assists plant survival.

Although in this experiment leaves died and tiller density decreased in the stressed plots, the surviving leaves were not particularly stressed in physiological terms. Minimum diurnal leaf water potential measurements 3 and 12 weeks after commencement of the stress treatment reached only -1.6 MPa (-16 bars) and -2.4 MPa (-24 bars) respectively. Even at -2.4 MPa the surviving leaves were only visibly wilted during part of the day and were able to recover at night.

Upon re-watering, tiller populations and herbage production temporarily increased in the previously stressed plots to levels exceeding those in the previously irrigated plots. This higher level of production, or "compensatory growth", was maintained for approximately 6 weeks. Enhanced tillering and growth upon recovery from a period of mild water stress has also been reported in prairie grass (Chu et al. 1979) and tall fescue (Horst & Nelson 1979). As leaf extension is more sensitive to water stress than cell division (Hsiao 1973), water stress presumably allowed tiller initiation to continue but not tiller emergence, which is a function of leaf expansion. The compensatory growth and tillering upon rewatering in the previously stressed swards could thus have been caused by rapid expansion of dormant tillers. Had the stress treatment been more severe plant death would have resulted and compensatory growth may not have occurred.

As tillers present at the start of the treatment died at similar rates in both treatments (0.029 and 0.024 tiller/tiller/day for the irrigated and the stressed swards respectively), it can be concluded that drought had relatively little effect on survival of the established tillers. A denser sward in early summer would therefore ensure that more tillers would survive summer drought. Increased tiller survival was one of the reasons given by Brougham (1970) for increased pasture production following relief of drought in leniently grazed pasture compared with close grazed pasture.

To prepare pasture for summer drought, spring management should encourage root growth and a high tiller density. A greater root depth before drought

ensures increased capacity to absorb available soil moisture. A higher tiller density would ensure a denser sward after drought.

Grazing to prevent rank reproductive growth certainly increases tiller density (Korte 1982) but very frequent and intensive grazing can reduce root growth (Weinmann 1948). Our current research is directed to finding a management regime that will give a deep rooting and dense sward, and then following the performance of such a sward during and after drought.

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