LEAF AND SHOOT GROWTH ON *ACACIA KEMPEANA* F. MUELL. AND SELECTED OTHER ARID-ZONE SPECIES

J. R. MACONOCHIE*

ABSTRACT

A study of leaf and shoot growth on certain Australian arid zone shrubs, and in particular, species of Acacia, *suggested that these plants may fall into two groups with different growth responses. One group having a seasonal response and the other having a seasonal and summer-rain growth dependent response.*

Artificial grazing of shoots of A. kempeana *suggested that light grazing was not detrimental to the plant, but rather increased the size of new shoots produced on the treated shoots.*

INTRODUCTION

This study is concerned with measuring the growth of the edible portions namely, leaves and shoots of selected browse species of the central Australian region. These parts of the browse or topfeed species form an important component in the diet of stock during drought conditions when native pastures are at a low nutritive level, Siebert *et al* (1968).

Chippendale (1964) reported that during drought the browse formed up to 10% of the diet of cattle.

METHODS AND MATERIALS

These investigations were carried out at two sites: the Musgrave Ranges area, Sth. Australia from June 1965 to October 1966 and at Alice Springs, N.T., from January 1969 to June 1970.

At site 1 *Acacia aneura, A. kempeana, A. ligulata, A. murrayana* and *Eremophila longifolia* were investigated. A population of shrubs was selected, and coded aluminium tags were affixed to the internode between positions 5 and 6 distal from the apex of a shoot. For *A. murrayana* only two bushes were examined, but they were heavily tagged. At site 2 shoots of *A. kempeana* having 15 or more leaves were selected and tags affixed at the internode between positions 15 and 16. Also at site 2 the following set of treatments, in triplicate, was applied to shoots of each of 25 bushes of *A. kempeana.*

I Control—15 leaves on shoot
II Total defoliation—0 leaves (15 scars) on shoot
III Pruning of terminal 1/3rd—10 leaves on shoot
IV Pruning 1/3 and defoliation—0 leaves (10 scars) on shoot
V Pruning of terminal 2/3rd—5 leaves on shoot
VI Pruning 2/3 and defoliation—0 leaves (5 scars) on shoot

Site 1 was visited at irregular intervals, whilst visits to Site 2 occurred at four weekly intervals. The presence, absence and size of new shoots or leaves was recorded in the terminal and axillary positions distal to the tag.

Climatic data for Musgrave Park and Alice Springs were obtained from records of the Commonwealth Bureau of Meteorology.

* Animal Industry and Agriculture Branch, Arid Zone Research Institute, Alice Springs, N.T.

Nelson (1930) using this technique found it unsatisfactory because of high twig mortality on the low sample number used, but Maconochie and Lange (1970) found it suitable for recording the occurrence and duration of shoot growth and also for comparing different species of a community.

RESULTS

The percentage cumulative net and total gains, and losses in new foliage ($\% \Sigma T/T_0$ where T = cumulative total of new positions and T_0 = total initial portions tagged) of the five species at Site 1 are presented in Table 1.

TABLE 1

The percentage cumulative net and total gain and calculated losses in new foliage for five arid zone species

Trip Interval		II	III	IV	V	VI	VII	VIII
Species								
A. aneura	Net gain	1.7	4.3	5.0	19.4	31.6	29.5	45.7
	Total gain	1.7	4.5	5.3	22.4	39.4	46.0	67.6
	Loss	—	0.2	0.3	3.0	7.8	16.5	21.9
A. kempeana	Net gain	2.3	4.2	3.9	10.4	74.1	109.2	105.9
	Total gain	2.3	4.6	5.2	13.4	81.4	124.6	140.1
	Loss	—	0.4	1.3	3.0	7.3	16.4	34.2
A. ligulata	Net gain	0.3	23.8	34.2	35.7	31.7	34.7	120.3
	Total gain	0.6	25.2	42.0	46.5	46.5	52.3	162.8
	Loss	0.3	1.4	7.8	10.8	14.8	17.6	42.5
A. murrayana	Net gain	—	—	217.1	421.8	381.5	338.0	320.4
	Total gain	—	—	286.1	650.5	660.0	660.0	670.4
	Loss	—	—	69.0	228.7	278.2	322.7	350.6
Eremophila longifolia	Net gain	4.0	87.2	98.2	310.1	272.9	321.8	238.9
	Total gain	4.4	90.4	114.3	358.1	394.8	508.0	525.6
	Loss	0.4	3.2	16.0	48.0	118.2	186.1	286.7
Time (wks)		7	16	25	36	47	58	74

Figure 1 gives the relative rates of gain or loss of foliage for four species (excluding *A. murrayana*) and selected climatic data. The rates were calculated from:

$$\frac{T_{n+1} - T_n}{\frac{(T_{n+1} + T_n)}{2} \times \Delta \text{Time}}$$

where T is total number of new leaves or scars at times n and n + 1

None of the four species of *Acacia* had the same rate of growth as the *Eremophila*, but *A. kempeana*, *A. ligulata* and *A. murrayana* grew more rapidly than *A. aneura*. Initially *A. kempeana* did not show the high growth response of *A. ligulata* and *A. murrayana*.

A. aneura showed peaks of foliage gain during periods of summer rain (November 1965 and February 1966), and after good winter rains (July 1966), whilst the daily temperatures were increasing. Peaks of loss occurred during late summer-early autumn when water stress prevailed.

A. kempeana had peak gains during the late summer period when good rains fell and also showed a response to high winter rains. The spring seasonal responses for the years 1965 and 1966 were much less than the responses to high falls of rain. Maximum losses occurred during the period of active growth, and consisted of both mature and immature foliage.

A. ligulata and *A. murrayana* both showed a distinctly seasonal pattern of new growth with the peak rate of gain occurring during the period of increasing daily temperature. The highest losses also occurred during this period of growth activity and for both species "spring" flowering preceded new shoot growth.

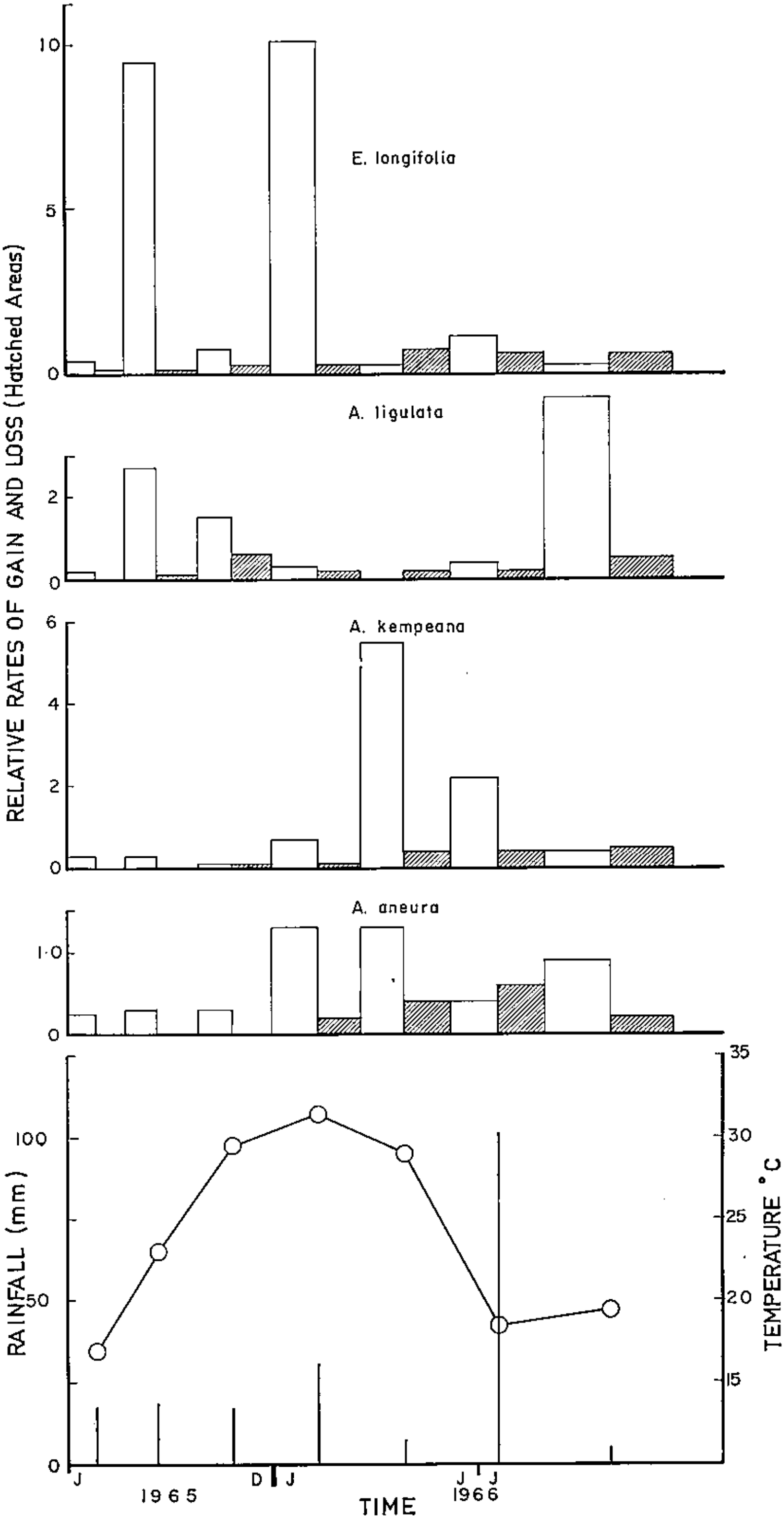

FIGURE 1

The relative rates of gain and loss (hatched) of foliage for four species at site 1 and available climatic data of the site.

Eremophila longifolia had highest rates of gain of new foliage during the winter-spring and mid-summer periods. Growth responses for this species appeared to be more closely related to current water availability as the peaks coincided well with periods of high rainfall and appeared to be independent of temperature. Losses reached maximum values after the period of active growth and during water stress periods.

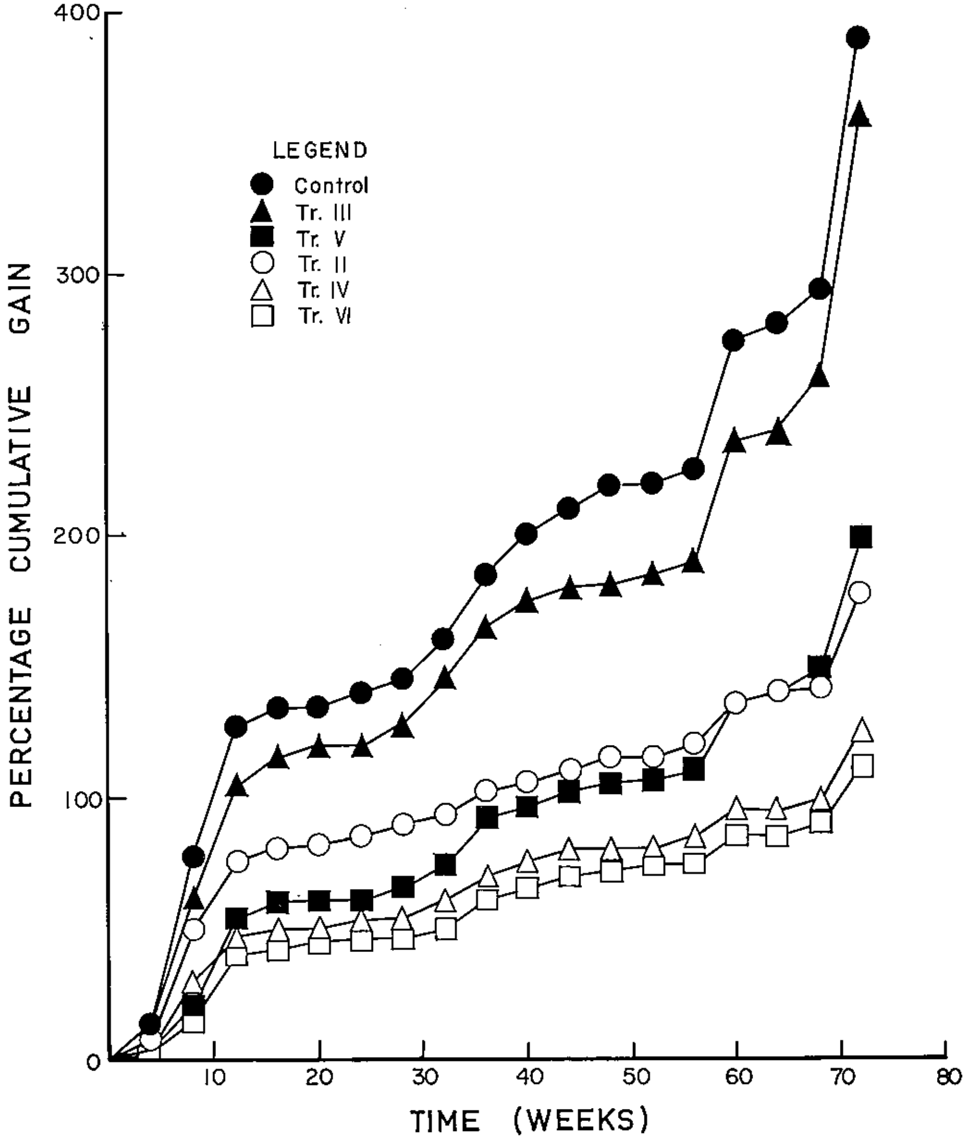

FIGURE 2

The percentage cumulative gain in new foliage for control and pruning and defoliation treatments of *A. kempeana* at site 2.

The percentage cumulative gains in new foliage for control and treatments of *A. kempeana* shoots at Site 2 are presented in Figure 2. The relative rates of gain and loss of new foliage for control and treatment 0 leaves (5 scars) are shown in Figure 3.

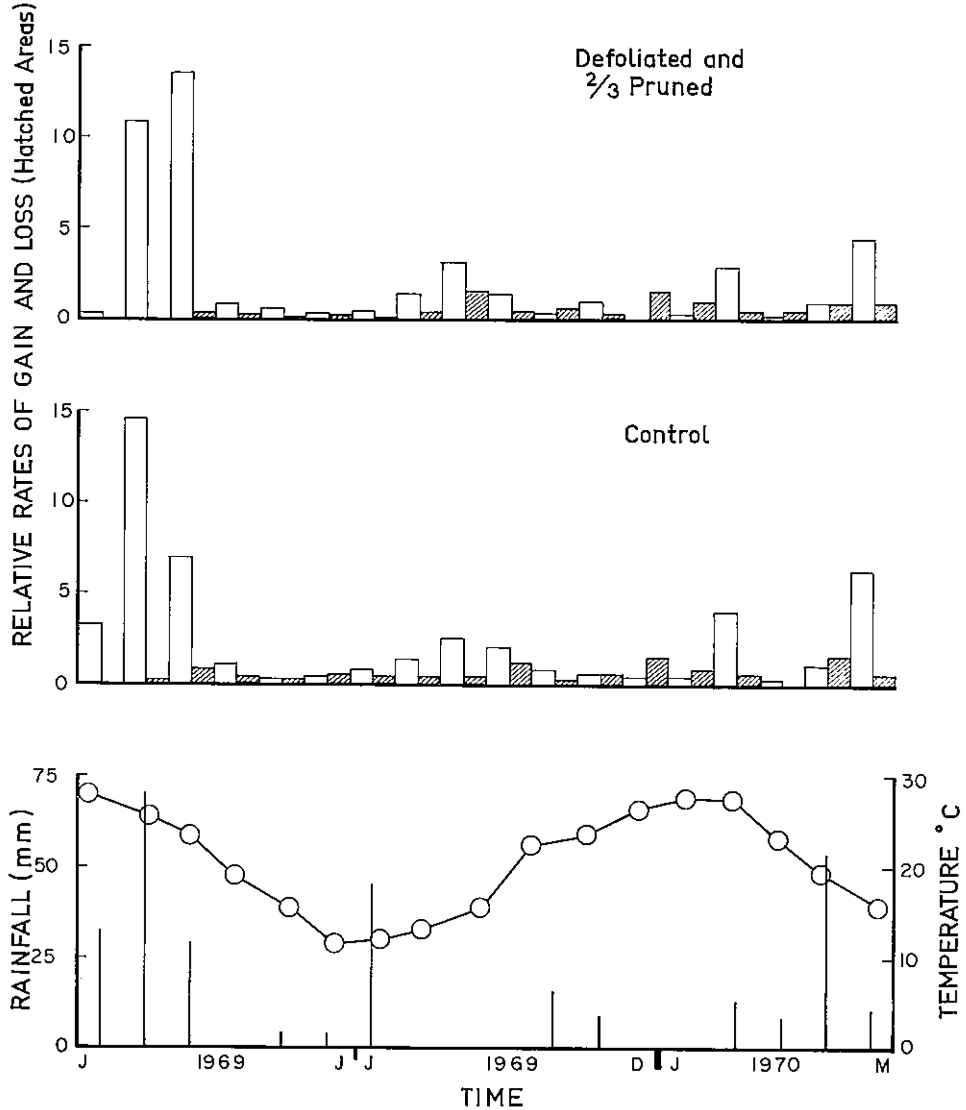

FIGURE 3
The climatic data and relative rates of gain and loss (hatched) of foliage for control and treatment VI of *A. kempeana* at site 2.

The cumulative gain data show that defoliation reduced the nett gain and the magnitude of the reduction increased with time. As these values are based on cumulative totals of new leaves they have not been subjected to statistical analysis.

The data presented in Figure 2 show that there appeared to be negligible differences in gain of foliage between the following pairs of treatments.

1. Control (15 leaves) and Treatment III (10 leaves) or light pruning effect.
2. Treatments IV (0 leaves, 10 scars) and VI (0 leaves, 5 scars) i.e. defoliation combined with light and heavy pruning.
3. Treatments II (0 leaves, 15 scars) and V (5 leaves) i.e. between heavy defoliation and heavy pruning.

Thus the results show that light pruning did not effectively reduce the net gain in foliage, but the treatments using heavier pruning and/or total defoliation did reduce the net gain.

At this site *A. kempeana* responded vigorously to high falls of rain during the midsummer period, but as temperatures declined, growth rates decreased to almost zero. With the onset of increasing daily temperatures and suitable winter rain, a further growth response occurred. The shoots which were heavily defoliated and/or pruned showed an initial lag in the relative rates of gain of new foliage during the first growth response.

Peaks of rate of loss of foliage occurred during two phases namely, (1) during new shoot growth and (2) during periods of water stress (low rainfall and higher temperatures).

DISCUSSION

In general the arid zone species of *Acacia* appear to fall into two groups, with respect to their shoot growth phases. One group, e.g. *A. ligulata*, *A. murrayana*, *A. sowdenii* (Maconochie and Lange 1970), and *A. victoriae* (Maconochie unpublished data 1970), seems to be distinctly seasonal with new growth occurring after the spring flowering.

The second group shows seasonal growth if soil moisture is available, and also a growth response to summer rain e.g. *A. aneura* and *A. kempeana*. A similar response has been noted in *Cassia nemophila* varieties *coriacea* and *platypoda* (Maconochie and Lange 1970).

Wetherall (1966) reported that both spring and summer growth occurred on *Acacia harpophylla* in western Queensland. Sometimes this occurred as a continuous phase and other times as two periods, and the amount and duration of growth was dependent on soil moisture conditions. Preece (1971) suggested that mulga could flower several times in one year and had two principal periods of flowering, spring and late summer. If shoot growth is associated with this flowering then two similar phases can be expected.

Eremophila longifolia in contrast to the *Acacia* species showed responses which appeared to be dependent on available water and independent of temperature. During the first winter period the growth was very high, but during the second winter period the response was much reduced. This may have been due to shoot mortality during the summer period. The *Acacia* species tended to have no shoot growth during the cold winter period.

The results of the defoliation and pruning treatments on *A. kempeana*, as a simulation of grazing, indicated the "light" grazing (Treatment III) did not effectively reduce net production of new foliage, but could instead stimulate larger new shoots, when conditions are favourable for growth. "Heavy" grazing effectively reduced the amount of new foliage produced. Ferguson *et al* (1966) found that topping of old shrubs of *Pershia tridentata* produced nearly nine times as much twig growth as the control shrubs in the first year after treatment, but thereafter the increase declined.

On the heavily defoliated shoots there occurred an initial lag in the relative rates of gain of foliage during the first growth response. Tagged shoots which were foliated obviously had an advantage over the defoliated when conditions were suitable for growth. Once the defoliated shoots had developed secondary shoots this lag effect no longer occurred.

At both sites the bushes of *A. kempeana* showed a similar pattern of growth response, namely a seasonal one, and another dependent on summer rainfall.

ACKNOWLEDGEMENTS

The author wishes to thank Dr. R. T. Lange of the Botany Department, University of Adelaide for his help and encouragement and the Department of Aboriginal Affairs, South Australia for permission to work in Musgrave Park. The Australian Meat Research Committee also provided finance for the second part of the project. The technical assistance of Mr. D. Nelson and Mrs. J. Harmer is also acknowledged.

REFERENCES

CHIPPENDALE, G. C. (1964)—Determination of plant species grazed by open range cattle in central Australia. *Proceedings of the Australian Society of Animal Production* **5**: 256-257.

FERGUSON, ROBERT B., and BASILE, JOSEPH V. (1966)—Topping stimulates bitterbrush twig growth. *The Journal of Wildlife Management* **30**: 839-841.

MACONOCHIE, J. R., and LANGE, R. T. (1970)—Canopy Dynamics of Trees and Shrubs with particular reference to the Arid-zone Topfeed species. *Transactions of the Royal Society of South Australia* **94**: 243-248.

NELSON, E. W. (1930)—Methods of studying shrub plants in relation to grazing. *Ecology* **2**: 764-769.

PREECE, P. B. (1971)—Contributions to the Biology of Mulga. 1. Flowering. *Australian Journal of Botany* **19**: 21-38.

SIEBERT, B. D., NEWMAN, D. M. R., and NELSON, D. J. (1968)—The chemical composition of some arid zone pasture species. *Tropical Grasslands* **2**: 31-40.

WETHERALL, A. J. (1966)—Leaf growth of brigalow (*Acacia harpophylla*) suckers in relation to seasonal conditions. *Queenlsand Journal of Agricultural and Animal Sciences* **23**: 453-456.