Maximising forage production from saltbushes grown on salt-affected agricultural land

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Summary. Saltbush *(Atriplex)* species varied in response to simulated grazing. Growth rates of most species peaked after 12 months recovery. Accessions of river saltbush (A. *amnicola)* differed in timing of peak growth rate, from 10 months to 12 months after complete defoliation. Growth of river saltbush before and after complete defoliation was up to 3 times greater than other species. Most saltbush species produced more grazeable dry matter (leaf and small stem) in the first year of recovery than the second. Differences in timing of peak rate of regrowth and magnitude of regrowth within and between saltbush species indicate potential to select for greater productivity in grazed systems. Production may also be increased by manipulating the timing, frequency and level of defoliation by grazing.

Introduction

In Western Australia, saltbushes *(A triplex* spp.) are commonly grown by farmers on land alienated from conventional agricultural use by salinisation to provide forage for sheep during late summer and autumn (7). Grazing saltbushes during this period of feed shortage often replaces the need to purchase supplementary sheep feed (7, 2). Grazing management is determined principally by preferred farming practice rather than an understanding of the seasonal growth of saltbushes or their response to timing. frequency or duration of grazing. There has been little study of the effects of grazing management on the growth and forage production of saltbushes grown under dry-land agricultural conditions. It is possible that current grazing management may not be realising the full productive potential of saltbushes. This paper describes aspects of the regrowth of some saltbush species following simulated grazing in autumn and suggests areas for further research which may lead to improved grazing management and greater production.

Methods

Site description

The experiment was done at Tammin (31? 41' S, I I7? 29' E) about 170 km east of Perth, Western Australia. The area's climate is Mediterranean, characterised by cool wet winters and hot dry summers. Annual rainfall is 342 mm. December is the hottest month with daily maximum temperatures averaging 33.9?C and July the coldest, with mean daily maximum temperatures of 16.3?C. Elevation above sea level is about 245 m.

Cereals were grown on the experimental site prior to it becoming saline about 15 years ago. Pasture was dominated by sea barley grass *(Hordeum geniculatum)* which covered more than 80% of the soil surface. Located on salt affected duplex soils of a broad valley floor (I and 4), the site was underlain with a shallow saline watertable.

The soil profile comprised 15 to 30 cm of loamy coarse sand over a coarse sandy clay loam. The top 40 cm of soil was neutral (pH of extract of 7.6, s.d. 0.4), saline (electrical conductivity of extract of 7.1 dS/m, s.d. 3.3 dS/m) and sodic (sodium absorption ratio of 20, s.d. 7). The water table fluctuated in depth from 0.45 to 1.20 m below the soil surface, was neutral and saline (electrical conductivity of about 20 dS/m).

Species

Commonly grown saltbushes including quail brush *(Atriplex lentiformis),* wavy leaf saltbush *(A. undulata)* and two accessions of river saltbush (A. *amnicola* 573 and 577) were selected for this experiment, which formed part of a wider evaluation programme (Ward. unpublished data).

Site preparation and experimental design

In mid August 1984, volunteer pasture was killed by spraying with Roundup?. A fortnight later, the site was cultivated to a depth of about 15 cm with a chisel plough to loosen the soil for transplanting. By this time the likelihood of waterlogging had decreased and the 4 month old seedlings were transplanted. Twenty single plant replicates per accession were planted in a randomised block design. Each seedling was planted on a grid pattern at intervals of 4 m. As the soil was moist to the surface at planting, no supplementary watering was necessary.

Treatments and measurements

Severe grazing by sheep was simulated by complete defoliation of all leaf material and stems less than 7 mm in diameter, by hand in March, 8 and 32 months after transplanting. The pattern of regrowth between the defoliations was described by measuring changes in shrub canopy dimensions (height, width and length) and calibrating them with measures of dry matter production. Additional measures of plant dimensions were made 1, 4, 8, 1 I. 14. 15, 17, 20, 23 and 32 months after transplanting. The pattern of regrowth for each species was characterised by fitting logistic equations of the form: y = c/(1+e-b(t-r")) (5). These curves were used to estimate the timing of the period of optimal growth rate (m), the magnitude of peak growth rate (cb/4) and dry matter production (y) 12 months after defoliation (t).

Results and discussion

Timing of peak growth rate

For most species growth rate peaked about 12 months after complete defoliation (Table I). Current annual autumn grazing coincides with this period of peak growth. Interestingly, river saltbush accessions varied in the timing of peak growth. with accession 573 peaking in growth rate 2 months earlier than accession 577. There were, however, no differences between river saltbush accessions in the magnitude of their peak growth rate. The implication of grazing saltbushes at different times during the year, and hence during periods of different growth rate, on production is not known and warrants further research.

Table 1. Timing of peak growth rate and dry matter yield (DM) of saltbushes

Species	Timing of peak growth rate (months after harvest 1)	Weight of DM 8 months after transplanting (kg/plant)	Estimated weight of DM 12 months after harvest 1 (kg/plant)[a]	Weight of DM 24 months after harvest 1 (kg/plant)
River saltbush 573	10 (a)[b]	0.17 (b)[b]	1.64	2.25 (a)[b]
River saltbush 577	12 (b)	0.34 (a)	1.40	2.75 (a)
Quail brush	12 (b)	0.16 (bc)	0.89	1.06 (b)
Wavy leaf saltbush	12.6 (c)	0.11 (c)	0.37	0.59 (b)

[a] estimated from fitted logistic curve; [b]different letters denote significant differences between groups of means at $P<0.05$.

Dry matter production

River saltbush 577 produced 0.34 kg/plant of dry matter by the first autumn, about 8 months after transplanting, between 2 and 3 times more than the other accessions (Table 1). After 24 months of regrowth, the river saltbush accessions yielded 2.75 and 2.25 kg/plant of dry matter, producing 60% more than quail brush and 80% more than wavy leaf saltbush. Comparisons of estimates of the amount of dry matter produced in the first year of regrowth, with amounts produced over 2 years, showed that for most species, the majority of dry matter was accrued in the first year of recovery (Table 2). Quail brush, for example, produced 84% of its dry matter regrowth in the first year of the 2 year recovery period. Although the river saltbush accessions produced a similar amount of dry matter after 2 years of recovery from defoliation, accession 573 produced 22% more dry matter in the first year of the 2 year recovery period than accession 577. It is possible that river saltbush accession 573 may be even more productive if grazed on a rotation approximating the timing of its peak growth rate, rather than annually, and this should be evaluated.

Differences in dry matter production between the river saltbush accessions may be correlated to differences in the timing of their peak growth rates, discussed earlier. These differences indicate potential to select provenances within river saltbush species for superior dry matter production. The differences in timing of production suggest that some species and accessions may be more suited to annual grazing than others, and that for most species there is little yield advantage to be gained by deferring grazing longer than I year.

Table 2. Percentage of dry matter (DM) yield accrued during first year of 2 year recovery period following complete defoliation (harvest 1).

	Species			
	River saltbush 573	River saltbush 577	Quail brush	Wavy leaf saltbush
% DM, year 1	73	51	84	62

Timing and frequency of defoliation

The effect of annual autumn grazing of saltbushes on sheep carrying capacity in Western Australia under similar environmental conditions to Tammin, has been reported (6). In the first year of grazing the carrying capacity of river saltbush and wavy leaf saltbush was between 1700 and 2000 sheep grazing days per hectare per year respectively. After 6 years of autumn grazing, river saltbush had maintained a similar carrying capacity, whereas the carrying capacity of wavy leaf saltbush had halved. Although the maintenance of carrying capacity by river saltbush was attributed to its superior ability to survive and recover from grazing, the effect of grazing on dry matter production during the 6 year period went unmeasured. Despite the recommendation and wide practice of annual autumn grazing, the ability of saltbushes to maintain dry matter production under this grazing system has not been demonstrated quantitatively. This deficiency should be redressed by further research.

Studies of the effect of timing and frequency of defoliation on dry matter production of irrigated quail brush in USA report that multiple harvests during the first 6 months of growth did not yield more than single harvests taken later in the 6 month period (3, 8). As the timings of the latter harvests were delayed, there was less difference between the dry matter yield of the quail brush harvested several times and the quail brush harvested once (3, 8). Both studies focussed on the early growth of quail brush, before the exponential increase in growth rates had occurred. It is possible that multiple harvests or grazing timed during periods of greater growth rate may result in greater dry matter yields than single harvests of longer rotation. To my knowledge, the effect of multiple grazing on dry matter production of saltbushes grown under dryland agricultural conditions in Australia has not been studied. The effect of shorter rotation grazing (eg less than I year) on dry matter production should also be assessed.

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