THE EFFECT OF STOCKING RATE ON DRY MATTER PRODUCTION OF MEDITERRANEAN ANNUAL PASTURES

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SUMMARY

A long term stocking rate experiment was continuously grazed by wethers to determine the influence of stocking rate (5.6 - 16.3 sheep/ha) on pasture production. Large pasture cages were placed on plots and moved frequently such that pasture growth could be measured. Total annual pasture production was reduced from 7.5 to 4.0 t/ha with increased stocking rate. The proportion of clover in the sward declined from 70% in June to 39% in October and increased stocking rate reduced grass and increased herb content.

INTRODUCTION

Most previous stocking rate experiments have concentrated on measuring livestock production per animal and per hectare without considering the influence of grazing on pasture production. Nevertheless many workers have observed long term changes in composition and densities of Mediterranean annual pastures following changes in grazing regime (Rossiter 1966; Davies 1965) and it is known that animals selectively defoliate plants, return nutrients to the soil through faeces and urine and depress pasture qrowth through treading and fouling (Curll 1980).

The aim of this experiment was to investigate the effect of stocking rate on pasture production and to relate animal production to pasture production.

MATERIALS AND METHODS

This experiment commenced in 1981 on an existing stocking rate experiment (commenced 1968) at Kojonup in S.W. of Western Australia (6.4 month growing season 542 mm average annual rainfall) following a year of crop and two years in pasture. A total of 40 plots were used, 8 at each of the five stocking rates (SR) (5.9, 8.9, 11.1, 13.6 and 16.3 sheep/ha). Considerable differences in composition and densities had been generated by 12 years of grazinq. Merino hoggett wethers (4 - G/plot) were placed on plots after dyebanding in May 1981. Autumn rains commenced late (end of May) so high SR plots were unable to support animals through summer. A rain-bearing depression brought heavy rain in January 1982 (250mm was recorded on site), the season is thus atypical.

Pasture dry matter production (PG) under grazing was estimated from measurements of pasture availability (PA) between dates within enclosed areas. Single, large (7m x 10m) areas, visually assessed to be representative of the plot as a whole were fenced off at the beginning of each sampling period. PG (kg/ha/day) was estimated as the difference between PA at two dates expressed on a daily basis. Assessments of PA in plots were recorded monthly. Techniques used for estimating PA were dependant on the amount of material present. The visual techniques of Hutchinson et al. (1972), or Campbell and Arnold (1973) were used when PA was less than 1 t/ha or between 0.5 and 1.5 t/ha respectively and the "Ellinbank" plate meter (McGowan and Earle 1978) was used at higher levels of PA. Correlation co-efficients between observed and estimated PA ranged from 0.92 to 0.95.

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Estimates of pasture composition were made using the dry weight ranking technique of Jones and Hargreaves (1979).

RESULTS

Pasture growth and pasture on offer

PG varied from 16.5 kg/ha/day during the 42 days following January rains to 50.1 kg/ha/day between late August and mid September (Table 1). Total PG at the highest SR was 53.7% of that at the lowest SR (See Table 2).

Table 1 Pasture dry matter production (kg/ha/day) between sampling times averaged across all treatments

Date of Sampling	L May	June	E July	L July	Aug	E Sept	Sept/Oct	Feb
Dry matter production	26.5	24.3	31.2	23.1	27.4	50.1	27.7	16.5

SED = 3.22 E = Early L = Late

Table 2 Annual and average daily dry matter production at 5 stocking rates

Stocking rate (sheep/ha)	5.9	8.9	11.1	13.6	16.3	SED
Total annual production t/ha/yr	7.5	6.2	5.6	4.2	4.0	0.77
Mean daily kg/ha/day	35.1	29.1	26.1	19.7	18.8	3.58

There was a significant ($P < .005$) interaction between date of measurement and SR in PA. PA is shown in Fig. 1 from May 1981 to May 1982 for the five SR's.

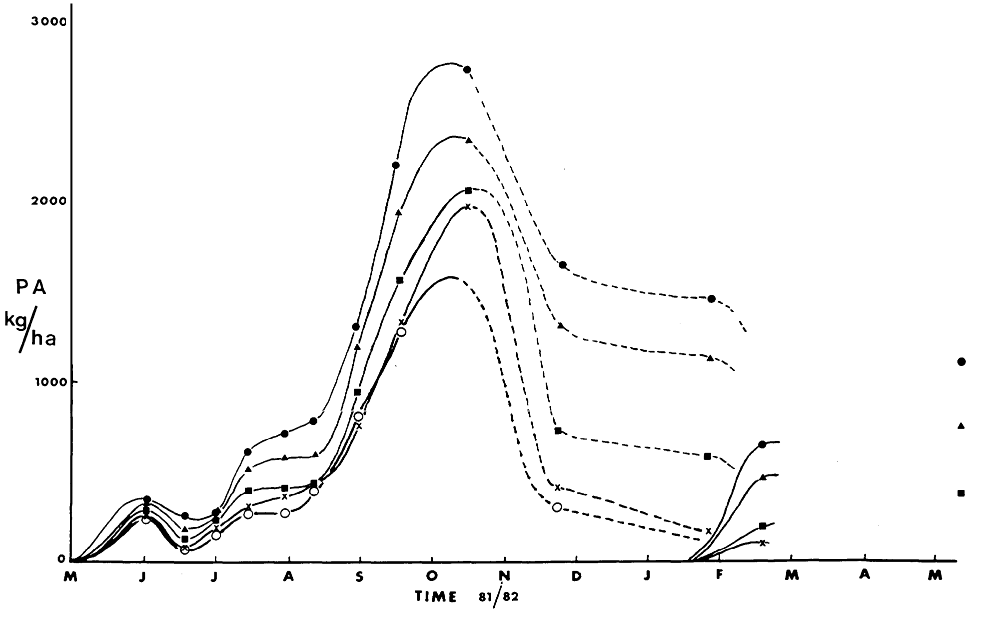

Fig. 1 Pasture availability (kg/ha) at 5.9 (●), 8.9 (▲), 11.1 (■), 13.6 (x) and 16.3 (○) sheep/ha on green —— and dry --- pasture during 1981/82

PA at the highest SR was always lower than those at the lowest SR, differences being less pronounced in October, at the peak of the spring flush. In absolute terms, the difference in PA between the highest and lowest SR was 188 kg/ha in mid June and 584 kg/ha in mid October. Amounts on offer at the highest SR represent 25.7% and 78.1% of the amounts on offer at the lowest SR at these respective dates.

Woolgrowth

Woolgrowth during winter (June - August) averaged 9.8 g/hd/day increasing to 26.0 g/hd/day in spring (August - November) and decreased to 12.0 g/hd/day in summer/autumn.

Pasture compositions

Sward compositions in winter (June) and spring (October) are shown in Table 3. The proportion of clover in the sward decreased through the season. At each date, clover content stayed relatively constant across SR's but grass content was higher at the low SR, and herb content higher at the high SR.

Table 3 Percentage composition of sward (dry matter) during June and October at each of the five stocking rates

Stocking rate	June			October		
sheep/ha	% clover	% grass	% herb	% clover	% grass	% herb
5.9	69	26	6	41	46	13
8.9	59	36	6	35	44	21
11.1	66	20	14	40	37	24
13.6	83	10	7	40	39	31
16.3	73	11	16	41	24	35

DISCUSSION

Increasing SR from 5.9 to 16.3 sheep/ha resulted in a large and significant decline in estimated total annual pasture production (PP) from 7.54 to 4.05 tonnes/ha/yr. A linear regression was fitted to this data.

$$PP = 9.47 - 0.35 (\pm 0.064)\ SR \qquad r = 0.66,\ 38\ df,\ RSD = 1.47$$

The slope of the equation was highly significant ($P < .001$) and suggests a decline in production of annual pastures of 0.35 tonnes/ha for each additional grazing wether. Williams and Allden (1976) demonstrated an interaction between grazing pressure and plant density where total pasture production under nil grazing was unaffected by plant density whereas in a grazed sward, total pasture production was substantially reduced in swards of low density. The changes in botanical composition, observed by Davies (1965) and Rossiter (1966), were repeated here and would appear to be the principal mechanism whereby PP is reduced by SR in the long term. Poor seed set has resulted from high SR's (Sharkey et al. 1964) so this, as well as lower leaf area indices on heavily grazed swards contribute to lower production at high SR's. Previous work on annual (Carter and Day 1970) and perennial pastures (Langlands and Bennett 1973; Curll 1980) have suggested declines of 0.16 - 0.18 t/ha with each additional grazing wether on short term experiments. The results produced here are from a long term trial where soil structure changes and wind erosion have taken place as a consequence of higher SR's. It is suggested that effects in the long term may be substantially larger than those indicated by previous shorter term experiments. As pasture growth under grazing can only be estimated using the exclosed quadrat technique, small but biassed relationships between pasture growth and stocking rate will occur. Pasture growth will be underestimated as nutrient return due to urination and defaecation is limited (Curll 1980) although it will also be overestimated as the technique does not measure decay (Mannetje 1978). The net result of these two errors is unclear but is likely to depend on stocking rate and length of time areas are exclosed.

Annual wool production (GFW, kg/hd/yr) was related to total annual pasture production (APP, kg/hd/yr) by the equation: GFW = 6.924 - 1165 ($\pm$ 56)/APP (r = 0.71) df = 95, RSD = 0.734.

This equation is similar to that produced by Rowe (1982) from the original data of Carter and Day 1970 and indicates that above 0.5 t/hd/yr, woolgrowth is relatively insensitive to changes in APP but that below this level, woolgrowth becomes quite sensitive. Decreased wool production per animal at high SR is compounded by the effect of SR on PG and thus APP.

These pronounced effects of SR on PG and animal performance have been overlooked in many situations. For instance some simulation and management models do not incorporate a feed back of SR on PG and this would appear to be a serious although easily correctable omission. Additionally, many experiments where there are differences in animal pressure on pasture (SR, time of lambing) are only short term but results of this work indicate that longer periods may result in detrimental effects on stock performance. Such work needs to be re-evaluated in the light of our results.

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