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Effects of Stocking Density and Grazing Period on Herbage and Seed Production of *Paraggio* Medic

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ABSTRACT

Three stocking densities (20, 40, and 60 sheep/ha) were applied in four stocking periods (0, 2, 4, and 6 weeks) on a *Medicago truncatula* cv. Paraggio pasture. Treatments were arranged in a split plot system and compared through a completely randomised block design with four replications.Grazing period had a significant effect (P<0.001) on availability of both medic and other species separately. Total available forage (medic and other species) was significantly affected by both stocking density (P<0.05) and grazing period (P<0.001) and there was a significant interaction between stocking density and grazing period (P<0.001). Grazing period was the only factor affecting the cumulative forage production of medic and other species. Stocking density and grazing period both had significant effects on total cumulative pasture production. Pod production significantly decreased as grazing period increased. More seeds per pod were observed at low stocking density as compared with other densities. There was a dramatic reduction in seed production as grazing period increased (P<0.05).

Keywords: Forage production, Grazing, Medic, Seed production, Sheep, Stocking density.

INTRODUCTION

Pasture production is affected by grazing animals. Stocking rate and grazing method are the two most important management variables affecting herbage production, seasonal pattern of production, herbage quality, and botanical composition.

The optimum stocking rate is achieved when the pasture is neither over nor undergrazed while meeting livestock requirements. At low stocking rates selective grazing occurs and weed invasion results (Carter 1977, 1990). Consequently, considerable forage is wasted and there is little opportunity to exercise pasture management. During the peak of herbage production, quality of the herbage quickly declines unless the excess is removed for forage conservation. In many circumstances, at low stocking rates both animal and pasture growth approach their maximum potential rates, whereas at very high stocking rates both herbage production and intake per animal are severely reduced. However, there is a wide range of tolerance to grazing pressure on good, dense pastures. Carter (1977) showed clearly that pasture production increased with increasing stocking rate but eventually declined at very high stocking rates a false seasonal break and loss of plant density being followed.

Bolland (1987) compared the seed production of single-strain ungrazed and grazed swards of six *Trifolium* species with seed production of annual medic swards on a mallee soil in Western Australia. The *Medicago* species produced higher seed yields than the *Trifolium spp*. under grazed conditions. However, grazing reduced the seed yield of medics by almost 30% as compared with non-grazed treatments. At Katanning in Western Australia, Thorn and Revell (1987)

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found that severe grazing at 16 sheep/ha from 33 days after sowing to the start of flowering reduced seed yield from 582 to 362 kg/ha in all medic cultivars. Similarly, Tow (1990) in a series of grazing experiments on Jemalong medic pasture at Roseworthy concluded that there was a marked negative relationship between seed yield and stocking rate. In such circumstances high stocking rates greatly reduced seed yields. Seed production is extremely sensitive to grazing management and reduced seed production is typically the plant's first response to defoliation by heavy grazing (Tow 1981; Cocks 1988). Management practices, such as lax frequent grazing before flowering and weed control should be used to encourage pasture seed set (Cregan 1985). The main purpose of grazing management of medic pastures is to achieve the highest possible per hectare livestock production while ensuring adequate seed yield and subsequent regeneration of a dense pasture.

Most of the research work reported has concentrated on the final seed yield and only limited work has been done to understand the relationship between herbage production and seed yield also sheep production in a particular grazing season (spring or autumn). The effect of grazing management, during vegetative growth and through the flowering stage on seed production, warrants further investigations.

This experiment aims to assess the impact of grazing intensity in spring on medic performance. The main goal of the experiment is to determine the best spring stocking intensity to optimize the production of herbage and seed.

MATERIALS AND METHODS

Location and Preparation of Site

The grazing experiment was established in spring, 1991 on transitional red-brown earth soil at Korunye, South Australia, approximately 50 km north of Adelaide. The grazed pasture comprised self-regenerated *Medicago truncatula cv. Paraggio* containing some 20 percent wheat (*Triticum sativum)* from the previous crop year. Pasture components were in generative growing stage (full flowering for medics and early grain developing for grasses) when grazing started on September 30. The previous cropping history of the paddock was pasture in 1989 and wheat in 1990. On August 2, 1991, the experimental site was sprayed with Targa® to control grass weeds.

Experimental Design

Three stocking densities viz Low =20, Medium = 40, and High = 60 sheep/ha were applied for four grazing periods of 0 (control), 2, 4, and 6 weeks. Treatments were arranged in a split plot system and were compared through a completely randomised block design with four replications. Stocking densities were allocated to main plots while grazing periods considered as sub plots. Sub plots were defined by grazing exclosures within main plots. These were made up of self-supporting galvanised mesh (75 mm x 50 mm x 900 mm high) formed into a circle of 1200 mm diameter. The cages were placed in position at the end of the respective grazing periods. No cages were erected after 6 week treatment which coincided with the end of the experiment so the measurements of herbage and seed components for this grazing period was made on the main plots. The experimental area was fenced into 12 paddocks each with a water supply. To obtain the best representative estimates of parameters for each treatment, all 12 paddocks were subdivided into four notional strata for sampling.

Three sheep were assigned to each main plot, plot size being adjusted to give the appropriate stocking density. Considering the need for a minimum of three sheep per plot, main plot areas were 1500, 750 and 500m^2 for 20, 40 and 60 sheep/ha respectively.

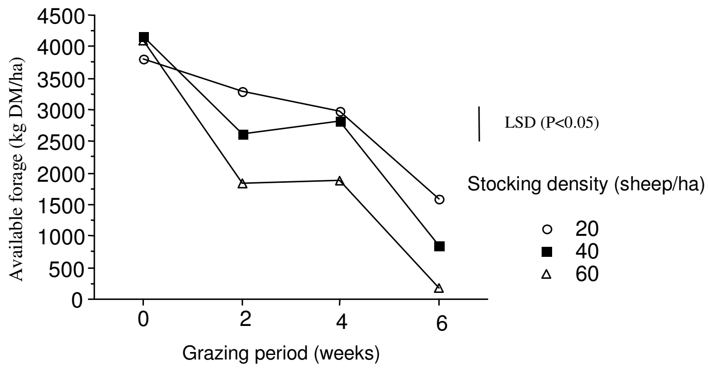

Figure 1. Availability of medic forage in response to grazing treatments.

Measurements

Herbage availability: One random 50x50 cm open quadrat cut to ground level per stratum was used to determine pasture availability (pasture on offer) on 30 September, 14 October, 28 October and 11 November, at the end of 2-week, 4-week and 6-week grazing periods respectively. An open quadrat method was used to measure seed production and dry pasture residues in the various grazing period treatments. The cut material was hand-separated into medic and other species components. Herbage samples were dried at 85°C for 24 hours in a forced-draught dehydrator.

On each harvest occasion paired sites were selected: one site was cut to determine availability and a cylindrical quadrat cage (grazing exclosure) was placed over the other site and secured by tent pegs.

Final pasture yield inside the cages: Pasture inside the exclosure cages positioned after completion of each grazing period was kept intact until the end of the growing season and seed production. Precautions were taken to prevent any dry matter loss within cages. However, there is a possibility of some minor dry leaf loss due to wind following the senescence of the pasture.

All closed-cage areas were harvested on November 12, 1991 after all pods were matured. This was done by sampling the dry material in one 50x50 cm quadrat per cage. A stiff fibre brush was used to collect all pods and dry residues from the surface. These samples were hand-separated into medic (including pods) and other species.

Seed yield inside the cages: Medic pods in samples harvested on November 12, 1991 within the cages were separated from dry residues and soil by using the organic solvent Perclean with S.G 1.62 by the method of Carter *et al.* (1977). Pod samples were oven dried at 40°C in a forced-draught dehydrator for 24 hours, weighed and counted. Sub-samples of 80 pods for dissection were taken at random from each treatment (5 pods from each cage, bulked over the four strata in each plot and the four replications). Pods were carefully pulled apart using forceps, so that the exact number and weight of seed could be determined. Yield components measured from the seed harvest were: total pod weight (kg/ha) and seed yield.

Data Analysis: Analysis of variance was conducted on all data for parameters of medic and other species using the Super Anova program. An overall analysis was made to assess possible Stocking density x Grazing period interaction. If only the stocking density was significant as a main effect, each grazing period was analysed separately to examine more closely differences between stocking densities within a grazing period. Data were transformed whenever necessary.

Table 1. Effects of grazing pressure on medic pod yield (kg/ha) at Korunye in November 1991.

	Grazing period (weeks)				
Stocking density	0	2	4	6	Mean
Low (20 sheep/ha)	917	573	499	487	619
Medium (40 sheep/ha)	977	592	325	208	525
High (60 sheep/ha)	754	331	259	142	371
Mean	883	499	361	279	
Least significant differences (5%)					
Stocking density			219		
Grazing period			117		

RESULTS AND DISCUSSION

Pasture Yield

Availability of medic herbage: The grazing period x stocking density interaction was significant ($P<0.05$) for available medic herbage (Fig. 1). The decline of c.4000 kg DM/ha over 6 weeks at 60 sheep/ha gives a crude utilization of 94% and an average decline of 1.6 kg DM per sheep/day without taking into account pasture growth during this period.

In terms of crude utilization of pasture (Carter 1965) the overall decline in pasture availability of 2226, 3312 and 3918 kg DM over the six-week period equates with crude utilization figures of 53%, 80% and 94% of the total herbage availability in control after 6 weeks for the stocking densities 20, 40 and 60 sheep/ha. Again these data do not account for pasture growth during the 6-week period.

The very dry October (8 mm) severely restricted regrowth of medic at all stocking densities and clearly affected seed production.

An availability of forage between 1000 - 2500 kg DM/ha has been suggested by Doyle *et al.* (1993) for optimum pasture growth rate during the vegetative phase in annual pasture legumes. The effects of duration and intensity of defoliation during vegetative growth on growth rate of pasture is variable from increase to substantial decrease in pasture growth and production (Collins *et al.* 1983; and Thompson *et al.* 1994). The results of this Korunye experiment showed that in a dry spring (restricted soil moisture) and during the flowering stage of pasture growth, the availability of forage was negatively correlated with increment in stocking density. Only at the low stocking density could the availability of pasture be maintained within the boundary limits suggested by Doyle *et al.* (1993), over the whole period of the experiment .

In this experiment at low stocking density (20 sheep/ha) the availability of the forage ranged from around 4000 kg DM/ha (at the start) to 1500 kg DM/ha after 6 weeks. This is an accepted amount of forage to maintain optimum herbage production (Doyle *et al.* 1993). However, in a wetter season there is possibility that light stocking densities for a short period of grazing do not utilize the available forage properly. This could have a negative impact on seed production because of low light penetration through the canopy and lower number of flowers (Muyekho 1993).

The lower availability of pasture at medium and high stocking densities was due to the combined effects of high grazing pressure and low rainfall in October.

Final pasture yield inside the grazing exclosure cages: Following grazing for 2, 4 or 6 weeks the medic-based pasture was allowed to recover in the grazing exclosures.

Table 2. Effects of grazing on medic seed yield (kg/ha) at Korunye in November 1991.

	Grazing period (weeks)				
Stocking density	0	2	4	6	Mean
Low (20 sheep/ha)	351	210	190	148	225
Medium (40 sheep/ha)	354	220	113	65	188
High (60 sheep/ha)	351	123	105	38	154
Mean	351	184	136	84	
Least significant difference (5%)					
Grazing period			51		

Both stocking density and grazing period significantly affected total yield. However, there was also a significant stocking density x grazing period interaction ($P<0.01$) for total yield. It should be emphasised that the data show final levels of pasture yield rather than true production except for the control treatment (Fig. 2).

The total herbage yield inside the cages followed very much the same trend of total pasture availability in grazed treatments. The dry conditions during the second half of this experiment did not provide conditions for pasture regrowth after being grazed for 2, 4 or 6 weeks. The physiological growing stage of pasture components (full flowering stage for medic and early grain developing for grass) at time when treatments were applied played a crucial role in this respect. Increasing stocking density in spring, under continuous grazing has differing effects on herbage production in different years (Reeve and Sharkey 1980; Birrell 1981). The total final forage availability at medium and high stocking densities followed the same trend and decreased at the rate of 500 kg per week as the grazing period increased.

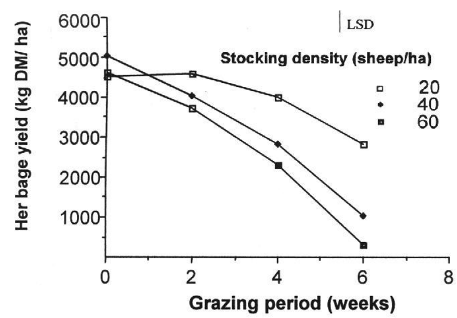

Figure 2. Total final herbage yield (medic + other spp.) inside the cages.

Seed Production

Medic pods were obtained from the same quadrats as final pasture yield measured at maturity within the grazing exclosures. Components measured included total pod yield/ha and seed yield.

Pod yield: Pod yield significantly decreased as grazing period increased ($P<0.01$). Stocking density also had an overall significant effect on pod production (Table 1). Further analysis of variance for each grazing period separately showed that there was a significant decline in pod yield with each increase in stocking density following 4 and 6 week grazing periods. Medic pod production and/or survival and consequent seed production (Table 1) was very sensitive to stocking density and grazing period. The impact of stocking density on pod production increased with period of grazing.

Seed yield: There was a severe reduction ($P<0.01$) in seed yield as grazing period increased (Table 2) but there was no significant stocking density effect or stocking density x grazing period interaction. However, the trends are obvious. The relationships between seed yield and pod density, pod yield, and medic available forage are illustrated in Figure 3, 4 and 5.

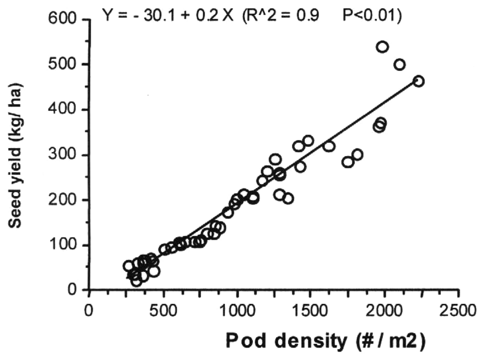

Figure 3. Relationship between pod density and seed yield.

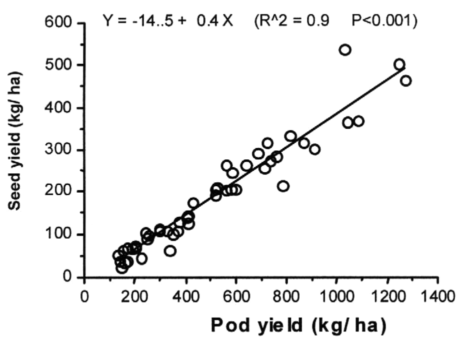

Figure 4. Relationship between pod yield and seed yield.

Seed production across all grazing periods decreased as stocking density and grazing period increased. The results of this experiment support the results obtained by Tow (1981) and Cocks (1988) who also found that seed production was very sensitive to heavy defoliation by grazing during flowering.

The time of grazing, dry climatic conditions during the experiment as well as grazing period all played a critical role in reducing the seed production at heavy stocking densities. Tow (1990) indicated that sub-optimal levels of soil moisture along with high stocking densities had a devastating effect on seed yield of Jemalong medic pasture. Similarly Thorn and Revell (1987) found that severe continues grazing beyond flowering reduced dry matter and seed yield by more than 75%. A seed reserve of at least 200 kg/ha has been suggested as the minimum to guarantee a satisfactory regeneration for barrel medic pasture (Carter 1982; Tow 1989). Under conditions of this experiment seed production after 4 weeks of grazing at low stocking density and two weeks of grazing at medium stocking density were 190 and 220 kg/ha respectively.

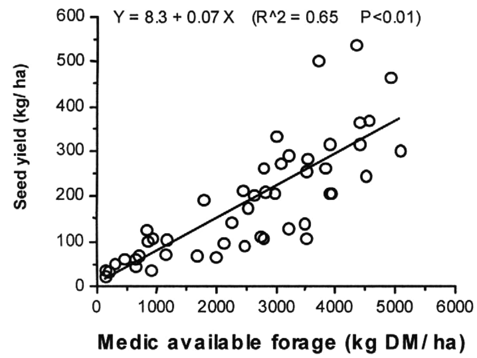

Figure 5. Relationship between medic available forage and seed yield on November 11.

Medic seed production was also related to available DM during pod and seed development (Fig. 5). In climatic conditions of this experiment (dry spring) there were there little regrowth after cages were put in place, when the availability of medic forage dropped below c. 2500 kg DM/ha, seed production was reduced to less than 200 kg/ha (Fig. 5) which is the minimum acceptable seed production in a medic grazing system which relies on medic seed reserves for self-regeneration (Carter 1982). These lower levels of forage availability and seed production occurred at high and medium stocking densities when continued for more than two weeks of grazing.

Lower grazing pressure led to greater medic herbage in spring which in turn led to greater production of pods. Under normal grazing conditions defoliation increases the rate of flower production and promotes burr production in subterranean clover (Carter 1987). In this Korunye experiment because of the late application of treatments (1 October) and due to the very dry growing season the grazed paddocks did not have opportunity for regrowth and under higher grazing pressures more developing pods were undoubtedly consumed which led to lower pod (and seed) production. For the 4 and 6 week grazing periods under all stocking densities, seed production was less than 200 kg/ha which is not enough for a successful re-establishment in the following year (Carter 1982) unless there are substantial reserves already in the soil.

CONCLUSIONS

The spring grazing experiment at Korunye in 1991 has shown that a low stocking density (20 sheep/ha) led to highest herbage availability and seed production.

The results of the experiment revealed that a minimum availability of 1500 kg DM/ha forage should be kept available all through the grazing season to provide adequate leaf area and growing points to ensure good forage production. However, acceptable seed production was obtained when availability was at least 2000 kg DM/ha.

The severity and duration of grazing especially beyond the flowering and pod development period should be closely monitored to prevent excessive consumption of flowers and newly-developed pods to ensure good seed production.

Seed production was favoured by lower stocking densities and shorter grazing periods. This supports the contention that to produce a reasonable seed yield, a minimum amount of herbage is required to provide flowering and pod-developing points and photosynthates to nourish the developing pod/seed. There was enough evidence obtained from this Korunye grazing experiment that severe grazing during full flowering and early pod developing stages, reduced seed yield to unacceptable levels.

The results of this experiment showed that grazing pressure could significantly affect pasture availability as well as pod and seed yield. In terms of high residual seed reserves, the grazing pressure of 40 sheep/ha for two weeks is superior under conditions of this experiment. These results are specific to site and growing season (in this case a dry spring). However, the experiment supports the principle that applying severe grazing pressures at flowering and pod developing stage could be detrimental to pod and seed production of medic pasture.

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اثر تراکم دام و طول دوره چرا بر عملکردعلوفه و بذر یونجه یکساله رقم Paraggio

چکیده

برای انجام این آزمایش از سه تراکم دام (۲۰ ، ٤۰ و ٦۰ گوسفند در هکتار) برای چهار دوره (۰ ، ۲ ، ٤ و ٦ هفته) بر روی مرتع یونجه یکساله *Medicago truncatula* C.V. Paraggio استفاده شده تیمارها به صورت کرتهای خرد شده در قالب طرح بلوکهای کامل تصادفی با چهار تکرار با هم مقایسه شدند. طول دوره چرا اثر معنی داری ($P<0.01$) بر روی علوفه قابل دسترس یونجه و سایر گونه های همراه (بصورت علف هرز در مزرعه یونجه) داشت. کل علوفه قابل دسترس (یونجه + سایر گونه ها) نیز به طور معنی داری تحت تاثیر تراکم دام و طول دوره چرا قرار گرفت ($P<0.01$). همچنین اثرات متقابل تراکم دام × طول دوره چرا نیز معنی دار بود ($P<0.01$). طول دوره چرا تنها عاملی بود که بر روی علوفه تجمعی یونجه (مجموع علوفه تولید شده در طول دوره آزمایش اعم از مصرف شده بوسیله دام و باقیمانده پس از پایان

آزمایش) و سایر گونه ها به طور جداگانه اثر معنی داری داشت (P<0.01). تراکم دام و طول دوره چرا بر روی کل علوفه تجمعی مرتع (یونجه + سایر گونه ها) اثر معنی داری داشتند (P<0.01). عملکرد بذر یونجه با افزایش طول دوره چرا به طور معنی داری کاهش یافت. در تراکم کم دام (۲۰ گوسفند درهکتار) نسبت به سایر تراکم ها بذر بیشتری در هر غلاف مشاهده شد. با افزایش طول دوره چرا عملکرد بذر به شدت کاهش یافت (P<0.05).