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Liveweight gain of lambs grazing 'Ceres Tonic' plantain (*Plantago lanceolata*) or perennial ryegrass (*Lolium perenne*)

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ABSTRACT

The pasture herb plantain has been successfully adapted to pastoral agriculture and, while it is readily accepted by livestock, there is little information on corresponding animal performance of regularly grazed leafy plantain forage. Liveweight gain and trace element status of lambs grazing pure plantain (*Plantago lanceolata)* swards and high endophyte perennial ryegrass (*Lolium perenne*) pastures was evaluated for 85 days during summer (December - March) under irrigated conditions. Liveweight gain was significantly ($P<0.01$) higher for lambs grazing plantain (222 g/head /day) than ryegrass swards (135 g/head/day) when both were offered at an allowance of 2.5kg DM/head/day. Despite a lower stocking rate on plantain swards, lamb liveweight gain expressed on a per-hectare basis tended to be greater for the plantain treatment (6.0 kg/ha/day) than for the ryegrass treatment (5.1 kg /ha/day) although this did not reach statistical significance. Lambs grazing pure plantain swards had significantly ($P<0.01$) higher liver copper (2250 vs 715 (µmol/kg fresh wt) and higher liver selenium (671 vs 380 (nmol/kg fresh wt) concentrations but similar vitamin B_{12} (620 vs 571 nmol/kg fresh wt) concentration compared with ryegrass-fed lambs. These results indicate that well managed plantain is able to support relatively high rates of liveweight gain in lambs through summer and elevate liver copper and selenium concentrations and, therefore, could make a significant contribution to pastures in lamb finishing systems.

Keywords: plantain; lamb; liveweight gain; trace element; perennial ryegrass; copper; selenium

INTRODUCTION

Narrow-leaved plantain (*Plantago lanceolata*) is a perennial herb species present in grasslands throughout the temperate world. The species establishes rapidly (Peri *et al*. 2000), is productive on a wide range of agricultural soils and is tolerant to drought and many common pests and diseases. The forage is mineral-rich and contains biologically active compounds, some of which may influence rumen function and reduce scouring and daggyness in lambs (Stewart, 1996). These valuable agronomic features have lead plantain (*cv*. Tonic) to become a widely used pasture herb in many parts of New Zealand and Australia

However, previous authors (Robertson *et al.*, 1995, Fraser & Rowarth, 1996) have recorded poor lamb liveweight gain on plantain swards relative to chicory, white clover and ryegrass. This may have been a result of grazing plantain at an advanced stage of maturity where seedhead made up 60% of DM on offer (Fraser & Rowarth, 1996) rather than any inherently poor forage value of vegetative growth. The aim of this experiment was to re-evaluate the animal performance achievable on plantain, relative to high endophyte ryegrass with a cultivar more suited to providing quality forage and under a grazing management which minimised seedhead build-up.

MATERIAL AND METHODS

A lamb-finishing experiment was conducted between 6 December 2000 and 1 March 2001 (85 days) at Ceres Research Centre, Canterbury on an irrigated two-year-old pure plantain seed production area. The experimental site was located on a Waimakariri silt loam soil and had an annual rainfall of 620 mm.

Three replicates of each pasture species (plantain (*cv*. Ceres Tonic) and high endophyte perennial ryegrass (*cv*. Ceres Kingston) were used in pure stands. Within the plantain seed production area plots were sprayed out (4.0 l/ha glysophate 360; Monsato (N.Z.) Limited) to establish the ryegrass treatment and these plots were resprayed in October with 1.0 l/ha of Versatill (300 g/l clopyralid as a water-soluble concentrate, Dow Agrosciences, plus Pulse surfactant) to remove plantain and clover from these plots.

Ryegrass plots were sown at 20 kg/ha in late May. Nitrogen fertiliser (50 kg/ha N as urea) was applied in early spring and mid - January. The trial received 45 mm of water through irrigation four times during the experimental period in addition to 52 mm of natural rainfall. Each replicate plot (0.68 ha) was divided into five equal areas of 0.135 ha with temporary electric fencing.

Corriedale ram lambs (n = 163), approximately 8 weeks old and 26.0 kg ± 0.22 (mean ± SEM) live weight were used in the trial. Initially, lambs were ranked according to pre-trial live weight and randomly assigned to a treatment so that treatment groups were similar in mean live weight (25.7 and 26.0 kg for plantain and ryegrass lambs, respectively). Lambs were rotationally stocked on a weekly basis and offered 2.5 kgDM/head/day. Where necessary, pastures were topped immediately after grazing. Regrowth periods were 28 days. Lambs were added or removed on a weekly basis to maintain an allowance of 2.5 kgDM/lamb/day. Lambs remaining on the treatment for the duration of the experiment were deemed sentinel lambs. The number of animals per treatment group (sentinel + additional lambs) was calculated weekly using Equation 1.

$$\text{Animals per group} = \frac{\text{herbage mass (kg DM/ha) x total area of break}}{\text{grazing period (days) x pasture allowance(kg/head/day)}} \quad (1)$$

Pre-grazing herbage mass (kg DM/ha) was measured before animals were introduced into each break, and post-grazing herbage mass was measured immediately after the animals were shifted from each break. Herbage mass (both pre- and post-grazing) was measured by harvesting 8 x 0.25 m^2 plots to ground level in each treatment. Herbage harvested from each quadrat cut was weighed, and a 500 g sub-sample was oven dried at 80°C for 48 h to determine percentage dry matter. A further 500 g sub-sample was taken for botanical analysis of stem and leaf.

Lambs were weighed on a weekly basis and only lambs that remained on treatment blocks for the 85 days of the experiment were used to analyse treatment effects. Liveweight gain was defined as the regression coefficient of the linear relationship between liveweight (kg) and days for sentinel lambs only. Treatment effects were analysed using ANOVA.

At the conclusion of the experiment, 10 lambs randomly selected from each treatment, were slaughtered and livers analysed for copper, selenium and vitamin B12 concentration.

RESULTS

Pre- and post-grazing herbage masses (Table 1) were higher for perennial ryegrass than for plantain (P< 0.01).

TABLE 1: Mean (± SEM) pre- and post-grazing herbage mass (kg DM/ha) of perennial ryegrass and plantain grazed for 12 weeks by lambs during summer and autumn.

	Perennial ryegrass	Plantain
Pre - grazing (kg DM/ha)	3100 ± 220	2020 ± 130
Post - grazing (kg DM/ha)	2310 ± 170	1070 ± 79
Apparent removal (kg DM/ha)	790 ± 80	950 ± 73

Lambs grazing ryegrass were offered more leaf but a similar amount of reproductive stem compared with lambs grazing plantain (Table 2). Leaf represented 83 and 72% of total allowance for ryegrass and plantain, respectively. Post-grazing leaf masses were lower for plantain than for ryegrass but apparent removal of leaf (pre-grazing leaf mass – post-grazing leaf mass) was similar (920 vs 720 kg DM/ha).

Pre-grazing reproductive stem mass was similar for both treatments but lambs apparently removed 44 % of pre-grazing stem in the plantain treatment while stem was rejected by lambs grazing ryegrass.

TABLE 2: Mean (± SEM) pre- and post-grazing herbage mass and apparent removal (kg DM/ha) of leaf and reproductive stem of perennial ryegrass and plantain grazed for 12 weeks by lambs during summer and autumn.

	Ryegrass	Plantain
Pre-grazing vegetative leaf	2630 ± 115	1450 ± 48
Post-grazing vegetative leaf	1710 ± 81	730 ± 54
Apparent leaf removal	920 ± 98	720 ± 75
Pre–grazing reproductive stem	460 ± 178	570 ± 130
Post-grazing reproductive stem	600 ± 205	320 ± 79
Apparent stem removal	-140 ±116	250 ± 58

Liveweight gain of lambs grazing plantain was 64 % higher than those on ryegrass (P< 0.01, Table 3). Plantain was stocked at a lower rate than the ryegrass treatment (27.2 vs 37.3 lambs/ha) but the liveweight gain per-hectare (LWG/ha) tended to be higher for the plantain treatment compared with the ryegrass treatment but was not significant.

TABLE 3: Liveweight gain per-head (LWG), liveweight gain per-hectare (LWG/ha), initial liveweight (kg) the number of sentinel animals and the stocking rate (including additional animals) in each rep for lambs grazing perennial ryegrass and plantain for 85 days during summer and autumn.

	Ryegrass	Plantain	
Sentinel animals	19 ± 1.7	10 ± 0.0	NS
SR (lambs/ha)	37.3 ± 1.1	27.2 ± 0.1	P < 0.05
Initial liveweight (kg)	25.7 ± 0.5	26.0 ± 0.2	NS
LWG (g/day)	135 ± 1.9	222 ± 5.0	P < 0.01
LWG (kg/ha/day)	5.1 ± 0.2	6.0 ± 0.2	NS

Liver trace-element status was significantly (P < 0.01) affected by grazing treatment (Table 4). Liver concentration (μmol/kg fresh wt) of copper and selenium was significantly higher in lambs after grazing plantain for 85 days compared with ryegrass. Liver vitamin B_{12} concentration was similar on both treatments.

TABLE 4: Liver concentrations (mmol/kg fresh wt) of vitamin B_{12}, copper (Cu) and selenium (Se) for lambs grazing perennial ryegrass and plantain for 85 days during summer and autumn.

Treatment	Liver B_{12} (nmol/kg)	Liver Cu (μmol/kg)	Liver Se (nmol/kg)
Plantain	620	2250	671
Ryegrass	571	716	380
Sig	NS	P < 0.01	P < 0.01

DISCUSSION

The faster rate of average daily liveweight gain for lambs grazing plantain (222 g/day) compared to ryegrass swards (135 g/day) produced an extra 7.3 kg over the ryegrass treatment over 85 days. It is likely that a greater apparent intake of both vegetative leaf and reproductive growth (Table 2) at a common herbage allowance was at least in part responsible for this difference. Burke *et al.* (2000) showed plantain had a rapid rumen degradation rate relative to perennial ryegrass. Fast rumen degradation is related to fast rumen clearance and higher intakes.

Pre-grazing pasture mass was greater for ryegrass compared with the plantain treatment and, as a consequence, supported a higher stocking rate. The plant population in the plantain plots was lower than ideal and would have contributed to the lower yield and lower stock carrying capacity of this treatment. Dryland pure-species trials (Stewart 1996) show yields from plantain were similar to those of ryegrass over the summer period. Yields from a more uniform and densely populated sward would have supported a higher stocking rate, probably more similar to that of ryegrass over the summer period. The high endophyte ryegrass in this experiment produced similar summer liveweight gain in lambs (135 g/day) compared to those reported previously in grazing experiments (98-136 g/day (Fraser & Rowarth 1996); 84-104 g/day, (Bluett *et al.*, 1997); 115-122 g/day, (Bluett *et al.*, 1999). Previous studies have suggested plantain was

only able to support similar (84-141 g/day; Fraser & Rowarth, 1996) or lower (51 g/day; Robertson *et al*., 1995) animal performance compared to high endophyte ryegrass but this work has shown plantain is able to support animal performance comparable to clover (219-233 g/day) and chicory (181-214 g/day; Fraser & Rowarth, 1996) when managed appropriately.

Fraser & Rowarth (1996) reported low animal liveweight gain on plantain swards in which 60 % of DM on offer was seed head. In the current experiment, seed head was present in both plantain (28% seed head) and ryegrass (15% seed head) swards during the trial but there was much more green leaf on offer in plantain treatments in this experiment. Under rotational grazing management with frequent (28 day interval) grazing the immature seed head was readily removed from plantain (Table 2). In contrast, under the same grazing management, ryegrass seed head was almost totally avoided by lambs.

The difference in animal performance between this experiment and that of Fraser & Rowarth (1996) is probably due to (1) a cultivar effect based on the lower propensity of Ceres Tonic to produce aftermath seed heads than Grasslands Lancelot which was used in previous experiments and (2) the stem present was grazed at an earlier stage and therefore will have been more palatable (Stewart 1996). Although grazing intervals in this experiment were only up to a week shorter than those of Fraser & Rowarth (1996) palatability of reproductive stem appears to decrease rapidly approximately 25 days after seed head emergence (Moorhead, unpublished data). Older mature leaves and hardened stem of plantain are known to be much less palatable to stock than fresh leaf material (Ivins, 1952) but reproductive stem can be highly palatable if grazed before flowering while the reproductive stem is soft (Stewart, 1996).

Both copper and selenium liver concentrations were higher in lambs grazing plantain than those grazing ryegrass. The copper liver concentration in lambs grazing ryegrass (716 μmol/kg fresh wt) was similar (811 μmol/kg fresh wt) to lambs grazing unsupplemented pasture as described by Grace *et al*. (1998). Lambs grazing unsupplemented plantain in this study had liver copper concentration higher than the lambs of Grace *et al.* (1998) lambs grazing ryegrass supplemented with 1.8 kg of $CuSO_4$/ha. Although copper herbage concentrations of ryegrass and plantain were not determined, previous authors (Adams & Elphick, 1956; Stewart 1996) and the liver concentrations in the current experiment suggest that plantain is able to achieve a better uptake of copper from soils than ryegrass. Lambs grazing plantain had elevated liver selenium concentrations compared with ryegrass-fed lambs. Deep-rooted plants like plantain accumulating greater amounts of Se in herbage than shallow-rooted plants like ryegrass (Grace, 1994). These results suggest animals on plantain have a higher copper and selenium intake than those on ryegrass in the same soil.

REFERENCES

Adams, A.F.R.; Elphick, B.L. 1956: The copper content of some soil and pasture species in Canterbury. *New Zealand journal of science and technology A* 38: 345 – 358.

Bluett, S.J.; Hodgson, J.; Kemp, P.D.; Barry, T.N. 1997: Animal evaluation of Aries HD perennial ryegrass selected for high digestibility.–*Proceedings of the New Zealand Grassland Association 59:* 245 – 249.

Bluett, S.J.; Hodgson, J.; Kemp, P.D.; Barry, T.N. 1999: Evaluation of the feeding value of Aries HD perennial ryegrass (*Lolium perenne*) II Performance of weaned lambs in summer. *New Zealand journal of agricultural research 42:* 449 – 458.

Burke, J.L.; Waghorn, G.C.; Brookes, I.M.; Attwood , G.T.; Kolver, E.S. 2000: Formulating total mixed rations from forages – defining the digestion kinetics of contrasting species.–*Proceedings of the New Zealand Society of Animal Production 60:* 9 -14.

Fraser, T.J.; Rowarth, J.S. 1996: Legumes, herbs or grass for lamb performance*? Proceedings of the New Zealand Grassland Association 58:* 49 – 52.

Grace, N.D.; Knowles, S.O.; Rounce, J.R.; West, D.M.; Lee, J. 1998: Effect of increasing pasture copper concentration on the copper status of Romney sheep.–*New Zealand journal of agricultural research 41:* 377 – 386.

Grace, N.D. 1994: Managing trace element deficiencies. New Zealand Pastoral Agricultural Institute Ltd, Palmerston North.

Ivins, J.D. 1952: The relative palatability of herbage plants. *Journal of the British Grasslands Society 7:* 43 – 54.

Peri, P.L.; Brown, H.E.; McKenzie, B.A. 2000: The effect of sowing depth on the emergence and early development of six pasture species. *Agronomy New Zealand 30:* 45 – 53.

Robertson, H. A.; Niezen, J. H.; Waghorn, G. C.; Charleston, W. A. G.; Jinlong, M. 1995: The effect of six herbages on liveweight gain, wool growth and faecal egg count of parasitised ewe lambs. *New Zealand Society of Animal Production 55:* 199-201.

Stewart, A.V. 1996: Plantain (P*lantago lanceolata*) – a potential pasture species? *Proceedings of the New Zealand Grassland Association 58:* 77- 86.

Thomas, B.; Thompson, A.; Oyenuga, V.A.; Armstrong, R.H. 1952: The ash constituents of some herbage plants at different stages of maturity. *Empire journal of experimental agriculture 20:* 10 – 22.