Two-Dimensional Monitoring of Spatial Distribution of Herbage Mass under Grazing

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This collection is currently under construction.

The XIX International Grassland Congress took place in São Pedro, São Paulo, Brazil from February 11 through February 21, 2001.

Proceedings published by Fundacao de Estudos Agrarios Luiz de Queiroz

ID # 07-06

TWO-DIMENSIONAL MONITORING OF SPATIAL DISTRIBUTION OF HERBAGE MASS UNDER GRAZING

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Abstract

Spatial distribution of herbage mass (HM) was monitored two-dimensionally during the grazing season (from May to November) in a bahiagrass pasture rotationally grazed by cattle. An electronic capacitance probe was used to estimate HM in 1464 permanent positions (50 × 50 cm) whose centres formed 1.5 × 1.5 m grids in the central 90 × 34.5 m area of the pasture. The highest mean HM was in September and October, while coefficient of variation in November. The two-dimensional charting of HM showed almost stable spatial patterns throughout the grazing season, with some patches of high HM appearing and disappearing. The development of new patches was considered to be partly due to the avoidance of areas affected by newly deposited dung pats, and the extinction of patches to the grazing down of areas where dung pats were disappearing or had disappeared. It was concluded that the technique is useful for monitoring the spatial pattern of HM, herbage production and consumption, and for associating the consumption with ingestive behavior of grazing animals.

Keywords: Electronic capacitance probe, herbage mass, spatial distribution, spatial heterogeneity, two-dimensional charting

Introduction

HM distribution in a grazing pasture is spatially heterogeneous due to dynamic interactions between plants and animals (e.g. Liu and Hirata, 1995; Hirata and Fukuyama, 1997). To develop an understanding of such interactions, it is important to monitor the spatial distribution of HM, preferably over the whole area of the pasture. However, most previous measurements of spatial pattern of sward characteristics were limited only to a small part of pastures (Jones and Ratcliff, 1983; Bakker et al., 1983; Cid and Brizuela, 1998) because it is laborious to monitor the whole area. The use of an electronic capacitance probe is an option to overcome such limitations (Hirata, 2000). In this study, using the probe, the spatial distribution of HM was monitored two-dimensionally in a one-third area of a pasture (1.1 ha) throughout the grazing season, to examine the usefulness of the technique in analyzing the spatio-temporal dynamics of plant-animal interactions.

Material and Methods

The study was conducted from May to November 1999 in a 1.1-ha paddock of a Pensacola bahiagrass (*Paspalum notatum* Flügge) pasture at the Sumiyoshi Livestock Farm (31°59'N, 131°28'E), Faculty of Agriculture, Miyazaki University, Japan. The paddock was one of five paddocks (total area =6.3 ha) rotationally grazed by Japanese Black cows and calves with supplements (fed mainly to calves). During the grazing season (about 187 days between May and November) of 1999, the paddock was grazed by 29-33 cows and 9-13 calves for five 4-6 days (22-25 May, 21-25 June, 3-7 August, 13-18 September and 22-25 October). The daily grazing was conducted as daytime grazing, from 0900 to 1600 h.

A monitoring area of 90 × 34.5 m was established in the centre of the paddock, and 1464 (61 × 24) permanent measuring positions (50 × 50 cm quadrat) were fixed so that their centres formed 1.5 × 1.5 m grids. HM at the individual positions was estimated on 15 May, 15 June, 21 July, 5 September, 17 October and 20 November with an electronic capacitance probe (PastureProbe^{TM}, Mosaic Systems Ltd., New Zealand) by measuring capacitance (corrected meter reading; CMR) as described by Hirata (2000). The CMR was measured 5 times within each quadrat, and the mean value was recorded. The CMR was converted into HM (dry matter (DM) in an area of 50 × 50 cm and above a height of 3 cm) with a calibration equation which was developed on every measurement occasion.

Results and Discussion

In all measurement dates, HM was linearly related to CMR. All the calibration equations were highly significant (r =0.959 to 0.995, p<0.001).

HM characteristics in the measurement area changed considerably with season (Figure 1). Mean HM was high in September and October (87.9 and 94.1 g DM/2500 cm^2). Maximum HM and standard deviation were high from September to November. Coefficient of variation was higher in November (0.720) than from May to October (0.314-0.508).

In contrast to such drastic changes in the HM characteristics (Figure 1), two-dimensional HM charting (Figure 2) showed relatively stable spatial distribution of HM throughout the grazing season. High HMs were located mainly in the area of 0-18 m and 46.5-67.5 m on the horizontal axis (x) and 22.5-34.5 m on the vertical axis (y) in all measurement dates. Fig. 2 also detected some bare areas in the paddock which had little HM throughout the grazing season (e.g. (x=75, y=25.5) and (x=61.5, y=22.5)). Correlation coefficients between HMs on two measurement dates were all highly significant (r=0.329-0.694, p<0.001). These results indicated that mean HM in the pasture seasonally varied, maintaining the spatial pattern which existed at the beginning of the grazing season. This stability of spatial heterogeneity in the pasture was consistent with the results from previous studies (Bakker et al., 1983; Hirata, 1998). However, in the present study, some high HM patches newly appeared in the middle and the late of the grazing season in the areas whose HM was low in the early season (e.g. (x=1.5, y=30) and (x=75, y=12) in September and November). This is considered to be partly due to the avoidance of areas affected by newly deposited dung pats. On the contrary, some areas which had high HM in the early season became low HM areas (e.g. (x=55.5, y=1.5) in November). This may be partly due to the grazing down of areas where dung pats were disappearing or had disappeared.

It was concluded that the technique is useful in monitoring the spatial pattern of HM in a grazing pasture. This measurement may also be useful for monitoring the spatial pattern of herbage production and consumption, and for associating the consumption with ingestive behaviour of grazing animals. However, this study measured HM at discretely fixed positions (50 × 50cm quadrats on 1.5 × 1.5 m grids) to quantify the spatial pattern. Such measurements have a disadvantage of omitting patches smaller than the quadrat-to-quadrat distance, though they save labor and time and give less disturbance to pasture vegetation. Further studies are therefore needed to evaluate the effect of grid size of measurements on the overall performance of the technique.

References

Bakker, J.P., de Leeuw J. and Wieren S.E. (1983). Micro-patterns in grassland vegetation created and sustained by sheep-grazing. Vegetatio **55:**53-161.

Cid, M.S. and Brizuela M.A. (1998). Heterogeneity in tall fescue pastures created and sustained by cattle grazing. J. Range Manage. **51:**644-649.

Hirata, M. and Fukuyama K. (1997). Dynamics of the horizontal distribution of herbage mass in a bahiagrass (*Paspalum notatum* Flügge) pasture with grazing by cattle. Grassl. Sci. **43:**1-6.

Hirata, M. (1998). Dynamics of the horizontal distribution of herbage mass in a bahiagrass (*Paspalum notatum* Flügge) pasture grazed by cattle: stability of spatial pattern of herbage mass. Grassl. Sci. **44:**169-172.

Hirata, M. (2000). Quantifying spatial heterogeneity in herbage mass and consumption in pasture. J. Range Manage. **53:**315-321.

Jones, R.M. and Ratcliff D. (1983). Patchy grazing and its relation to deposition of cattle dung pats in pastures in coastal subtropical Queensland J. Aust. Inst. Agric. Sci. **49:**109-111.

Liu, S. and Hirata M. (1995). Spatial distribution of herbage mass in bahiagrass (*Paspalum notatum* Flügge) pasture under grazing, resting and mowing. J. Jap. Grassl. Sci. **40:**457-470.

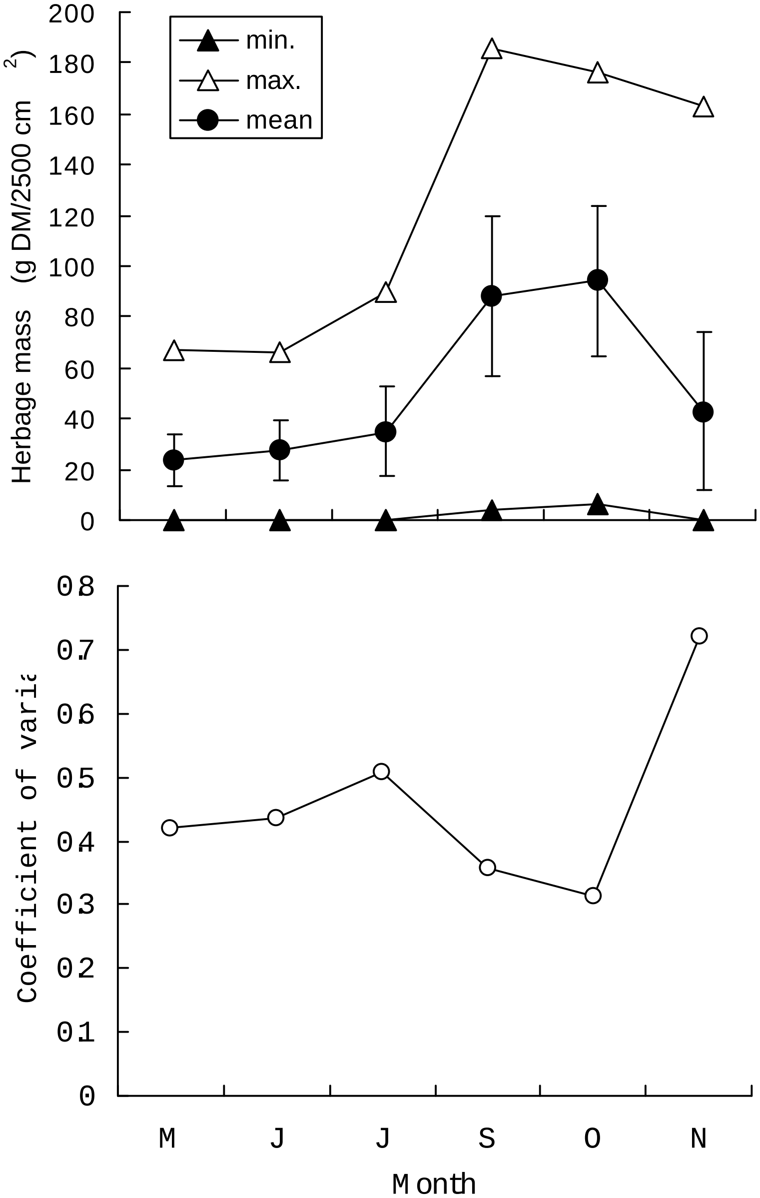

Figure 1 - Minimum, maximum and mean herbage masses and coefficient of variation in the monitoring area. Vertical bars show standard deviations (n=1464).

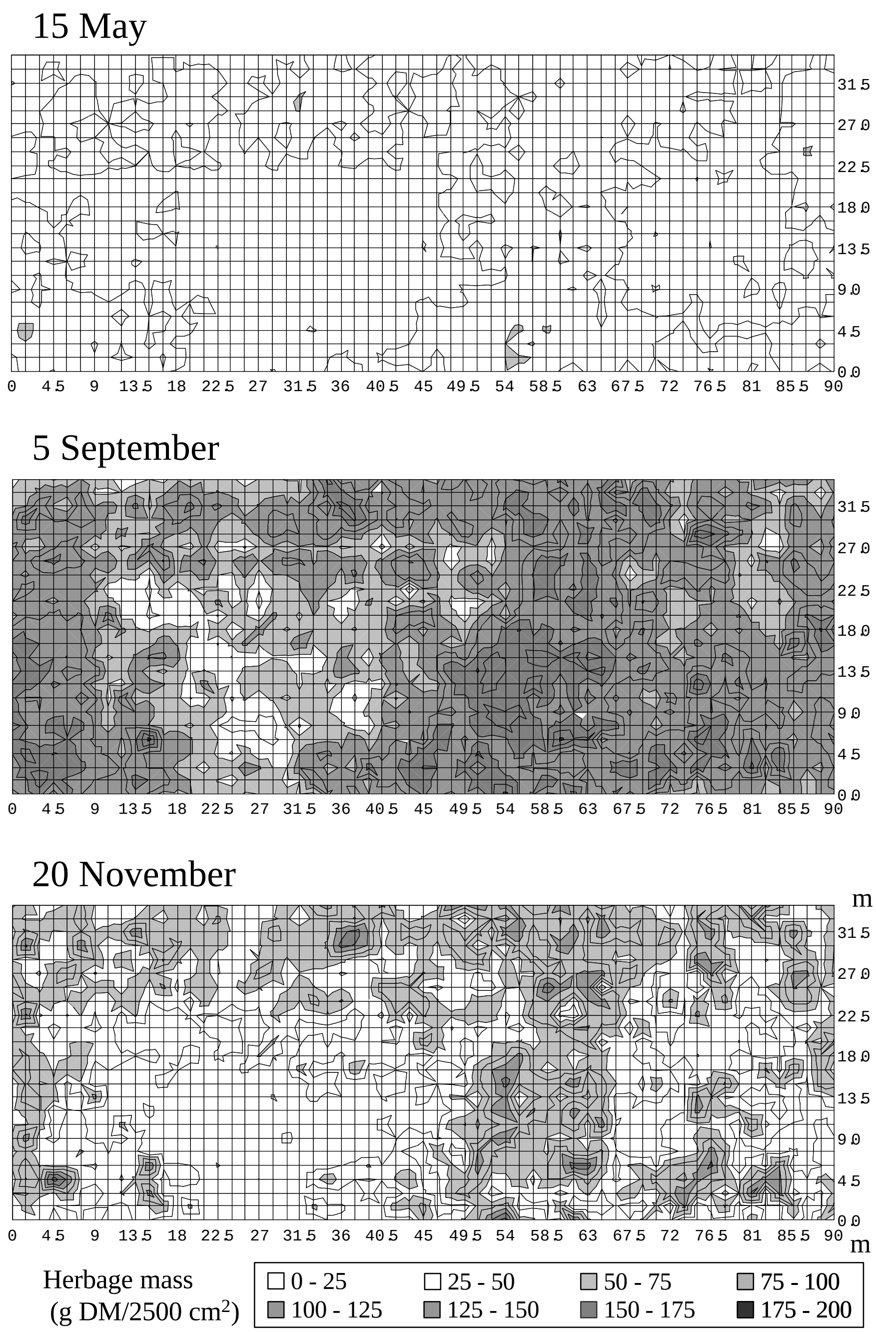

Figure 2 - Examples of two-dimensional charting of spatial distribution of herbage mass in the monitoring area illustrated in contour. Each intersection point shows the centre of permanently fixed measurement position (50 × 50 cm).