Pasture Conditions at the Initiation of Grazing to Optimize Forage Productivity: A Progress Report

A.S. Leaflet R1641

Sonja M. Kremer, research assistant,
James R. Russell, professor of animal science,
Daryl R. Strohbehn, professor of animal science,
Daniel G. Morrical, professor of animal science,
Stephen K. Barnhart, professor of agronomy, and
A.M. Cowen, sheep superintendent, McNay Research Farm

Summary

To determine environmental, soil, and sward effects at the initiation of cattle grazing in the spring on seasonal (forage accumulated during the grazing season) and cumulative (seasonal + initial forage mass) forage accumulation (FA), 15 commercial cow-calf producers from southern Iowa were selected by historical initial grazing date. At grazing initiation, twelve .25-m^2 samples were hand-clipped from each pasture and sward heights (SH) measured with a falling plane meter (4.8 kg/m^2) to determine initial forage mass. At each location, soil temperature and load bearing capacity (LBC) were measured and a soil sample was collected to measure pH and moisture, P, and K concentrations. Cumulative degree-days (base=3.85°C) and precipitation at grazing initiation were calculated from NOAA records. At the beginning of each month, at least three grazing exclosures were placed on each grazed pasture to determine monthly FA. SH in each exclosure was recorded, and a .25-m^2 forage sample was hand-clipped proximate to each exclosure. At the end of each month, SH was recorded and .25-m^2 hand-clipped forage samples from inside exclosures were obtained. In linear regressions, cumulative and seasonal SH increased with greater soil P (r^2=.5049 and .5417), soil K (r^2=.4675 and .4397), and initial forage mass (r^2=.1984 and .2801). Seasonal SH increased with earlier initial grazing dates (r^2=.1996) and less accumulated degree-days (r^2=.2364). Cumulative and seasonal FA increased with earlier initial grazing dates (r^2=.2106 and .3744), lower soil temperatures (r^2=.2617 and.2874), and greater soil P (r^2=.3489 and .2598). Cumulative FA increased with greater soil K (r^2=.4675). In quadratic regressions, cumulative and seasonal SH were correlated to soil P (r^2=.6310 and .5310) and soil K (r^2=.5095 and.4401). Cumulative and seasonal FA were correlated to degree days (r^2=.3630 and.4013) and initial grazing date (r^2=.3425 and .4088). Cumulative FA was correlated to soil P (r^2=.3539), and seasonal FA was correlated to soil moisture (r^2=.3688).

Introduction

Feeding stored feeds is the single largest cost in cow-calf production. In order to decrease the amounts of stored feed fed to the wintering cow herd, reduce diseases associated with calving in muddy drylots and diminish the possibility of soil compaction in crop fields used for winter grazing, producers commonly place their herd onto summer pastures in late winter or early spring. However, soil conditions tend to be muddy and forage supply is short during this period; therefore, long-term forage supply may be adversely affected by this practice. Unfortunately, no data currently exist quantifying the effects of the environmental, soil and forage conditions at the initiation of grazing on seasonal forage production. Therefore, information providers have little basis for recommending the optimal conditions at which to initiate grazing, and producers have little incentive for changing management practices. The objectives of this experiment were to quantify the effects of the environmental, soil and forage properties at the initiation of grazing on total forage yields, calf production, and cow reproduction in summer pastures.

Materials and Methods

Fifteen commercial cow-calf producers from southern Iowa were selected for this experiment by initial historical grazing date, pasture acreage, number of herds, interest in participation, and consistency of management. On January 1, 1997, all producers were placed on the Iowa State University-Integrated Resource Management-Standardized Performance Analysis (SPA) record program to allow economic analysis of each producer's enterprise. During the experiment, there was no attempt made to change producers' exhisting grazing management. At grazing initiation, forage samples were collected and sward heights measured in 12 random locations in each pasture on the farms to determine initial forage mass. Four samples per pasture were collected for plant morphology determination. Soil temperature and load bearing capacity were also recorded from these locations and a soil sample was collected to determine soil moisture, pH, and the concentration of soil P and K. Cumulative degree-days (base 3.85°C) and precipitation at grazing initiation were calculated from NOAA records. A minimum of three grazing exclosures were placed on each grazed pasture to determine monthly forage accumulation. At the beginning of each month, sward height of forage in each exclosure was recorded, and a representative .25-m^2 sample of the same sward height was hand-clipped proximate to each exclosure. At the end of each month, sward height was recorded and a forage sample was collected inside each exclosure to determine the previous month's forage accumulation. Forage samples were weighed and dried at 60°C, and seasonal (forage accumulated monthly during the grazing season) and cumulative (seasonal + initial forage mass) forage accumulation was determined. Data were analyzed through SAS regressions, and significance was determined at $p < .10$.

Results and Discussion

Seasonal forage accumulation (FA) decreased with increasing degree days and later date of grazing initiation and increased with increasing P concentration in the soil (Table 1). Although it might be assumed that the increase in seasonal production caused by early initiation of grazing was caused by the greater grazing season length (Figure 1), cumulative FA also decreased with increasing degree days and later date of grazing initiation. Cumulative forage accumulation also increased with increasing soil P and K concentrations. Initial soil pH, soil load-bearing capacity, cumulative precipitation, initial forage mass, and morphology index were selected to predict neither seasonal or total forage accumulation ($P > .10$).

Sward height was recorded in order to estimate growth each month and to provide a similar initial sample for each month without having to disturb plant growth. Cumulative sward height over the grazing season increased with increasing soil P and K concentrations, increasing initial forage mass, earlier initial grazing date and less accumulated degree days (Table 2). Cumulative sward height over the total grazing season increased with increasing soil P (Figure 2) and K concentrations, increasing initial forage mass, and decreasing soil load-bearing capacity. Cumulative sward height was not significantly related to initial soil temperature, soil pH, soil moisture concentration, cumulative rainfall, and morphology index ($P > .10$).

Although it was assumed that initiating grazing when pastures showed little forage growth and soil conditions were muddy would reduce forage yields, date of grazing initiation and cumulative degree days were negatively related to seasonal yield whether determined by hand-clipping or sward height measurement. Therefore, pasture forage production increased as the date of grazing initiation increased. This result may mean that early grazing is necessary to maintain forage in a vegetative and rapidly growing state throughout the grazing season. A closure relationship between pasture variables and entire forage yield may have been attained if some producers had initiated grazing of summer pastures at even earlier dates than those in this experiment.

Pasture forage accumulation increased with increasing concentrations of soil P and K. Pasture forage yields had a linear increase at soil P concentrations from 15.5 to 64.2 ppm when determined by hand clipping compared with recommendations of 16 to 20 ppm. Pasture forage accumulation as estimated by sward height, were maximized at a soil P concentration of 52.75 ppm, which is in excess of P levels which are considered optimal. Forage accumulation determined as total sward height accumulation increased linearly with soil K concentration of 134 to 324 compared to the recommendation of 91 to 130 ppm.

Implications

While these data may indicate that pasture forage yields in southern Iowa pastures may be increased by applying higher levels of P and K to pastures than previously recommended, it should be remembered that this is preliminary data from one year, and may not apply in all circumstances. If these results are also observed in subsequent years of this experiment, current P and K fertilization recommendations for pastures may need to be reconsidered.

Acknowledgment

This research was conducted with the financial support of the Leopold Center for Sustainable Agriculture, Ames, IA.

Table 1. Linear and quadratic equations predicting seasonal and total forage accumulation from initial environmental, soil, and forage properties.

	Linear			Quadratic			
Variable	Intercept	x	r^2	Intercept	x	x^2	r^2
Seasonal forage accumulation, kg/ha							
Initial grazing date	10318	-59.06	.37	20407	-230.79	.72	.41
Init. soil temperature, °C	7009.89	-305.5	.29	11491	-993.0	25.52	.31
Init. soil moisture,%	525	102.9	.03	-61467	5541.3	-117.83	.37
Soil pH	9274	-1096.5	.02	-72296	27458	-2495.74	.04
Soil P, ppm	1491	46.9	.26	-2161	2.8	.59	.27
Soil K, ppm	897	10.1	.13	-833	26.5	-.04	.14
Soil load-bearing capacity[a]	2999	-6.2	0	-17699	3640.8	-158.43	.09
Cumulative degree days	5446	-7.9	.34	7285	-21.0	.02	.40
Precipitation, cm[b]	4655	-81.3	.17	6475	-276.8	4.66	.20
Initial forage mass, kg/ha	2359	.7	.04	3316	-1.9	0	.07
Plant morphology index	3695	-526.7	.03	12598	-11100	2754.66	.12
	Total forage accumulation, kg/ha						
Initial grazing date	9441	-44.2	.21	31251	-415.4	1.55	.34
Init. soil temperature, °C	7798	-290.7	.26*	14280	-1285.3	36.92	.30
Init. soil moisture,%	1882	87.0	.03	-46784	4355.7	-92.49	.23
Soil pH	6013	-362.8	0	-72173	27008	-2392.23	.01
Soil P, ppm	2254	54.2	.35*	2843.4	15.4	.52	.35
Soil K, ppm	1459	12.2	.20	-4547.3	69.2	-.13	.26
Soil load-bearing capacity	6846	3151.4	.06	-12660	3181.4	-149.30	.14
Degree days	5675	-5.5	.17	9054	-29.6	.04	.36
Precipitation, cm	4720	-96.4	.04	8115	-402.6	8.7	.15
Initial forage mass, kg/ha	3025	1.1	.10	3573	-.4	0	.11
Plant morphology index	3593	220.2	.01	8136	-5176.1	1405.91	.03

[a]Determined with a shear vane.

[b]Cumulative precipitation from Jan. 1 to grazing initiation.

*P≤.05.

P≤.10.

Figure 1. Initial date vs. seasonal forage accumulation, kg/ha.

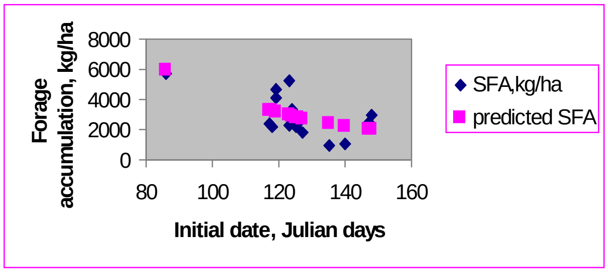

Table 2. Linear and quadratic equations predicting seasonal and total cumulative sward height from initial environmental, soil, and forage properties.

	Linear			Quadratic			
Variable	Intercept	x	r^2	Intercept	x	x^2	r^2
	Seasonal sward height accumulation, kg/ha						
Initial grazing date	73.8	-.37	.20	-4.5	.97	-.006	.23
Init. soil temperature, °C	48.8	-1.54	.10	93.9	-8.47	.257	.13
Init. soil moisture,%	15.7	.53	.01	-466.3	42.81	-.915	.29
Soil pH	27.6	.09	0	-516.9	190.72	-16.662	.01
Soil P, ppm	11.2	.55	.50	-.3	1.31	-.010	.53
Soil K, ppm	-3.1	.15	.44	-7.2	.19	.00009	.44
Soil load-bearing capacity[a]	45.5	-1.52	.03	-218.3	44.98	-2.020	.23
Cumulative degree days	45.8	-.06	.23	42.0	-.03	.00004	.24
precipitation, cm[b]	37.4	-.44	.07	19.3	1.51	-.046	.11
Initial forage mass, kg/ha	15.5	.02	.28	16.2	.01	.000001	.28
Plant morphology index	38.2	-6.93	.08	-14.5	55.72	-16.324	.13
	Total sward height accumulation, kg/ha						
Initial grazing date	47.2	-.10	.01	89.2	-.81	.0003	.02
Init. soil temperature, °C	49.0	-1.06	.04	86.6	-6.83	.215	.06
Init. soil moisture,%	13.4	.92	.03	-228.8	22.16	-.460	.10
Soil pH	-20.4	9.54	.02	-216.2	78.10	-5.992	.02
Soil P, ppm	16.1	.61	.54	-6.61	2.11	-.020	.63
Soil K, ppm	.4	.17	.47	-43.2	.59	.0009	.51
Soil load-bearing capacity	84.3	-4.31	.22	-45.5	18.56	-.993	.26
Cumulative degree days	39.7	-.01	.02	51.9	-.10	.0001	.05
Precipitation, cm	32.3	.30	0	28.6	.52	-.01	0
Initial forage mass, kg/ha	23.5	.01	.20	20.6	.02	.000004	.20
Plant morphology index	28.9	4.11	.03	-20.4	62.68	-15.259	.06

[a]Determined with a shear vane.

[b]Cumulative precipitation from Jan. 1 to grazing initiation.

$P \leq .10$.

Figure 2. Cumulative sward height accumulation vs. soil phosphorus.

$y=-4.45+1.96x-0.02x^2$